AN ANALYSIS OF DRIVERS AND BARRIERS FOR THE UPTAKE OF DIGITAL PLATFORMS IN EUROPE

POSITION PAPER | MAY 2022

OPENDEI

Point of view

This position paper investigates the major internal and external factors that could facilitate or hinder the adoption of digital platforms by European organizations across four sectors of Manufacturing, Energy, Agri-food and Healthcare. The paper also provides a broader cross-domain perspective of such drivers and barriers that are not sector-specific but rather common and existent among different sectors. The paper has been developed under the coordination and leadership of Task Force 4 lead by IDC of the Horizon 2020 project "OPEN DEI- Aligning Reference Architectures, Open Platforms, and Large-Scale Pilots in Digitalizing European Industry" with a solid collaboration of more than 30 experts of digital transformation and digital platforms representing more than 20 organizations from 10 Horizon 2020 projects and related initiatives.

The paper provides a set of recommendation to address the defined barriers and to facilitate and accelerate the uptake of digital platforms across European organizations in different sectors.

Contributing organizations

Contributing Projects

OPENDEI
ATLAS AGRICULTURAL INTEROPERABILITY AND ANALYSIS SYSTEM
ADLIFE
AIOTI Alliance for Internet of Things Innovation
BD4OPEM
demeter
EU IoT
GATEKEEPER
HOSMARTAI
PlatformUptake.eu
SYNERGY

Publisher

IDC

Copyright

Editors

Golboo Pourabdollahian, IDC
Giorgio Micheletti, IDC

Authors and Contributors

Theodoros N. Arvanitis, University of Warwick
David Augustin, UPC
Gash Bhullar, Digital Factory Alliance
Ismael Bravo Jimenez, UPC
Massimilano Claps, IDC
Andrea Cruciani, AGRICOLUS
Alberto Dognini, RWTH
Marianna Faraldