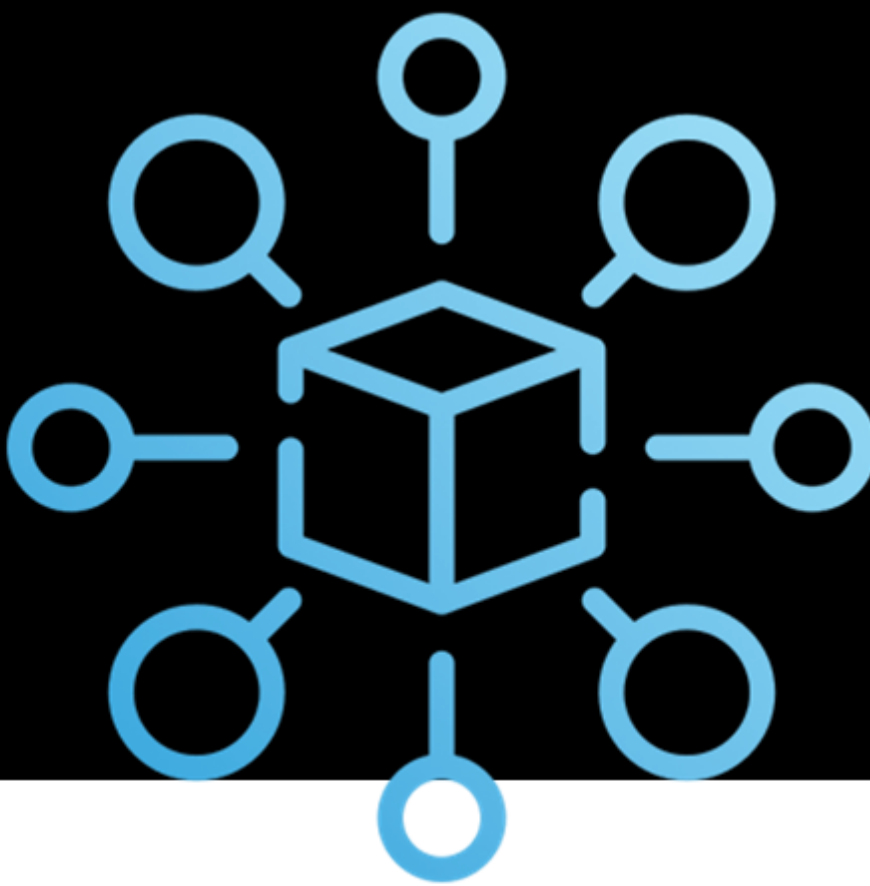# DATA SPACE 4.0

A European Common Digital Manufacturing Infrastructure and Data Space Pathway for Connected Factories 4.0 Data Value Chain Governance

Digital Europe EU Grant Agreement: 101083939

Title	D4.1 - Pan-EU Data Platform Catalogue
Document Owners	VDI TZ
Contributors	ENG, INNO, UNP
Dissemination	PU
Date	15.10.2024
Version	2.0

Document History

14/12/2022	Table of Content
13/01/2023	ENG's contribution
09/02/2023	Second Draft of the document, with VDI TZ and INNO Contribution
20/02/2023	ENG' contribution on Conclusions, WPL Review
22/02/2023	Internal Review
15/10/2024	Final version

Document Fiche

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Internal Reviewers	SQS
Workpackage	WP4 - Manufacturing Data Space Building Blocks and Blueprint Certification
Task	T4.1 - Pan-European Manufacturing Data Platform Inventory
Nature	OTH
Dissemination	PU

Project Partners

Participant organisation name	Acronym
ASOCIACIÓN DE EMPRESAS TECNOLÓGICAS INNOVALIA	INNO
FONDAZIONE POLITECNICO DI MILANO	FPM
COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES	CEA
VDI TECHNOLOGIEZENTRUM GMBH	VDI TZI
BRAINPORT INDUSTRIES COOPERATIE UA	BPI
INDUSTRIE 4.0 OSTERREICH – DIE PLATTFORM FUR INTELLIGENTE PRODUKTION	PIA
CHALMERS TEKNISKA HOGSKOLA AB	CHALMERS
INTERNATIONAL DATA SPACES EV	IDSA
ENGINEERING - INGEGNERIA INFORMATICA SPA	ENG
UNPARALLEL INNOVATION LDA	UNPARALLEL
SOFTWARE QUALITY SYSTEMS SA	SQS
FIWARE FOUNDATION EV	FIWARE
IDC ITALIA SRL	IDC ITALIA
SIEMENS AKTIENGESELLSCHAFT	SIE

Executive Summary

This report shows up the status of Task 4.1 "Pan-European Manufacturing Data Platform Inventory". It is not aimed to erect a further list of data platforms and data marketplaces but rather to characterize existing initiatives by aligned criteria. Therefore, a first characterization profile for data platforms and data marketplaces was elaborated based on outcomes of the Open DEI project, the Big Data Value Chain concept[3] and outcomes of the Boost 4.0 project[4]. This first draft of the catalogue shall be further elaborated in cooperation with existing data platforms and data marketplaces in a two staged process. On the first stage a request for expression of interest (EoI) was published including a small set of characteristics, to be self-assessed by the requested initiatives. The data platforms and data marketplaces, who express their interest, will be invited to co-create the final characterization profile for self-assessment during a dedicated workshop within the DSSC Flagship event on Mar 21st-23rd, 2023. All existing data platforms and data marketplaces will be then invited to self-assess and to complete thereby the inventory.

Keywords: Data platform inventory, characterization of data platforms, aligned criteria for self-assessment

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Acknowledgement

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Abbreviations and Acronyms

Acronym	Meaning
ADRA	Artificial Intelligence, Data and Robotics Association
BDVA	Big Data Value Association
DFA	Digital Factory Association
DS	Data Space
DSBA	Data Spaces Business Alliance
DSSC	Data Space Support Centre
DVC	Data Value Chain
EDIH	European Digital Innovation Hub
EIT	European Institute of Innovation and Technology
EFFRA	European Factories of the Future Research Association
IDSA	International Data Space Association
MaaS	Manufacturing as a Service
MiE	Made in Europe
P4P	Process for Planet
RA	Reference Architecture

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1 Introduction

Data Space 4.0 is an Industry 4.0 community born project to create a shared pathway and governance model for scale-up of cross-sectorial data spaces for manufacturing. One of its key objectives is to provide a comprehensive, highly usable and unified manufacturing data space 4.0 data platform inventory, that will include all data platforms based on the concept of Big Data Value Chain definition, as identified framework followed by the BDVA Task Force 10 "Data Sharing Spaces". The inventory will show practical examples of Data Spaces already in place. Doing this, Data Space 4.0 does not want to set up a 'simple', further list of lighthouse projects and initiatives but to characterize the data spaces in manufacturing by criteria to be developed in the project (see report regarding Deliverable D2.1 "Hierarchical and non-hierarchical predictive maintenance and agile value network data spaces requirements") and based on the OPEN DEI position paper "Design Principles for Data Spaces".

1.1 Document Structure

This report shows up the background and set up of the project, introduces the approach of the planned Pan-EU Data Platform Catalogue regarding the objectives, expected results and the context analysis, describes the Landscape in which the estimation will take place and gives an impression of the possible impact of the catalogue, ounce it is in place.

Therefore, the report provides a description of the project background and composition (see Chapter ¡Error! No se encuentra el origen de la referencia.). In this chapter it is underlined that t he methodology of the current project is closely linked to the design principles for Data Spaces, elaborated by the Open-DEI Task Force 1 "Data Sharing Spaces", to ensure the consistence to previous activities and to set up a solid foundation for deployment of future data spaces and data value chains in manufacturing as well as in related sectors.

Chapter 3 provides the Pan-EU Data Platform Catalogue objectives, its expected results and the approach, methodology and context analysis foreseen to the identification of the catalogue main criteria. It is pointed out that the Pan-EU Data Platform Catalogue aims on a highly usable and unified manufacturing data platform inventory to set the basis for the

identification of relevant uses cases in dynamic asset management, predictive maintenance, and agile supply chains (see 3.1). Thus, the knowledge transfer on technologies, techniques and methodologies needed to enable data sharing and exchange in a data space and across different communities and sectors will be supported. To fulfill this objective, it is strived to enrich the existing information on existing lighthouse projects and data sharing initiatives (see 3.4), by characterization based on the OPEN DEI Position Paper "Design Principles for Data Spaces" regarding the building blocks for data platforms and data marketplaces (see 0) as well requirements of European Data Space Community1. This chapter is completed by a context analysis of existing initiatives and related catalogues.

These activities will take place in a complex landscape of existing lighthouse projects and initiatives on European and national level. Against this background, some examples for strategic initiatives and the planned process to involve these stakeholders is sketched in Chapter 1. The engagement strategy and action plan aim on the co-creation of criteria with the contributors and final users coming from European SMEs, DIHs/TEFs as well as the main representatives of European manufacturing and digital community. The criteria of the catalogue will be developed by their valuable contributions. Therefore, a two staged process is proceeded. At first the collection of Expression of Interest (EoI) by the main strategic stakeholders was started on December 9, 2022 (First results are described in the section 4.2). Based on the expressions of interest, it has been organized the participatory and co-creative validation activity during a dedicated Workshop (March 21 to 23, 2023), to identify the Catalogue main pillars, its objectives, and the main elements to be identified by the inventory.

In Chapter 0 the strategic impact of the catalogue regarding the users and providers view of data platforms and marketplaces is presented. The main assumption is that the catalogue will mobilize European and National R&I community and foster the emergence of entrepreneurial mind-sets and disruptive business models in the Data Economy across Europe by the enabled knowledge transfer on technologies, techniques and methodologies needed to enable data sharing and exchange in a data space and across different communities and sectors. Thus, it will mobilize European and National R&I community and foster the emergence of entrepreneurial mind-sets and disruptive business models in the Data Economy across Europe. To ensure Data Space 4.0 success, measures to maximize the

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[1] The requirements must be also determined within the project (Task 2.1).

impact are figured out in section 5.2: based on the adopted AIDA model, the key pillar will be the dissemination via strategic initiatives on European and national level.

The descriptive part of the report is rounded by the conclusion in Chapter 6, where the connection between the Pan- EU Data Platform Catalogue and the European Data Strategy and its policy objectives has been described.

In Chapter 6, the actual capabilities of the Data Space 4.0 cataloguing tool is shown and the possibilities for SMEs and EDIHs to exploit and contribute to the knowledge base is also discussed in Chapter 7.

In Annex finally screen shots of the complete requests for expression of interest are shown, to give an impression which information the existing data platforms and data marketplace are asked to provide. This request has been additionally extended with an online survey of EDIH TWG DiM capacities for building data-driven solutions and technologies.

2 Data Platform Catalogue Approach

2.1.1 A balanced approach

The methodology adopted by Data Space 4.0 is closely linked to the framework developed by the EU Commission for the development of industrial data spaces and the most recent outcomes and recommendations from Open-DEI Task Force 1 (Design Principles for Data Spaces). This methodological approach is developed in order to ensure that all the building blocks are considered.

The methodology is therefore designed not only to drive in the short term (after 12 months) the deployment at EU scale of data spaces 4.0 but also to set in the long term the solid foundations for deployment of future manufacturing data spaces and data value chains in other areas of critical value and high economic common interest to manufacturing industry. It is organized in 3 phases covering the collection phase, definition phase and bootstrapping-transfer phase.
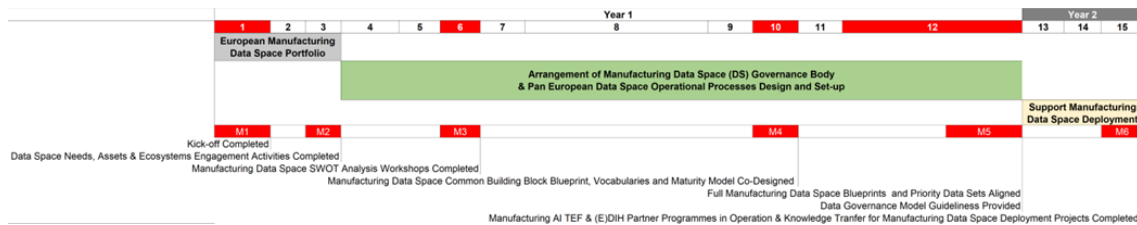
Figure 1 Three phases methodology

Each of the partners contributing to Data Space 4.0 will distribute the efforts accordingly across the 3 phases.

Phase 1 (M1-M3): Comprehensive European Manufacturing Data Space Portfolio Building.

This first phase is focused on the analysis of the needs for hierarchical and non-hierarchical manufacturing data space support for distributed data ecosystem building and distributed value network data space operations, strong business incentive identification for manufacturing collaborative data-driven operations and resiliency value (uses case). This phase will consolidate a rich and solid portfolio of European manufacturing data space assets as well as pan-European of needs and drivers for the future deployment of manufacturing data space that will populate various catalogues and inventories supported by the Digital

Factory Alliance (DFA). This phase focuses on addressing the why and what of a value data ecosystem. This first phase involves activities which will define the Multi-stakeholder Governance Framework and Federated Data Ecosystems definition carried out by INNO, VDI, CEA, PIA and BPI. Together, they will prepare the requirement elicitation for hierarchical and non-hierarchical Data Spaces Interoperability as well as the Governance Models for Predictive Maintenance and Agile Supply Chain scenarios. In parallel, FPM, IDC and SIEM will prepare the Business Models for Data Economy in Manufacturing. Then, activities for the Building Blocks and Blueprint Certification (VDI, UNP, ENG, SQS) as well as the Data Prioritization and Roadmapping (VDI, FPM, IDC, INNO) will be kicked off.

Phase 2 – (M04-M12): Arrangement of Manufacturing Data Space Governance Body & Pan European Data Space Operational Processes Design and Set-up.

This phase deals with the coordination activities for facilitating a Manufacturing Data Space Governing Body (the Data Space 4.0 Alliance) and establishing pan European solid operational procedures for the co-design and deployment of data spaces 4.0 and data value networks. The expected outcome of this phase is a set of models for the governance of manufacturing data spaces, technical blueprints and digital platform evolution roadmaps addressing instantiation of common data space enablers (cloud-edge continuum and basic data space services) as well the data space 4.0 continuum specific building blocks and prioritized data sets aligned with the proposed blueprints. This phase focuses on the methods and steps to implement the how to grow a value data ecosystem with the deployment of manufacturing data spaces. During this phase and in order to achieve the expected outcomes, different activities such as: national/European workshops, events, interviews, surveys, open dialogues, etc. will be carried out. During this second phase the partners will work on the aforementioned activities related with requirements, governance models will be continued as well as the kicked off activities in the definition of building blocks and blueprint certification along with the prioritization and roadmapping of data. Since the nature of this phase is to establish a robust procedure to deploy data spaces across Europe counting on multiple stakeholders, the activities of coordination with the Data Space Support Centre (DSSC) will play a vital role. The DSSC will be the entity in charge of putting together the best practices and defining common requirements across Europe for data spaces.

Phase 3 – (M13-M15): Support Manufacturing Data Space Deployment.

This phase should ensure that proper knowledge transfer towards Digital European manufacturing data space projects is achieved, providing the needed support in the ramp-up and bootstrapping of their manufacturing data space deployment activities. This phase will ensure that the DIH and TEF partner programme is fully operational and that an MVP data space toolkit is made available to all EU industry 4.0 national initiatives. The main outcome of this phase is not only to adopt the EU DATA SP4CE assets by the DE data space deployment projects but also to obtain the assessment at the national Industry 4.0 initiative level of the replicability of the EU DATA SP4CE pan-European manufacturing data space co-design, deployment and operation methodology to address other areas of future economic interest for manufacturing data spaces. During this phase, INNO, CHAK, IDSA and FPM will take care of the dissemination and community scale up activities putting in place actions to broaden the Data Space 4.0 outreach.

These 3 phases will be implemented in the context of a variable geometry principle that would allow to build an EU strategy and approach while fully respecting national and regional smart specialization considerations. along with the EU level dissemination and awareness raising activities (open dialogues, deep dives, workshops and tech talks), EU DATA SP4CE considers in parallel a set of national level activities driven by the Industry 4.0 national initiatives to be realized among all stakeholders (suppliers, vendors, partners, governments, etc.).
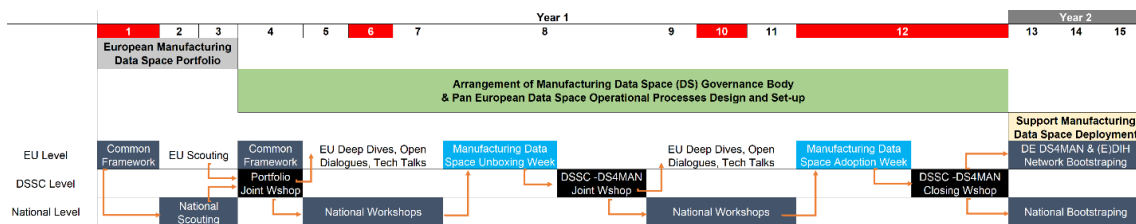
Figure 2 Three phases variable geometry principle.

This approach will allow the EU DATA SP4CE principles and common framework to better respond to the challenges encountered while, in parallel, will allow for as many industrial partners as possible (regardless size and location in EU) to become part of the EU manufacturing data ecosystems, building their own data value chains and/or joining ecosystems building those on top of similar design principles and federated common European data space foundations, services and infrastructures.

3 Pan-EU Data Platform Catalogue

Disruptive business models are emerging from data-sharing practices and opportunities. The creation of Data Spaces across Europe enhances the concept at the basis of a Data Economy, where data-sharing and openness, whenever relevant, ensures collaboration across sectors and value chains. Nevertheless, despite the collaboration is kick-starting across Europe and at an international level, several bottlenecks – legal, technical, economic, governmental, and societal – can be identified to ensure their adoption. The Pan-EU Data Platform Catalogue will support the identification of the main industrial Data Platforms and relevant Data Marketplaces deployed and running at the European level. The Catalogue will therefore help to compare the different available platforms and support a comprehensive analysis of the complex landscape, with a specific focus on technical bottlenecks and key elements and components available to ensure Data Spaces' adoption.

3.1 Objectives

Data Space 4.0 main objective is to enhance community collaboration and set the foundations for a harmonized roll out and scale-up of a sovereign European manufacturing data space continuum. Among its specific purposes, the Data Space 4.0 will leverage a comprehensive, highly usable and unified manufacturing data platform inventory.

The Pan-EU Data Platform inventory will:

- refine the former collected knowledge on data- platforms;
- screen and analyze relevant industrial marketplaces;
- support the knowledge transfer on technologies, techniques and methodologies needed to enable data sharing and exchange in a data space and across different communities and sectors;
- provide the wider research and innovation community with aggregated information;
- mobilize European and National R&I community acting in the field of the Common European Data Spaces, with the specific focus on Manufacturing value chains, related sectors, and data value chains;

- foster the emergence of entrepreneurial mind-sets and disruptive business models in the Data Economy across Europe.

Our single one-stop-shop of pan- European Industrial Data Platforms inventory will set the basis for the identification of relevant data platforms and data marketplaces to realize dynamic asset management, predictive maintenance, and agile supply chains.

Different sectors will be mapped within the Industrial Data Platforms inventory, namely automotive, process industries, ICT and electronics industries, textile, and mechanical engineering.

3.2 Expected Results

The Pan-EU Data Platform Catalogue will provide a unified profile for platform characterization, connected with the modular Data Space 4.0 blueprint deployment to be defined within the project scope and in collaboration with the Data Space Support Centre (DSSC).

The Catalogue will showcase the relevant examples of data platforms and data marketplaces available in the European industrial ecosystem, and acting at a European or National level.

The inventorial process will bring to a harmonized catalogue, describing the type of the available data platform and its related Business Process positioning, the application domain, the maturity level, the core enabling technologies, relevant building blocks and main platform architecture.

It will detail Data Platforms capabilities, in terms of automation, platform autonomy, interoperability capabilities, modular approach, and further characteristics of the data platforms and relevant marketplaces.

The European Data Platform Catalogue will be strictly correlated to the OPEN DEI Design Principles, the Data Value Chain high level activities and the manufacturing process life-cycle stages.

The Data Space 4.0 initiative supports the creation and the consolidation of an inventory of existing data platforms for manufacturing, which will support the identification of main practices and a blueprint for manufacturing-specific building blocks. This will contribute to the long-term convergence of existing and new data-related initiatives in manufacturing.

Exemplary criteria of the desired catalogue

To give an illustration, how the desired catalogue could be structured, Table 1 gives an impression, based on just exemplary criteria. The final set of criteria will be aligned with the contributing data platforms and data marketplaces in a two staged process (see 4.2).

			DP1	…	DPn
General Information		Data Platform – Name	DP1	…	DPn
		Data Platform – Short Marketing Description	…		
		Data Value Chain high-level activities supported	…		
		Position in Smart Business Processes	…		
		Maturity level			
		Number of Organizations involved			
		Fixed/ dynamic pool of organizations			
		National/ International Organizations involved			
		Private/ public Data Platform			
		Hierarchical/ Non-Hierarchical Network			
		Sectorial/ Cross-Sectorial			
		FURTHER…			
Technical requirements	Connectivity for data platform participants	Simple connectivity for data platform participants by…			
		Secure connectivity for data platform participants by…			
		cost-effective connectivity for data platform participants by…			
	User friendliness	Accessibility by…			
		Easy Adaptability by…			
		FURTHER…			
	Autonomy	Location of servers and services…			
		Confidentiality of data by…			
		FURTHER…			
	Sustainability	Social sustainability by…			
		Ecological sustainability by…			
		FURTHER…			
	Interoperability	Use of standard technologies and concepts like…			
		Use of Cross-industry federated infrastructure by…			
		Modular approach for/ by…			
		FURTHER…			
	Costs	Technical concepts supporting scalability of costs			
		Maintenance and support costs			
		FURTHER…			
Business/ Economic requirements		Ensuring clear, compatible economic options for data space participants by…			
		Alignment of objectives in the DVC among the partners by…			

	FURTHER…			
Legal requirements	Ensuring clear compatible regulations/ general terms by…			
	Legally binding and also trust among participants establishing by…			
	Support merging of different national/ international/ European regulations by…			
	Political independence by…			
	FURTHER…			

Table 1 Exemplary criteria of the desired catalogue

These exemplary criteria will be updated on forehand of discussion with data platforms and data marketplaces (while DSSC Flagship event to be held on Mar 21st-23rd, 2023, see 4.2) by the outcomes of the currently running requirement elicitation (see D2.1 "Hierarchical and non-hierarchical predictive maintenance and agile value network data spaces requirements).

3.3 Approach and Methodology

The analysis is based on the OPEN DEI Position Paper "Design Principles for Data Spaces"[2], where a first definition of data platforms and data marketplaces has been provided:

- *Data Platforms*, enabling effective solutions for data sharing and exchange as well as for engineering and deployment of data exchange and processing capabilities.
- *Data Marketplaces*, digital ecosystems where data providers can offer and data consumers can request data, as well as data processing applications.

The Data Spaces Technical Building Blocks, as depicted in Figure 3, enable the implementation of the Data platforms and marketplaces. The variety of technical components will be indeed mapped, with two major objectives: i) to showcase solutions currently available in the market; ii) to ensure that the available components support the technical building blocks necessary to establish a Data Space.

Figure 3 The Open DEI Data Spaces Building Blocks

Moreover the inventorial process will categorize the Data Platforms based on the Data Value Chains high-level activities as detailed in Figure 4, providing valuable information on the innovative tools and methodologies used to support the Platform' main activities.

As an analytical tool, the value chain's principle can be applied to the information flows, to understand the value creation of data technology. In a Data Value Chain, information flow is described as a series of steps needed to generate value and useful insights from data[3].
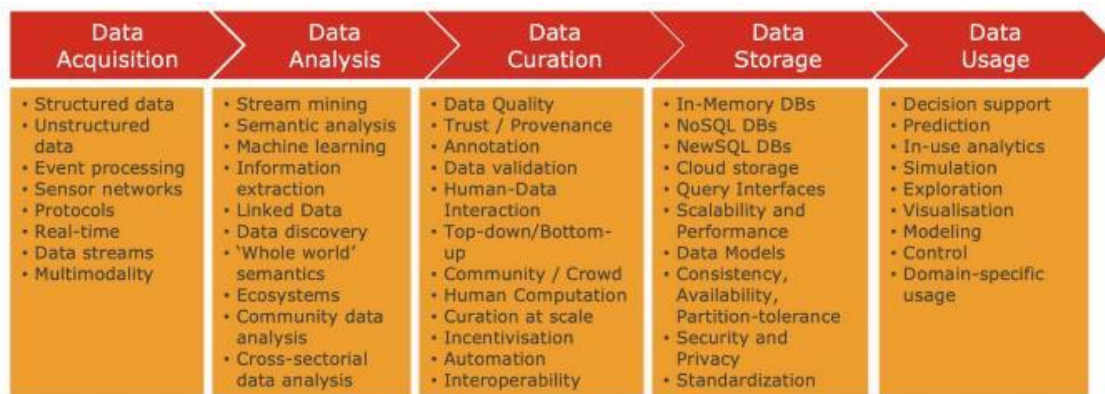
Figure 4 The Data Value Chain high-level activities

Therefore, the Data Value Chain high-level activities represent the main features developed to create value from a dataset. Enabling a Data Platform with specific data services based on

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[3] The Big Data Value Chain as described within Curry, E. (2016) "The Big Data Value Chain: Definitions, Concepts, and Theoretical Approaches", in Cavanillas, J. M., Curry, E., and Wahlster, W. (eds) New Horizons for a Data-Driven Economy: A Roadmap for Usage and Exploitation of Big Data in Europe. Springer International Publishing.

the Data Value Chain activities may amplify traditional data value, by enhancing its resiliency, availability, or validity. It is therefore essential to scan Data Platforms' services following the Data Value Chain high level activities.

Lastly, a focus on the main manufacturing industries' business processes should be envisaged. It has been therefore looked at the previous experience of the Boost 4.0 initiative and its Reference Architecture[4], as depicted in Figure 5. The RA consists of core horizontal layers, which represent a collection of functionalities/components performing a specific role in the data processing chain. The Business layer forms the overall manufacturing business solution across five process life-cycle stages (Smart Digital Engineering, Smart Production Planning & Management, Smart Operations & Digital Workplace, Smart Connected Production, Smart Maintenance & Service).
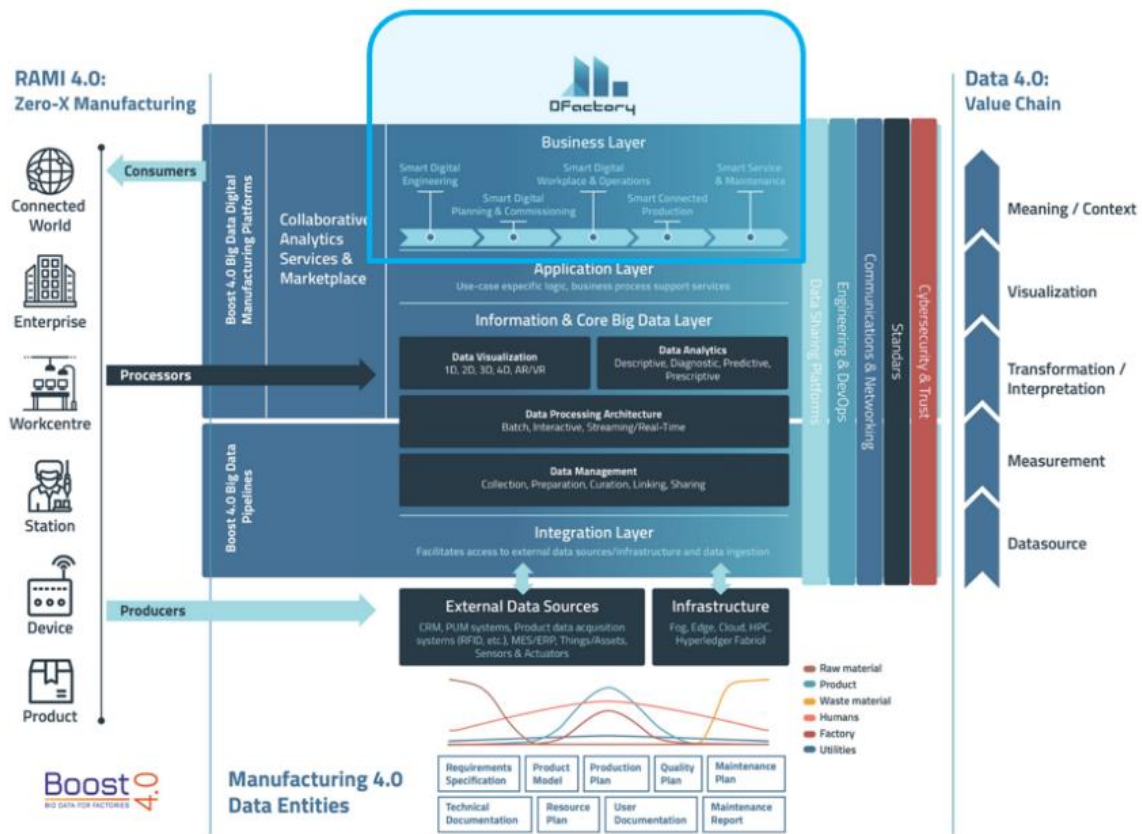

Figure 5 The Boost 4.0 RA

As detailed in the Boost 4.0 Reference Architecture, the identified process life-cycle stages are:

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[4]Boost 4.0 project G.A. n. 780732 (2019) *D2.5 – BOOST 4.0 Reference Architecture Specification v1*, available in https://boost40.eu/deliverables/

- *Smart Digital Engineering*: Collaborative engineering for redesign of the manufacturing system and product considering feedback from data acquired.
- *Smart Planning & Management*: Digital factory modelling and simulation, including access through cloud to modelling for process improvement and control, for example using machine learning methods.
- *Smart Operations & Digital Workspace:* Multiple source data mining and real time advanced analytics at the Factory and Value Network Levels.
- *Smart Connected Production:* Manufacturing as a Service (MaaS) for digital twin manufacturing capability extension across the entire value chain.
- *Smart Service & Maintenance:* Servitisation of maintenance, where data is shared between manufacturer and maintenance supplier.

3.4 Context Analysis

The mapping exercise takes advantage of relevant initiatives and related catalogues, which represent the available examples of inventorial processes devoted to Industrial Data Platforms and Marketplaces. Data Space 4.0 focused its attention on the following existing catalogues: i) the Innovation Portal[5] provided by the European Factories of the Future Research Association (EFFRA); ii) the Data Spaces' Radar[6] developed by the International Data Spaces Association (IDSA); iii) the ZX Marketplace[7] under development by the Digital Factory Alliance (DFA).

EFFRA Innovation Portal

In 2016, the contractual public-private partnership Factories of the Future, represented by the Research Association EFFRA, published the "Factories 4.0 and Beyond"[8]. This document described the research and innovation roadmap defined in the context of EFFRA. It sets the basis for describing the concept of Industrial Data Platforms within the manufacturing ecosystem, by providing a definition of the Digital Manufacturing Platforms[9]:

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[5] EFFRA Innovation Portal available in https://portal.effra.eu/home
[6] IDSA Data Space Radar available in https://internationaldataspaces.org/adopt/data-space-radar/
[7] DFA ZX Marketplace available in https://digitalfactoryalliance.eu/zx-marketplace-intro/
[8] EFFRA (2016) *Factories 4.0 and Beyond*, available in https://www.effra.eu/factories-future-roadmap
[9] European Factories of the Future Research Association's definition of Industrial Data Platforms available in https://www.effra.eu/digital-manufacturing-platforms

"Digital manufacturing platforms are enabling the provision of services that support manufacturing in a broad sense. The services that are enabled by digital manufacturing platforms are associated with collecting, storing, processing and delivering data. These data are either describing the manufactured products or are related to the manufacturing processes and assets that make manufacturing happen (material, machine, enterprises, value networks and – not to forget – factory workers."

In mid-2017, EFFRA launched its *Innovation Portal*, a valuable repository capable of collecting and promoting the Factories of the Future PPP projects, their results, and demonstrators. It currently shows 143 mapped results and 125 mapped demos, as depicted in Figure 4.
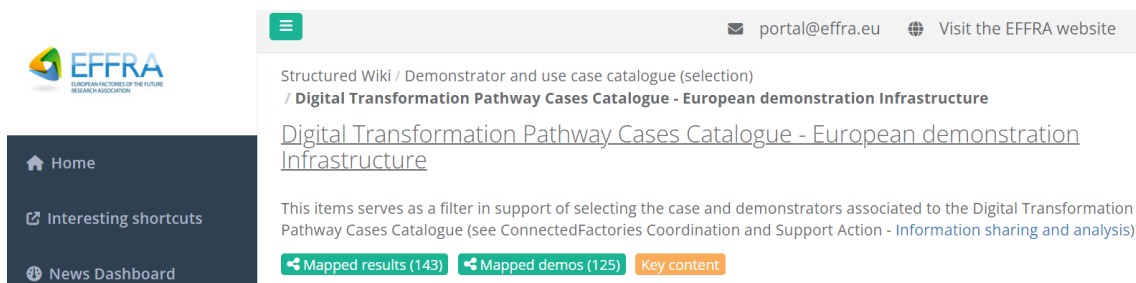

Figure 6 The EFFRA Innovation Portal

With its searchable function, the Innovation Portal sets structured wiki items, which enable the user to look for "Digital manufacturing platforms – data platforms (Technologies and enablers)" related results.
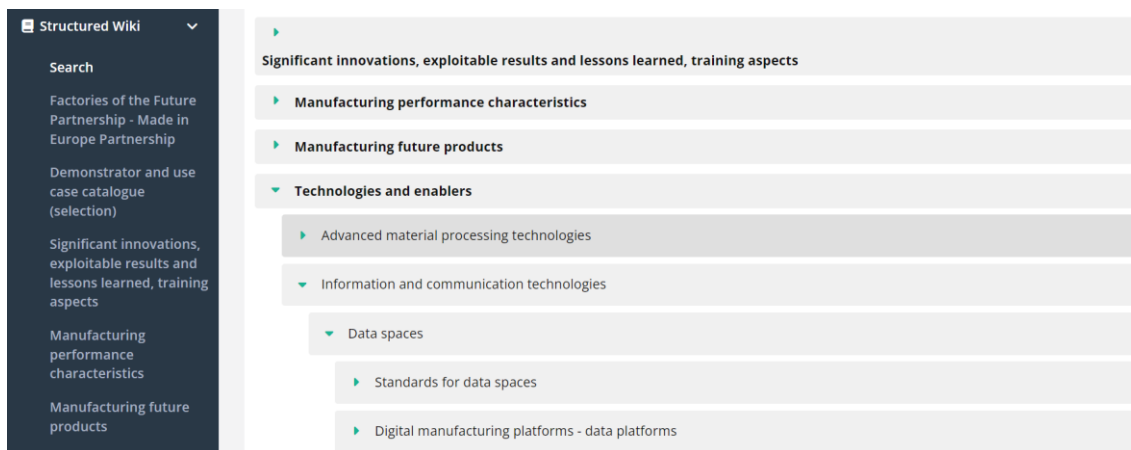

Figure 7 The EFFRA Innovation Portal – Wiki Items

As depicted in Figure 7, the Innovation Portal enables the user to look for data reflecting specific Pathways, with specific reference with the Data Space Pathway, divided into *DS Pathway – Maturity Levels* and *Data Space Pathway – Data oriented challenges dimensions*.
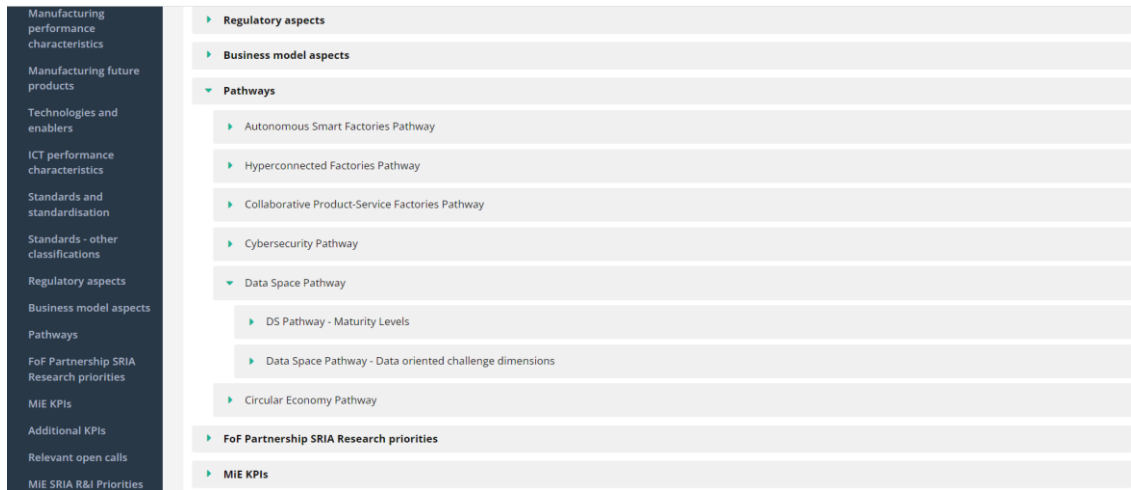

Figure 8 The EFFRA Innovation – Pathways

Despite the valuable collection of key assets, innovative results and dedicated European funded projects in the field, the EFFRA Innovation Portal sets the basis for the inventorial process on Industrial Data Platforms, by aggregating the main target community. Nevertheless, a solid analysis on the main available assets, the data platform maturity level and relevant Data Value Chains high level activities, remains as a main objective of the Pan-EU Data Platform Catalogue under Data Space 4.0.

IDSA Data Space Radar

The International Data Spaces Association (IDSA) is a coalition of more than 130 member companies, with the aim to develop the International Data Spaces adoption strategy, including their governance model, business models and certifiable software solutions.

Since September 2021, IDSA hosts the Data Spaces Radar, to actively scout potential data spaces and provide a unique overview of their evolution on a global level. The Data Spaces Radar is an initiative driven by IDSA in the framework of the Data Spaces Business Alliance[10]

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[10] The Data Space Business Alliance launch available in Big Data Value Association website https://www.bdva.eu/bdva-fiware-gaia-x-and-idsa-launch-alliance-accelerate-business-transformation-data-economy

(DSBA) and the collaboration among relevant stakeholders, as FIWARE Foundation, Big Data Value Association (BDVA) and GAIA-X European Association for Data and Cloud.

- The Data Space Radar provide an overview of the ecosystem by collecting the following information:
- The Data Spaces, as a domain-specific or cross-domain ecosystem of trusted partners that share data to benefit of the added-value potential in different use cases.
- The Use Cases, as two or more organizations that apply an IDS-based solution to a real-life challenge for sharing data in a sovereign way.

The provided information is defined on the basis of the Maturity levels of the Data Spaces and Use Cases, starting from the "*Lead In*" level – where there is still the conceptualization of the idea, the opportunities and the relevant challenges that can be addressed with sovereign data sharing – to the "*Live*" level, where the use case and/or the data space is running live and data flows in a sovereign way between data sharing parties.

The Data Space Radar is currently providing an overview of almost 25 Data Spaces and 54 Use Cases, divided per domain and maturity level, as described in Table 1.

Table 2 IDSA Radar mapped ecosystem on Dec 30th, 2022

IDSA Radar	Maturity Level				
Domain	Data Space vs. Use Case	Lead in	Case Committed	Pilot	Live
Supply Chain	Data Space	1	1	1	2
	Use Case			4	
Smart Cities	Data Space			1	
	Use Case	1	1	2	
Manufacturing	Data Space			2	
	Use Case	1	2	9	1
Energy	Data Space		1	1	
	Use Case	3	1	2	
Mobility	Data Space	1			2
	Use Case		1	2	
Automotive	Data Space		1		

	Use Case		1	2	
Cross Domain	Data Space	3	4	3	1
	Use Case	1	7	10	3
TOTAL	Data Space	5	7	8	5
	Use Case	6	13	31	4

The Data Spaces Radar provides a unique overview of the Data Spaces ecosystems across Europe. Nevertheless, information among the data platforms and data marketplaces building blocks might be provided in a more detailed way, so to identify the innovative tools and methodologies used to support the Platform' main activities.

DFA ZX Marketplace

Born in 2021, the Digital Factory Alliance aimed at creating an International Trusted Community, to foster knowledge sharing and industrial collaboration, and speed up data-driven digital transformation of the manufacturing industry.

It fosters trusted data-driven digital manufacturing product and platform integration, by promoting the use of Artificial Intelligence Technologies and Data Intelligence to strive for Zero X Manufacturing Environments.

Figure 9 The DFA ZX Marketplace
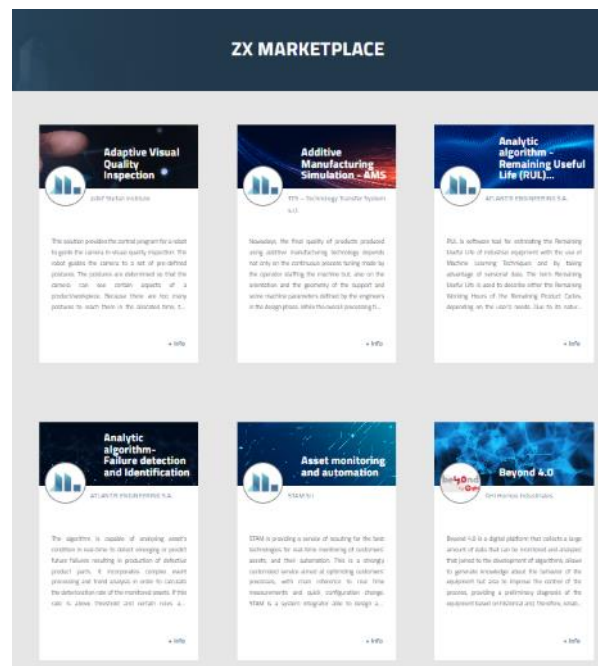
It further supports the ecosystem by accessing the latest knowledge, trends and deployable products and components via its Innovation Catalogue and its ZX Marketplace. The latter represents a valuable platform where effective digital solutions and new business opportunities are provided for end-users, technology providers, testing and experimental factories and digital innovation hubs.

A digital solution is described by providing its summary, product overview and its features, its potential applications and relevant use cases. It is developed to ensure the access to the latest digital solutions for the zero-defect manufacturing processes, where data-driven services and technologies are described as a digital solution per se, and not in relation to the access to an ecosystem or even to a data-driven added value, which are the main features behind a Data Space, a data platform and a data marketplace.

4 A complex Landscape

The landscape of actors in Europe that deal with data spaces and digital supply chains is diverse and includes both private and public actors.

Some of the key private actors include companies from various industries that are specialized in developing technologies and solutions for data sharing spaces and digital supply chains, such as IT companies, consulting firms and financial companies.

Public actors include regulatory authorities responsible for implementing laws and regulations in data spaces and digital supply chains, as well as European institutions like the European Commission and the European Data Protection Agency.

There are also many scientists and researchers that deal with developing technologies and solutions for data spaces and digital supply chains, as well as non-profit organizations that focus on promoting data privacy and security.

Lastly, a variety of initiatives and projects supported by these actors have been launched to promote the development of technologies and solutions for data spaces and digital supply chains.

4.1 Strategic Initiatives to be involved

As described in 3.4, there are already many existing catalogues of Industrial Data Platforms and Marketplaces. The listed initiatives in the existing catalogues of Industrial Data Platforms and Marketplaces should be included in the request for contribution respectively to express their interest (EoI) in first phase of the action plan (see 4.2) to contribute to Data Space 4.0 by joining the discussion on categories and by self-assessment according to the outcomes of the discussion.

Additionally, the Data Space 4.0 project partners[11] are asked to provide the survey to their members and stakeholders. By that the biggest portion of Digital Value Chain masterminds deriving from National Initiatives, networks of European SMEs, DIHs/TEFs as well as the main

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[11] see list of project partners on page 3 of this report

representatives of European manufacturing and digital community will be reached to ensure that no relevant, currently not listed Industrial Data Platform and Marketplace is missed.

On the European level, there are a variety of initiatives and projects that deal with data platforms and data marketplaces. Some of the key ones include:

- Gaia-X, federated system linking many cloud service providers and users together in a transparent environment that will drive the European data economy of tomorrow.

- The European Open Science Cloud (EOSC) is a European initiative aimed at creating a virtual environment for researchers, scientists and innovators to access, store and manage large amounts of data.

- The Big Data Value Association (BDVA) is a European industry association that brings together companies, research organizations and public authorities to promote the development of data-driven innovation in Europe.

- FIWARE provides an open-source framework of components for the development of digital twin solutions in different domains (Cities, Manufacturing, Energy, Agri-food etc.) and an extensive community of members from industry, academia and SMEs adopting and promoting FIWARE technology worldwide. Many of existing data platforms rely on FIWARE components, especially those ones which context and real time management is the key value. The data platforms from FIWARE members can be found in FIWARE marketplace.

- The European Commission has also established the Open Data Portal, which provides access to a wide range of datasets produced by the European institutions. The portal is designed to promote the reuse of data, and to support the development of new data-driven services and applications.

- The Data Innovations Initiative is a European initiative aimed at supporting the development of new data-driven business models. The initiative provides funding and support for the development of innovative data-driven services, applications and platforms.

- EIT Digital is a European initiative aimed at promoting the development of digital technologies and the digital transformation of European industry. The initiative supports the development of data platforms, data-driven services, and the integration of data into various industrial sectors.

- The European Cloud Marketplace (DOME project under the Digital Europe Program) aims at being the single access point for trusted cloud and edge services, building blocks deployed under the Common Services Platform for Public Administrations and software and data processing services developed under EU programs.

- The UNPARALLEL IoT-Catalogue.com is an explorer for innovations in IoT applications and technologies; it is a web-based tool that enables to pick & choose IoT solutions; it is a wide repository of knowledge, use cases, contacts, etc. of the Internet of Things.

- IDSA is a European initiative focusing on the creation of data spaces and their standardization.

- MyData Global is a European NGO, focusing on privacy and the security of personal data, that is also active in initiatives regarding data sharing.

- The Data Sharing Coalition is a collaborative project focusing on the creation of data sharing use cases, on gathering knowledge on data spaces and related topics, and on community building.

On the other hand, each Member States of the European Union also proceeds initiatives and projects on data spaces and digital value chains. Examples are:

- Catena-X in Germany: The project aims to create a secure and efficient data infrastructure that allows companies in the automotive sector to share and use data more quickly and easily.

- National Open Data Portals like Deutsche Bahn (Germany), GovData - Data Portal for Germany (Germany), Open Data Austria – data.gv.at (Austria)

- PLANETIC, the Spanish technological platform for the adoption and promotion of the digital technologies, holds a dedicated working group on data and participates actively in data spaces related initiatives at national level.

- Spanish national hub of GAIA-X is highly supported by national and regional governments, and actively endorsed by the Official Data Office of Spain. The hub is also launching the Tourism data space at European level.

- The Gaia-X Hub Austria is supported by two federal ministries and encompasses various data related organizations like the Austrian Institute of Technology (AIT), OSSBIG, ICT Austria, Eurocloud, the Austrian Platform Industry 4.0 or the Data Intelligence Offensive (DIO).

- EuProGigant is an Austrian-German initiative for building Gaia-X compliant use cases in the manufacturing industry.

4.2 Engagement strategy and action plan

An important pillar of the Data Space 4.0 is the interaction and partnership with strategic initiatives and relevant projects in the field of zero-defect manufacturing and agile supply chains.

According to the D7.1 "Dissemination, communication and engagement plan", the engagement strategy should be focused depending on the target group and its positioning on Data Space 4.0 mapped stakeholder's diagram, displayed in Figure 8.
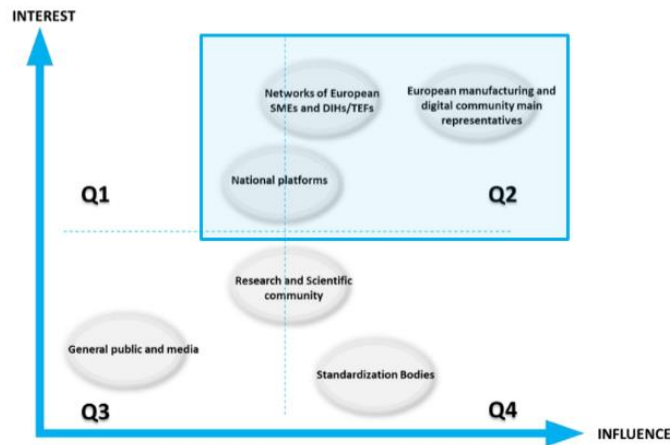

Figure 10 Data Space 4.0 mapped stakeholder's diagram

According to the Diagram, the target groups represented in the Quadrant 2 should be actively involved in the project activities, satisfied with its progress, representing both contributors and final users of the Data Space 4.0 results. Therefore, it seems essential that the inventorial process related to the Pan-EU Data Platform Catalogue relies on a co-creation process, where the valuable contributions provided by the strategic initiatives previously mentioned represent the main pillars of the inventorial process, to be furtherly analyzed, developed and deployed in the frame of the project activities.

The strategy behind Data Space 4.0 Communication and Engagement actions lays on the assumption that the deployment and take-up of emerging Data Platforms and Marketplaces can be fostered only if multiple stakeholders are engaged in the process. The AIDA main

framework has been adapted to the engagement strategy, to support an inclusive and participatory approach devoted at establishing the community around the Data Platform catalogue, at ensuring the connection between the Catalogue and relevant activities and related results of the project, and at supporting the subsequent deployment of the Data Platform knowledge and identified content.

The co-creation process has been divided in two main phases:

- the first collection of Expression of Interest by the main strategic stakeholders, and
- the participatory co-creative activity, organized during a dedicated Workshop, to identify the Catalogue main pillars, its objectives, and the main elements to be identified by the inventory (Action).

The Expression of Interest

The Expression of Interest collection has been supported via a survey (Annex I –Request for Expression of Interest), divided in two main sections:

a. Platform dedicated section, to provide information on the Data Platform marketing description, its alignment with the Data Value Chains, with the Smart Business Processes as described in Boost 4.0, and with the Maturity level of the Data Platform.

b. Contact Details section, to ensure future collaboration with the actor filling the survey with its contact details and the agreement to take part in the inventorial process.

The *Expression of Interest (EoI)* has been described as the first main phase to take part in the co-creation process dedicated to the Pan-EU Platform Catalogue.

The survey has been launched during the "Data Spaces in Manufacturing" Webinar, held on Dec 7th, 2022. Furthermore, it has been disseminated in the frame of the IDSA ecosystem building call held on Dec 19th, 2022.

During the first iteration, the collected results were represented by 15 EoIs.

The Expression of Interest collection identifies clearly a majority of respondents describing their related Data Platforms, instead of Data Marketplaces.

The Data Value Chains high level activities are represented mainly by Data Acquisition, Data Analysis and Data Usage services. A lower presence of Data Curation and Data Storage services is depicted in Figure 11.

🔵 Data Acquisition		12
🟠 Data Analysis		11
🟢 Data Curation		6
🔴 Data Storage		8
🟣 Data Usage		14

Figure 11 Data Value Chain activities in the collected EoIs

Figure 12 shows the Smart Business Process represented in the collected Expression of Interests, identifying the Smart Connected Production and the Smart Digital Engineering as the most relevant Business Processes supported by the Industrial Data Platforms replying to Data Space 4.0 Survey.
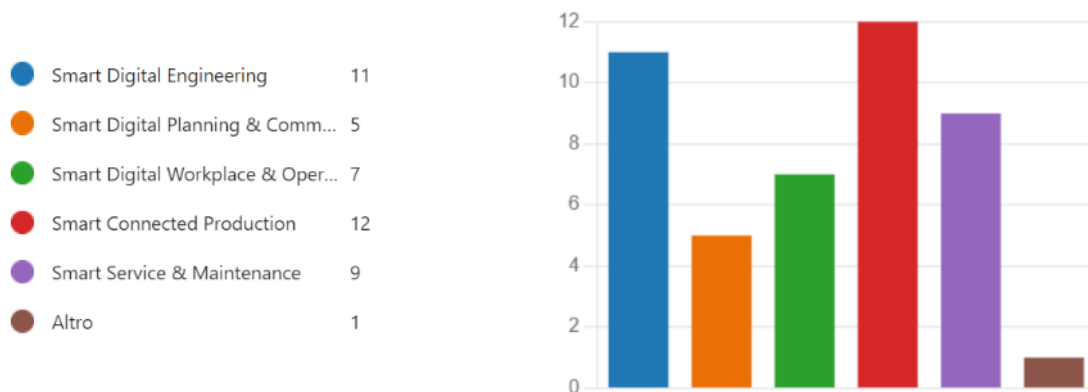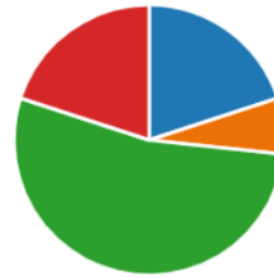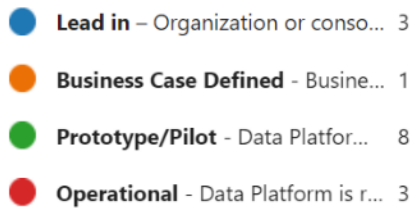
🔵 Smart Digital Engineering	11
🟠 Smart Digital Planning & Comm...	5
🟢 Smart Digital Workplace & Oper...	7
🔴 Smart Connected Production	12
🟣 Smart Service & Maintenance	9
🟤 Altro	1

Figure 12 Smart Business Processes in the collected EoIs

Figure 13 lastly identifies the Maturity Level of the collected Data Platforms, clearly showing the innovative dimension of the European Industrial data platforms, categorized in a piloting phase.

Lead in – Organization or conso...   3
Business Case Defined - Busine...   1
Prototype/Pilot - Data Platfor...   8
Operational - Data Platform is r...   3

Figure 13 Data Platforms Maturity Levels in the collected EoIs

The co-creation workshop

The second phase of the engagement strategy relies on the co-creation of the Platform elements, via the organization of a dedicated workshop open to the strategic initiatives identified in the Q2 of the mapped stakeholders' diagram, and the collaborative partners replying to the Expression of Interest.

The organization of a dedicated workshop is based on the following objectives:

- Framing the challenges and benefits of the Catalogue, through a dedicated analysis of the baseline and the direct involvement of the community.
- Connecting stakeholders, through a dedicated engagement campaign tailored to the identified stakeholder groups. This action will address the refinement of existing stakeholders' databases and communities and the setting up of a new list of participants to be further involved.
- Co-creating the Catalogue's main elements and supporting exploitation measures through the direct engagement of Data Space 4.0 community. This multi-stakeholder engagement will ensure that all perspectives are taken into consideration and their needs, ideas and visions are addressed by Data Space 4.0 co-creation process. This action will generate Data Space 4.0 outcomes- being indeed actionable, acceptable and responsible.

A Preparatory Package will be provided to the invited experts, containing the following:

- Workshop' objectives, plan and logistic details;
- A brief analysis of the collected Expression of Interests;
- A presentation of the available inventories at European level;

- An initial draft structure of the Pan- EU Data Platform Catalogue, to be discussed during the workshop.

The workshop will be organized in conjunction with the DSSC Flagship event to be held on Mar 21st-23rd, 2023.

The Workshop will be an opportunity for collaboration among Data Space 4.0, the Data Space Support Centre and the active Data Space Preparatory Actions.

5 Strategic Impact

5.1 Make use of the Catalogue

The catalogue of the available data platforms and data marketplaces, characterized by various factors such as application domain, maturity level, core enabling technologies, relevant building blocks, main platform architecture, community requirements and other criteria – to be aligned with the stakeholders (see 4.2)-, will have a significant strategic impact. As in chapter 3.1 introduced the catalogue as one-stop-shop will support the knowledge transfer on technologies, techniques and methodologies needed to enable data sharing and exchange in a data space and across different communities and sectors. Thus, it will mobilize European and National R&I community and provide the wider research and innovation community with aggregated information. That will foster the emergence of entrepreneurial mind-sets and disruptive business models in the Data Economy across Europe.

From a user's point of view the catalogue will provide many advantages, improving his decision making in which data spaces to invest (e.g. regarding interfaces, conversion of data formats etc.) based on the level of maturity, core technologies, and other relevant factors. The catalogue can also help users to align their data initiatives with their overall business goals, by identifying data platforms and data marketplaces that align with their specific requirements[12], needs and priorities. Caused by the one-stop-shop for information of the catalogue and the therein continuous classification and description of the offerings and approaches this decision will be accelerated. In addition, the catalogue can help to increase competitiveness and demand for the products or services being offered. Furthermore, the catalogue can foster collaboration across the community by linking users with complementary capabilities and use cases via best choice data platform offers. The included inventory of data marketplaces will help users to find data, users need for their work, more quickly and easily.

From a provider's point of view the knowledge about the characteristics of existing data platforms and data marketplaces allows them to learn from the experiences and best

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[12] For requirements on data spaces in manufacturing see D2.1 "Hierarchical and non-hierarchical predictive maintenance and agile value network data spaces requirements"

practices of others. This can help avoid potential mistakes and increase the efficiency of their own data platform and data marketplaces by adopting the most used technologies and tools, the relevant building blocks and interfaces that are successfully used. Thus, providers can ensure that their platforms are compatible and interoperable with other platforms. This can support the exchange of data and information between platforms, allowing for greater collaboration and data sharing. This will support the willingness of the users to use the offers, as this will avoid restrictions for the user due to the choice of a data platform or a data marketplace. This can promote the willingness for adoption and integration of data platforms into existing workflows and processes.

5.2 Catalogue Distribution and Measures to maximize DS 4.0 impacts

According to the D7.1 "Dissemination, communication and engagement plan", the AIDA model has been adopted to ensure that all its pillars have been fulfilled:

- *Awareness:* The Data Platform Catalogue has been launched during the first project communication activities at M1, by its advertisement as a main result of the project via its website: https://manufacturingdataspace-csa.eu/

- *Interest*: The inventorial process has been furtherly advertised through dedicated communication activities at M2 and M3 to ensure a wider interest to the activity:
  - Dedicated news on the Digital Factory Alliance website: https://digitalfactoryalliance.eu/join-the-data-space-4-o-data-platform-inventory/
  - Dedicated launch in the frame of the Webinar on "Data Spaces in Manufacturing", co-organized by the European Commission and EFFRA Association, held on December 7th, 2022
  - Dedicated promotion via the IDSA "ecosystem building event", held on December 19th, 2022

- *Desire and Action*: The Data Platform inventorial process has been structured in the two main phases: the first collection of Expression of Interest (Desire), and the co-

creation workshop, capable to further develop the Catalogue main features and the first outcomes of the inventorial process (Action).

The described activities correspond to the C&D activities specified in the D7.1 and summarized in Figure 10, where the Q2 mapped stakeholders will be the main recipients of the organization of dedicated workshops in the framework of major events, tailored dissemination materials and customer-oriented media interactions, via social and the project newsletter (see Figure 12).

QUADRANT	ENGAGEMENT ACTIVITIES					
	Events	Workshops	Periodic meetings and reviews	Dissemination materials	Social media interactions	Newsletters
Q1	X			X	X	X
Q2	X	X	X	X	X	X
Q3					X	X
Q4				X	X	X

Figure 14 Data Space 4.0 Engagement Activities

A dedicated promotional campaign will be launched to ensure the visibility and deployment of developed Pan- EU Data Platform Catalogue, envisaging the following activities:

- A News published in the project website
- A recorded presentation of the Catalogue structure and its main results
- Presentations and dedicated promotional e-mail campaigns to strategic initiatives and relevant multipliers.

Relevant multipliers and strategic initiatives

The cooperation with strategic initiatives and relevant multipliers seems essential to the success of the Data Platform Catalogue deployment. Among those, Data Space 4.0 identifies the following:

- EU Partnerships & Industrial Associations: Made in Europe (MiE) and EFFRA, Artificial Intelligence, Data and Robotics association (ADRA), Big Data Value Association (BDVA), EIT Manufacturing, EIT Digital, Process4Planet, International Data Space Association, etc.

- European initiatives: Open DEI, Connected Factories, ICT Innovation for Manufacturing SMEs (I4MS), Smart Anything Everywhere (SAE), Digital Factories part of the Digital Factory Alliance, etc.
- European funded projects under the following Topic Calls:
    - HORIZON-CL4-2021-DATA-01-01: Technologies and solutions for compliance, privacy preservation, green and responsible data operations
    - HORIZON-CL4-2021-DATA-01-03: Technologies for data management (AI, Data and Robotics Partnership) (IA)
    - HORIZON-CL4-2021-TWIN-TRANSITION-01-07: Artificial Intelligence for sustainable, agile manufacturing (AI, Data and Robotics – Made in Europe Partnerships) (IA)
- European Digital Innovation Hubs – EDIHs (Italian MADE, CIM 4.0, etc.); or relevant Innovation Hubs (GAIA X Hubs; etc.)
- National & Local initiatives (e.g. CATENA-X, WATCHMAN national project, etc.);
- European and national multipliers (Horizon Europe and Digital Europe Programme National Contact Points, European and National Observatories, etc.) or local stakeholders (e.g. Consorzio Intellimech, SITRA, etc.).

Key Performance Indicators

The European Data Platform Catalogue, as Key exploitable result of the Data Space 4.0 initiative, fully supports the Digital Europe Programme Key Performance Indicators, with specific reference to the "*Usage of common European libraries or interfaces to libraries of algorithms, usage of common European data spaces and usage of sites for experimentation and testing related to activities under this regulation[13]*".

To successfully perform the usage of common European Data Spaces, the Data Space 4.0 initiative set several Key Performance Indicators and Targets related to the project results. The number of companies with access to the inventory, which should be more than 20.000 individuals, has been set as the Key performance Indicator for the Pan EU Data Platform Catalogue.

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[13] Digital Europe Programme Key Performance Indicators available in https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/programme-performance-overview/digital-europe-programme-performance_en#performance-assessment

Expected outcomes and impacts	KPI	Target	Project Objective
Agreements on Governance Framework and Federated Data Ecosystems			
R1a - Data Set Provider Registry (Data Ecosystems)	# data set providers registered	500	O1.1
R2a - Data Governance Models for Dynamic Asset Management & Predictive Maintenance	# people reached by the Data Space 4.0 Alliance	300.000	O1.1
R2b - Data Governance Models for Agile Supply Chains	# people aware of Ref. DVC topologies	500.000	O1.2
Agreements on Sustainable Business Models for Data Economy			
R3 - Data Space 4.0 Business Modelling	# people accessing the Business Model Naviagator & maturity model	150.000	O2.1 O2.4
R1c - Incentives for Manufacturing Industrial Data, Data Marketplaces and Data Value Chains	# SMEs movilized to participate in DVC	1500	O2
Agreements on Data Spaces Building Blocks and Blueprint Certification			
R1 b Pan-European Manufacturing Data Platform Inventory	# companies with access to the inventory	20.000	O3.1
R4 - Manufacturing Data Space Co-Design, Validation and Data Space Radar Population	# people with acces to the DSBA Data Space 4.0 Radar y Ref. DVC topologies	200.000	O4.4
R5 - Data Space 4.0 Blueprints for Dynamic Asset Management, Predictive Maintenance and Agile SC.	# developers engaged in DS OSS projects	2000	O3.3
R6 – Building Blocks Catalogue.	# building blocks crontibuted to the catalogue	25	O3.2
R7 - Building Qualification	# building block self-assessment testbed download	500+	O3.2
Agreements on Data Prioritisation and Roadmapping			
R8 – Data Space 4.0 Roadmap	# stakeholders following the pathway	500+	O4.1
R9 - Smart Data 4.0 Model Repository (Material / Product Models, Production Models, Supply Chain Models)	# companies adopting the EU DATA SP4CE Data models	300+	O4.3
Coordination and uptake acceleration			
R10 - Joint DSCC-EU DATA SP4CE workshops	# attendees	150	O5
R11 - DIH & TEF4Man Partner Programme (PP)	# DIHs/TEF subscribing the PP	30	O5.5

Figure 15 - Data Space 4.0 Key Performance Indicators

6 Data Space 4.0 Data Platform Catalogue

The Data Space 4.0 Data Platform Catalogue has been integrated in the Data Space Catalogue so the platform information can be better contextualised and link with the various initiatives, projects and use case implemented across Data Spaces in Manufacturing.

The Catalogue has been built in a way that the content of the Catalogue can be collaboratively updated and allowing that the information in the catalogue can be exploited from multiple sources through open APIs that ensure that the information in the catalogue is best exploited for the intended use that is visualised.

The aim of the approach is to ensure that the Data Space 4.0 community could maintain a Single Point of Knowledge (SPoK) and that this SPoK can be used by the community for the very diverse purposes that the stakeholders could create.

The SPoK is implemented via a dedicated solution called DYMER (DYnamic Information ModElling & Rendering). With DYMER we can have a new way of managing information where the use of taxonomies and the power of metadata enable the organization of information catalogues, with a dynamic modelling and visualization. With the Data Space 4.0 approach the community can start organizing information with greater flexibility, in order to use it in the best way.

DYMER technology provides an integrated approach to catalogue design and management – See Figure below:

Catalogues Design and Management

Taxonomies and metadata use

Information dynamic modelling and visualization
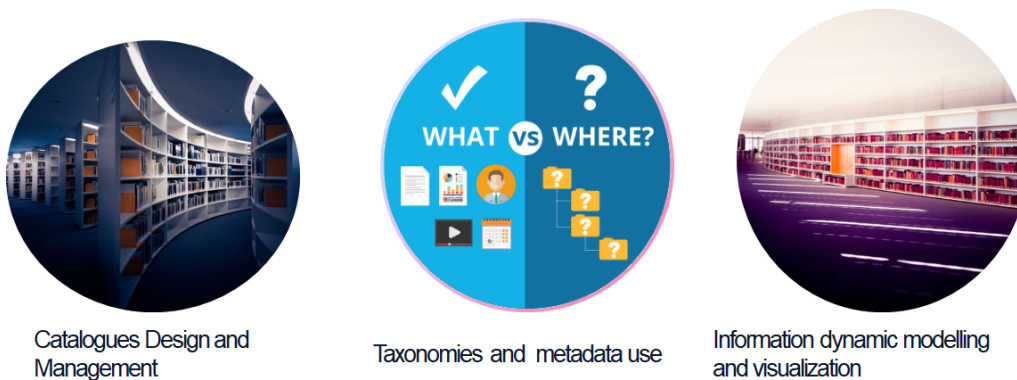
Figure 16 – DYMER features

The DYMER is ultimately an OSS suite for resource catalog visualization. DYMER provides advanced mapping capabilities between a data model in JSON format and its graphic template on the one hand, and on the other hand, it provides a JavaScript framework for integrating the DYMER template into a web-based application. The software is flexible because it adopts open technologies and can be used in various environments without considerable requirements.

The DYMER ([Git](#)) consists of two main components:

- DYMER-Core is based on a microservice architectural style with an approach to develop a single application as a suite of small services, each running in its own process and communicating with lightweight mechanisms using HTTP/REST protocols alongside JSON.

- Interaction with the DYMER-Core takes place through the DYMER-Client which is a fast, small, and feature-rich JavaScript library. Thanks to it, it is possible to interact with the platform facilitating the user in the use of data by offering a single search point and displaying the results in special graphic templates.
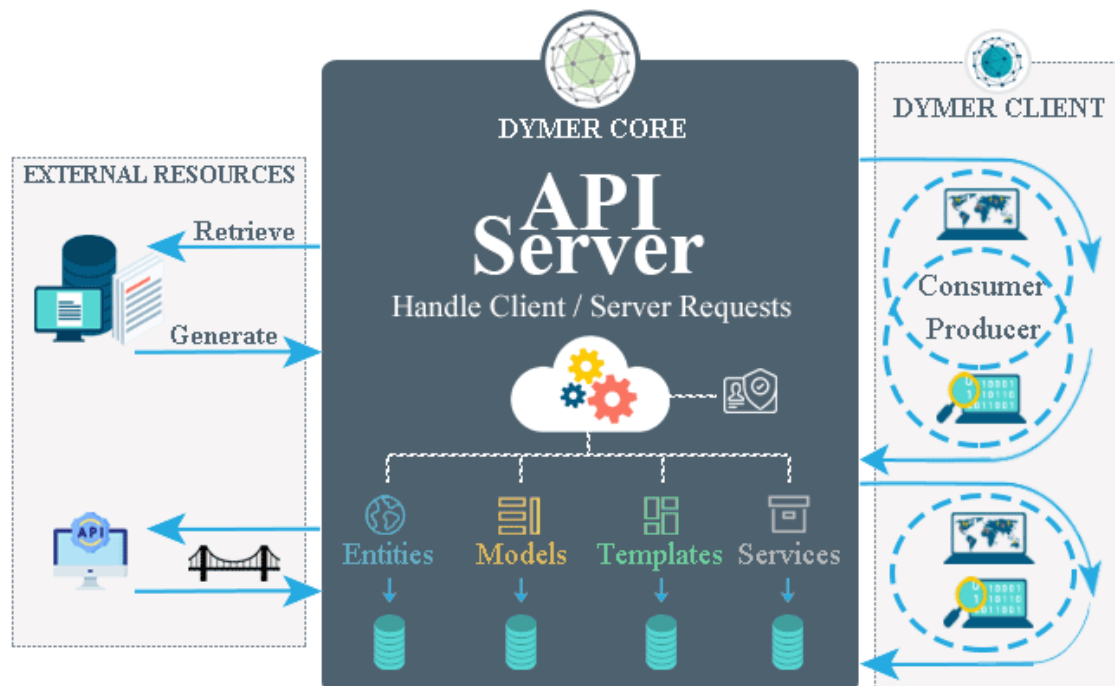
Figure 17 – DYMER Architecture

Each microservice is developed with a specific role, however among the main ones we can identify three that have the most impact:

- Templates microservice is responsible for generating graphic templates using logic-less templates.

- Forms microservice is responsible for modeling data.

- Entities microservice is responsible for managing the storage.
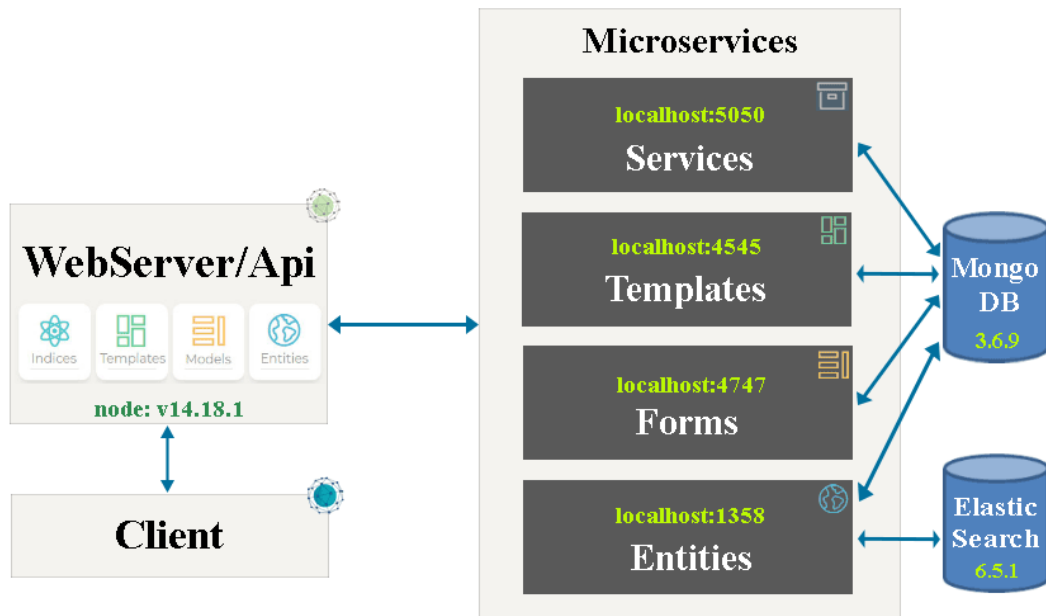
Figure 18 – DYMER Architecture technical details

In this way, different Portal Instances can use the DYMER ecosystem by importing a simple js library, which in cascade will take care of importing everything necessary, following the defined configuration.

Note that a Portal Instance A can also use, import resources and data from a DYMER of Portal Z, if enabled in the authorization section.
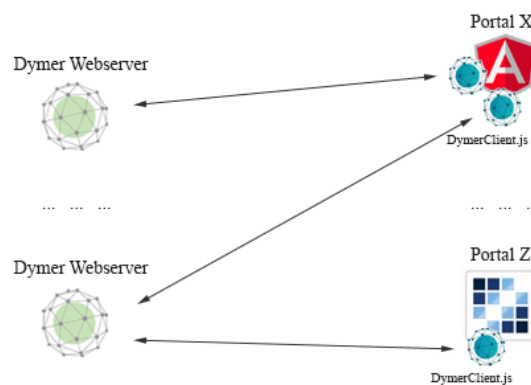
Figure 19 – DYMER ecosystem

Thus, the information workflow can be easily implemented following the process depicted in the Figure below:

Entities   *Models*   *Templates*

| Acquire Resource information from different data sources (e.g. CVS, JSON format) | Mapping Model for update resource (one Model for each Resource) | Mapping Visualization Template with Resource (one Template for each Resource) | Show results in generic client application (standalone web app, Liferay, others) in different ways |
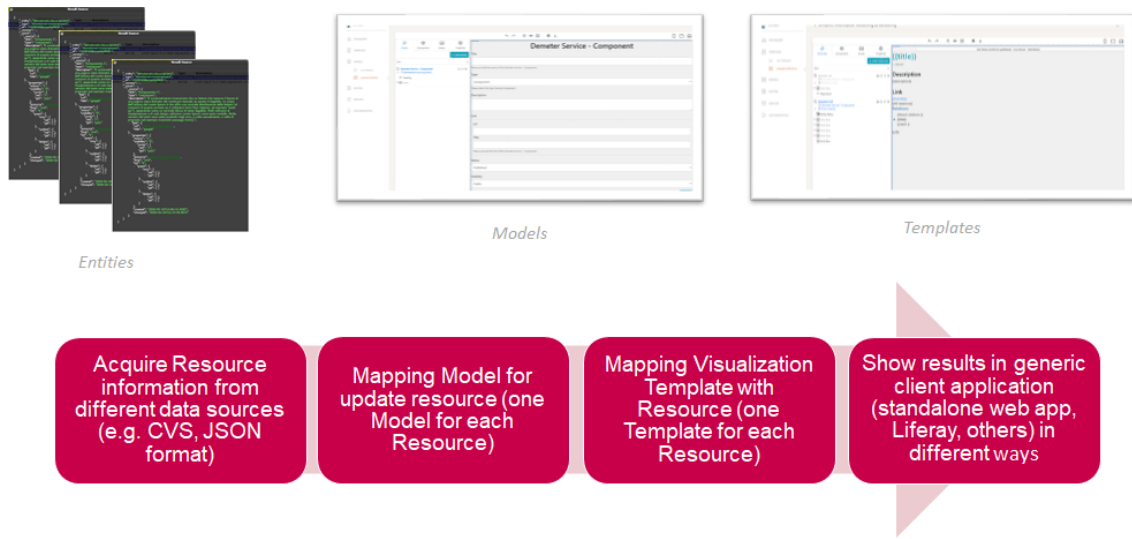
Figure 20 – DYMER Information workflow

Based on this approach, DYMER has been set up and maintained under the Digital Factory Alliance (DFA) domain. The SPoK is hence provided via the DFA. In the context of Data Space 4.0, the Data Platform as well as the OSS Catalogues have been implemented via the IoT Catalogue platform that is used to display and connect the different Innovation Assets related to Data Space 4.0 initiatives. The IoT Catalogue is embedded in the DFA Innovation Catalogue
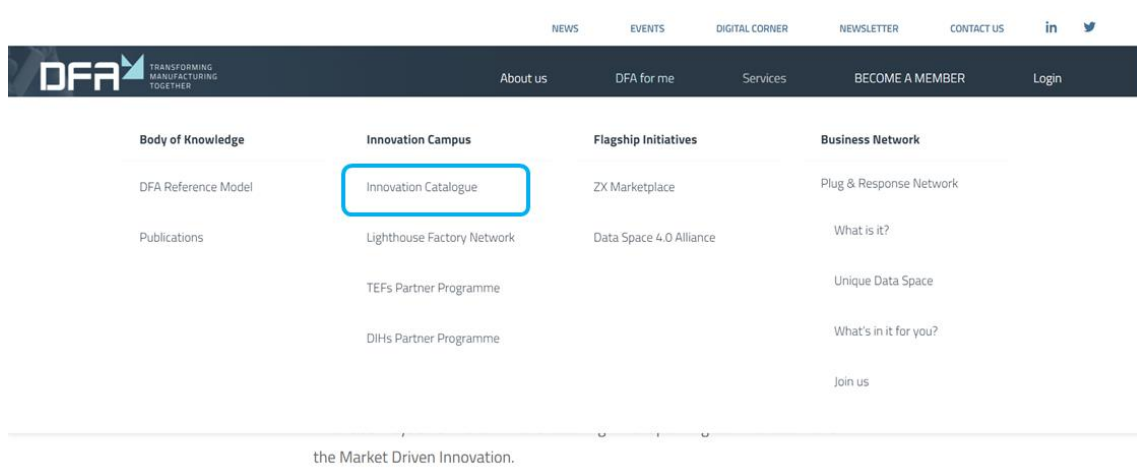
Figure 21 – Innovation Catalogue for Data Space 4.0 at DFA

The IoT Catalogue underlying the Innovation Assets for Data Spaces allows navigation on the catalogue resources from a main data space page – see below.

Figure 22 – Data Space Landing Page

The IoT Catalogue selects information from the DFA SPoK and showcase the use case related information allowing to start the navigation of Innovation Assets from a use case perspective or from a technology (platform/component) perspective.
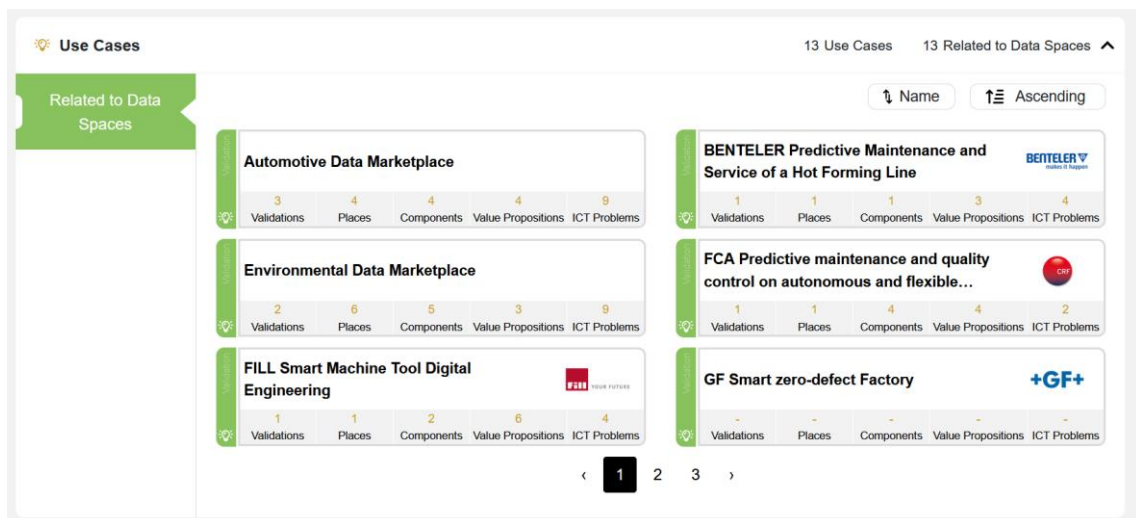

Figure 23 – Use Case information compiled from DFA SPoK

The catalogue allows to navigate projects that are focused entirely on Data Spaces 4.0 and/or related to the Data Space 4.0 topic
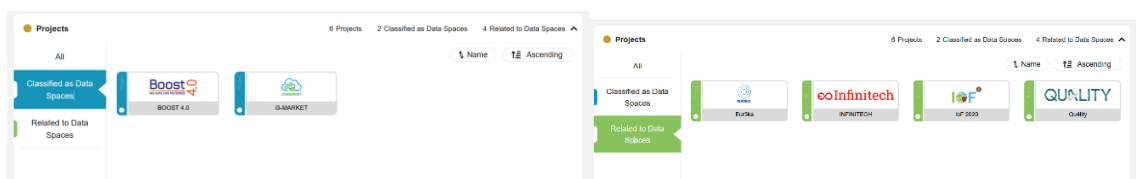

Figure 24 – Data Space 4.0 project- based navigation

The Data Space 4.0 Catalogue allows to visualize the technical components stored in the catalogue (research artefacts, platforms, OSS artefacts) under a unified framework. The Catalogue allows to navigate components that are core components of Data Space, components & platforms that are related to Data Spaces operation and ultimately those resources that are OSS.
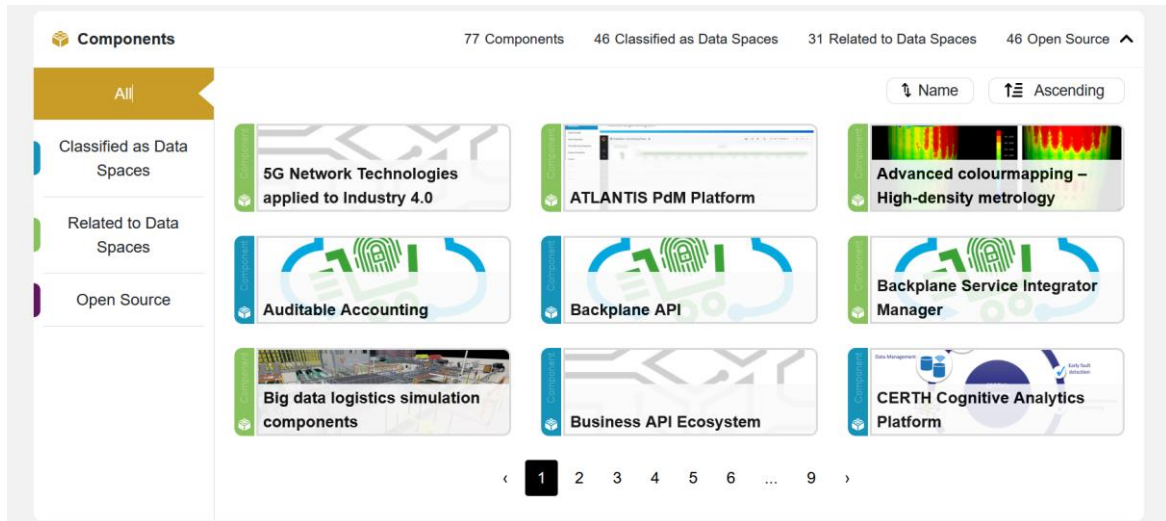
Figure 25 – Data Space 4.0 project- based navigation

This approach allows that participants of the DFA ecosystem focus on the activity that brings more value to the ecosystem. On one hand, DFA takes care of the completeness, richness, curation and quality of the information engaging with the widest possible stakeholder community and provides the SPoK. On the other hand, the various initiatives can either consume content directly from the tools and platforms provided by the DFA or they can develop or integrate the information in their own environments to meet the needs of their communities.

The catalogue provides information and access to key technical components that can be used to implement the blueprint as well as to platforms that can support data space stakeholders to prepare and consume Data Products made accessible via a Data Space. See Figures below:

Figure 26 – Data Space 4.0 catalogue- Data Sharing Agreement (DSA) Smart Contract component & OSS repository

Figure 27 – Data Space 4.0 platform related to data space usage in the catalogue

7 Data Space 4.0 Catalogue & EDIH Support to SMEs

The approach developed by Data Space 4.0 could be found useful by EDIHs to support the development of Data in Manufacturing solutions and the provision of services towards SMEs. Along this line of work Data Space 4.0 has been working within the EDIH TWG Data in Manufacturing (DiM) in the definition of a taxonomy that would allow EDIHs to share details on the DiM solutions that are being implemented to support data-driven transformation of manufacturing SMEs.

In the context of the activities of EDIH TWG DiM, two work streams have been defined from a technological point of view to support the data-driven transformation of SMEs – see Figure below.
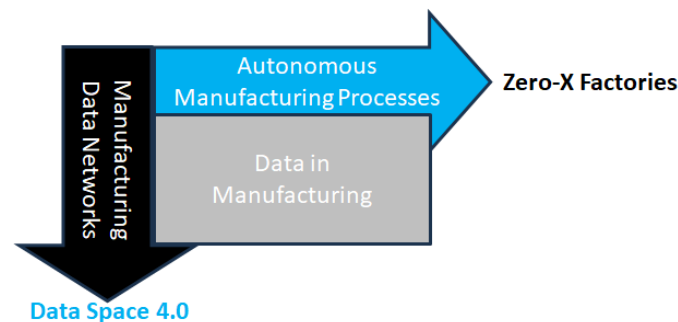
Figure 28 – Data-driven Industry 4.0 transformation for SMEs – EDIH TWG DiM

- Autonomous Manufacturing Processes. (Big) Data-driven transformation is targeting the improvement (resilience, competitiveness and sustainability) of internal factory processes. This is driven by the Zero-X operational paradigm.
- Manufacturing Data Networks. (Common) Data Driven transformation is targeting the participation and implementation of collaborative manufacturing services as part of emerging manufacturing data networks. This is driven by Data Space 4.0 continuum operational paradigm

BIG | COMMON | OPEN

Factory internal   Supplier network   Cross-factory manufacturing network

Figure 29 – Big , Common and Open Data-driven Industry 4.0 transformation

In the context of big and cognitive (AI-powered) manufacturing, the Zero- X operational paradigm targets improved manufacturing capabilities (circularity, autonomy and interoperability) acros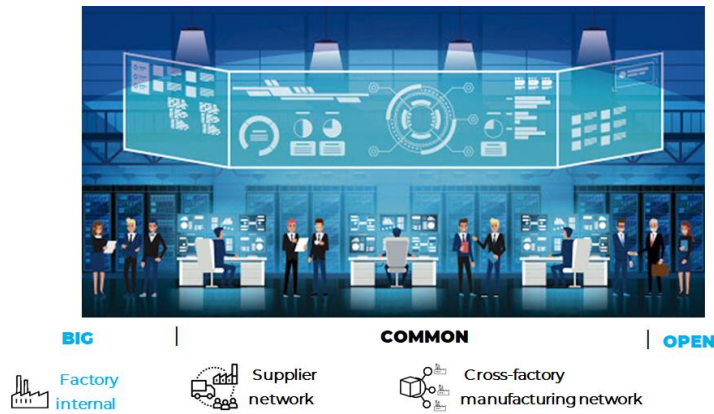s the full product/process lifecycle ;i.e. engineering/design, planning/commissioning, Production/SUMA, manufacturing& Logistics and Customer services & Maintenance; all targeting Zero-X target as reflection of manufacturing high performance and optimization.
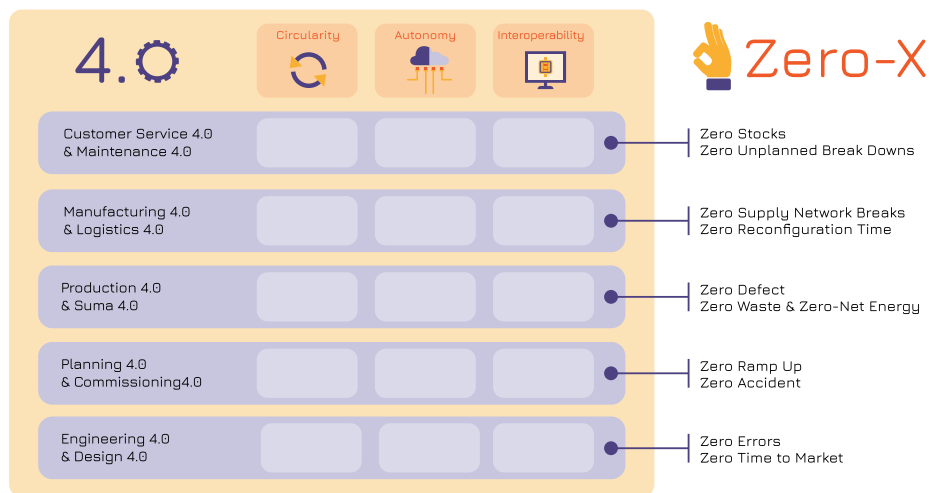
Figure 30 – DFA Zero-X operational paradigm

In the context of Common Data-driven collaborative services, the data space 4.0 operational paradigm emerges. This is mostly related to the engagement and participation in manufacturing data networks that are set to effectively deal with more collaborative operations in terms of asset 4.0 and supply chain management and implementation of more advanced manufacturing as a service flexible production scenario. This long-term vision is intended to complement the more traditional egosystem Zero-X operation with an ecosystemic approach, whereby the establishment of these manufacturing networks is

articulated for the benefit of economies of scale and cost reduction; particularly addressing circular manufacturing and nearshoring production configurations – see Figure below
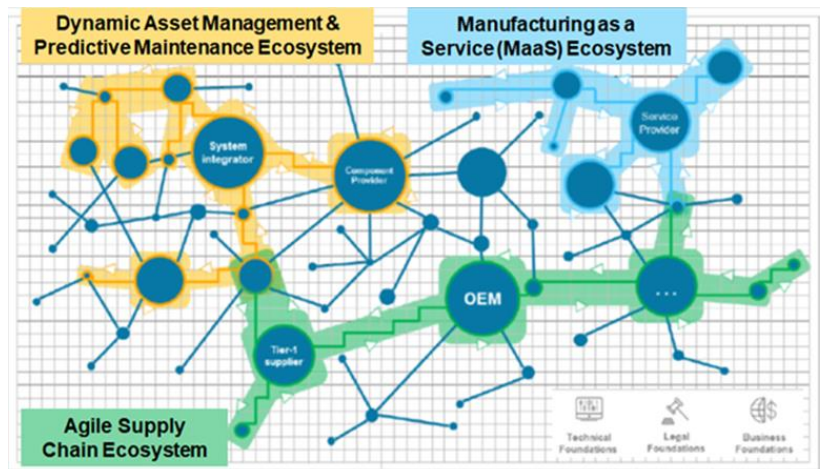
Figure 31 – Data Space 4.0 continuum operational paradigm

The EDIH TWG DiM has defined a framework to address these two dimension of data-driven transformation of SMEs – See Figure below
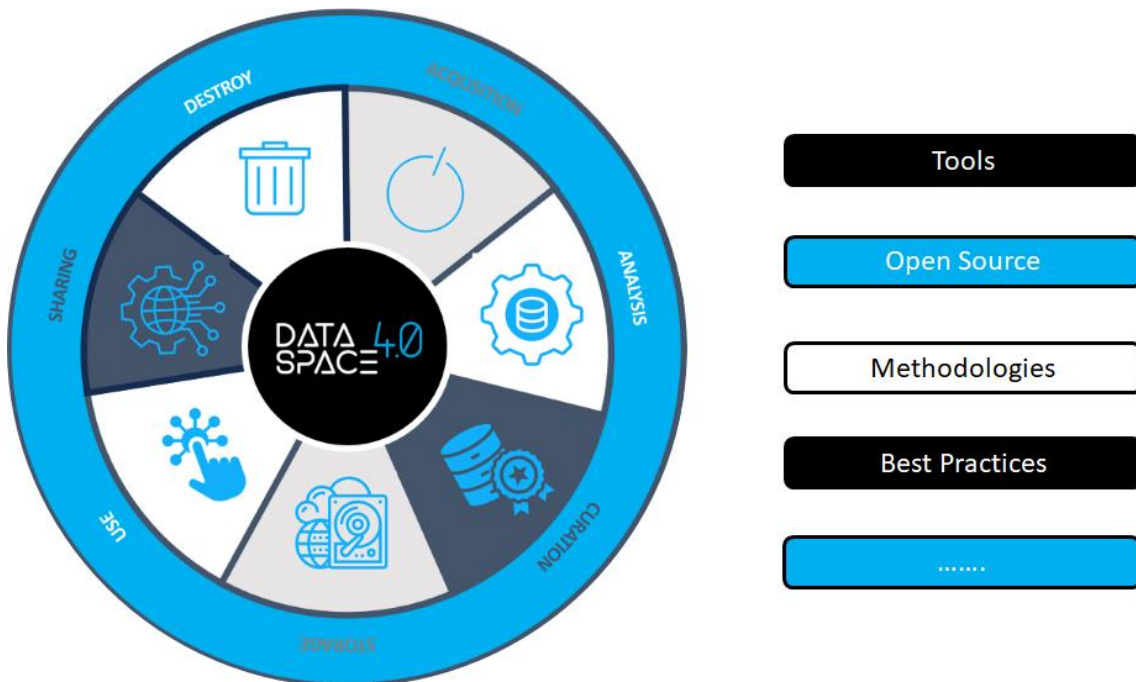
Figure 32 – Data Space 4.0 virtuous data lifecycle (EDIH TWG DiM)

The Data Space 4.0 Catalogue represent a relevant information point but as well a very relevant asset to provide visibility to other SMEs and EDIHs on the technical solutions implemented as well as the open source artifacts and data platforms used for the implementation of the different solutions. Hence, the Data Space 4.0 catalogue has been

designed to serve as well the current and future needs of EDIHs in terms of data driven transformations.

8 Conclusions

A flourishing ecosystem of Data Spaces, Data Platforms and Data Marketplaces is growing at national and European level, supporting the data sharing economy main principles and key concepts.

In the vision set out by the "European strategy for data", the creation of EU-wide common, interoperable data spaces in strategic sectors aims at overcoming legal and technical barriers to data sharing by combining the necessary tools and infrastructures and addressing issues of trust by way of common rules[14].

The development of a Pan-EU Platform Catalogue needs to be seen broadly by considering it together with those of EFFRA Innovation Portal, IDSA Radar and the ZX Marketplace developed under DFA. The Pan EU Platform Catalogue will support the emergence of data spaces in the manufacturing sectors, creating numerous business opportunities among data providers and data users, and even among data intermediaries, data operators and data space service providers.

It will provide evidence about the Data Platforms practices across Europe, relevant building blocks and available components to establish Data Spaces, Sharing Platforms and Data Marketplaces. The process will be based on the OPEN DEI Design Principles and Data Value Chains high level activities. Boost 4.0 Smart Business Processes will be also at the basis of the inventorial process so to ensure a deeper understanding of available solutions across Europe.

The community will be made capable to identify data value chains, relevant business models and connections with global value chains.

Finally, a deeper understanding of the common practices will ensure a focused and subsequent analysis of interoperability barriers and proper standardization measures.

A co-creation process and a validation exercise on the Catalogue criteria will be designed to ensure its adoption and population among stakeholders and user communities, promoting transparency and openness. To ensure trustworthiness and wide adoption by user

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[14] COM(2020) 66 - A European strategy for data

communities for the benefit of society, actions should promote high standards of transparency and openness.

In this sense, Data Space 4.0 supports the major objectives described in the Staff Working Document on Common European Data Spaces[15], launched in February 2022 in conjunction with the European Data Act, which promotes the diffusion of platforms for data sharing and the availability of interoperable datasets as one of the key success factors which may help to drive the European data economy and industrial transformation.

Finally, the data Space 4.0 has been built and will be populated beyond the end of the project with the collaboration of different initiatives that will be able to exploit the information provided in may different forms.

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[15] SWD(2022) 45 – Commission Staff Working Document on Common European Data Spaces

9 Annex I –Request for Expression of Interest
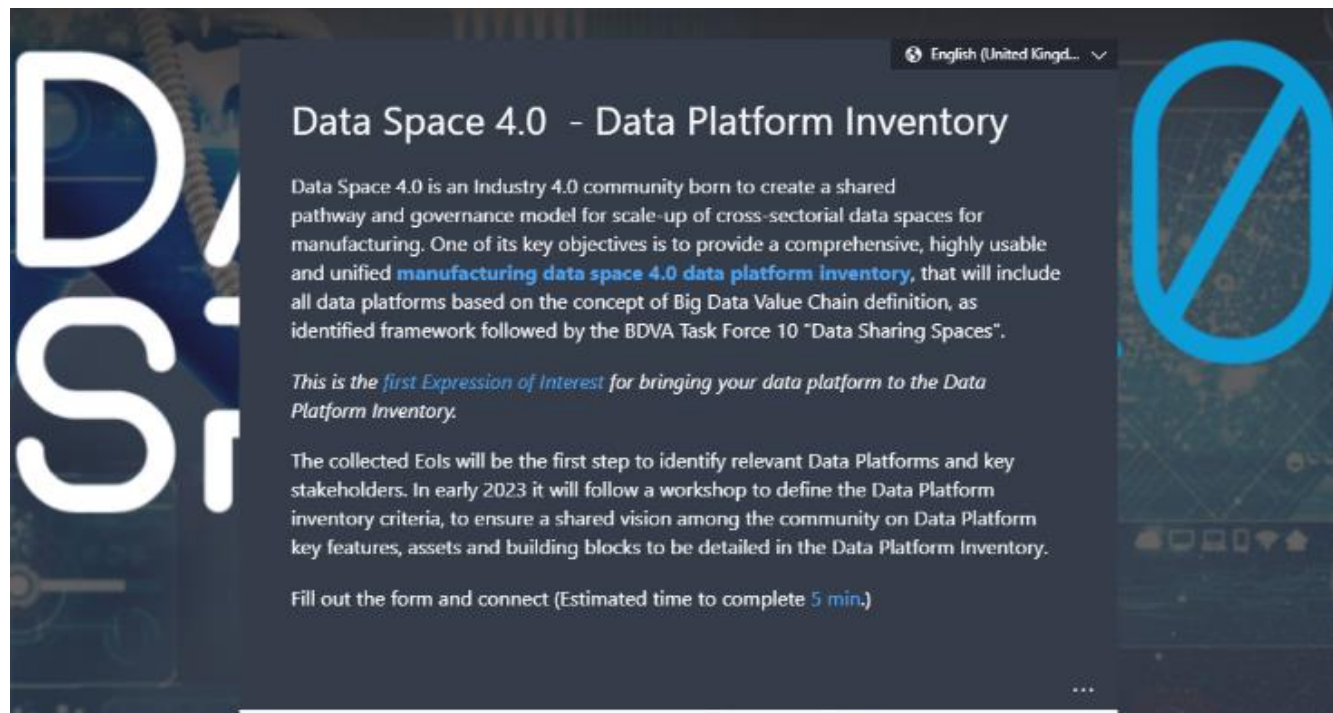
* Required

1

Data Platform - Name *

Enter your answer

2

Data Platform - Short Marketing Description *

Enter your answer

3

In your opinion, in which **Data Value Chain high-level activities** can you position your solution? *

*The Big Data Value Chain as described within Curry, E. (2016) "The Big Data Value Chain: Definitions, Concepts, and Theoretical Approaches", in Cavanillas, J. M., Curry, E., and Wahlster, W. (eds) *New Horizons for a Data-Driven Economy: A Roadmap for Usage and Exploitation of Big Data in Europe*. Springer International Publishing.

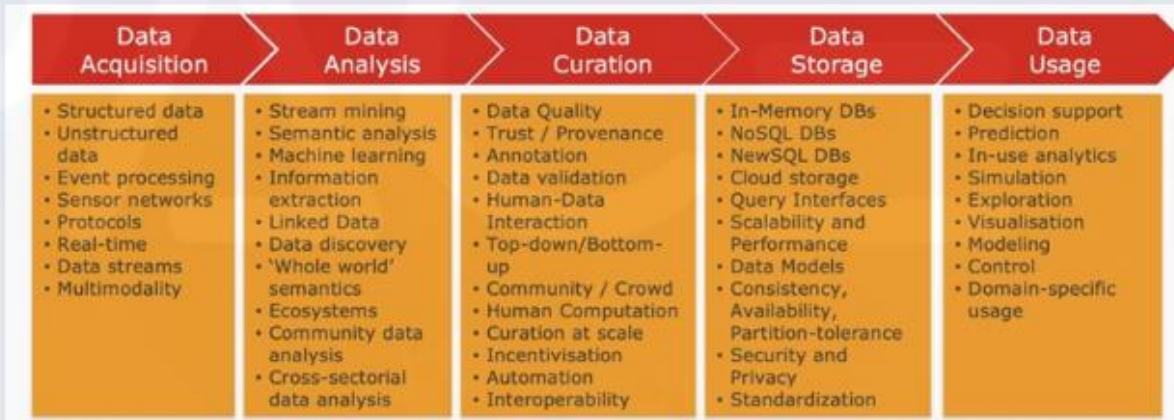| Data Acquisition	Data Analysis	Data Curation	Data Storage	Data Usage
• Structured data • Unstructured data • Event processing • Sensor networks • Protocols • Real-time • Data streams • Multimodality	• Stream mining • Semantic analysis • Machine learning • Information extraction • Linked Data • Data discovery • 'Whole world' semantics • Ecosystems • Community data analysis • Cross-sectorial data analysis	• Data Quality • Trust / Provenance • Annotation • Data validation • Human-Data Interaction • Top-down/Bottom-up • Community / Crowd • Human Computation • Curation at scale • Incentivisation • Automation • Interoperability	• In-Memory DBs • NoSQL DBs • NewSQL DBs • Cloud storage • Query Interfaces • Scalability and Performance • Data Models • Consistency, Availability, Partition-tolerance • Security and Privacy • Standardization	• Decision support • Prediction • In-use analytics • Simulation • Exploration • Visualisation • Modeling • Control • Domain-specific usage

☐ Data Acquisition

☐ Data Analysis

☐ Data Curation

☐ Data Storage

☐ Data Usage

4

In your opinion, in which of the identified **Smart Business Processes** can you position your solution? *

*The Smart Business Processes described below referes to the Boost 4.0 Big Data Reference Architecture as described within Lázaro, O. *et al.* (2022) "Next-Generation Big Data-Driven Factory 4.0 Operations and Optimization: The Boost 4.0 Experience". In: Curry, E., Auer, S., Berre, A.J., Metzger, A., Perez, M.S., Zillner, S. (eds) *Technologies and Applications for Big Data Value* . Springer International Publishing

- [ ] Smart Digital Engineering

- [ ] Smart Digital Planning & Commissioning

- [ ] Smart Digital Workplace & Operations

- [ ] Smart Connected Production

- [ ] Smart Service & Maintenance

- [ ] Other

5

Maturity level - Please define the maturity level of your data platform
(This is a self assessment. A detailed maturity assessment will follow at a later stage). *

○ **Lead in** – Organization or consortium is in the phase of shaping the Data Platform by identifying opportunities and/or challenges that can be addressed with sovereign data sharing

○ **Business Case Defined** - Business case(s), roles of organizations involved in the data platform and the value created for each role have been identified.

○ **Prototype/Pilot** - Data Platform solution has been implemented and first prototypes have been tested in a use case pilot.

○ **Operational** - Data Platform is running live and data flow among data sharing parties.

Next

Page 1 of 2

Data Space 4.0 - Data Platform Inventory   ...

* Required

Contact Information

How Data Space 4.0 uses Your Information

Your personal information, including your name and email address, will be processed in accordance with the Regulation EU 2016/679 (GDPR) only for Data Space 4.0 related activities. Data Space 4.0 won't sell, rent or exchange any personal information supplied by you to any third party. Nor will Data Space 4.0 use any of the information you provide for direct marketing.
Your personal information will be used only for the Data Space 4.0 purposes and just until the end of the project. Further information about the European Union funded initiative called Data Space 4.0 is available at the project website: https://manufacturingdataspace-csa.eu/
The detailed Privacy Policy is available at: https://innovalia.org/politica-de-privacidad/

6

Name and SURNAME *

Enter your answer

7

Organisation *

8

Email Address *

Enter your answer

9

Please provide your Consent to be included in Data Space 4.0 Mailing List *

◯ Yes, I agree.

You can print a copy of your answer after you submit

Back   Submit   Page 2 of 2 ▬▬▬▬▬▬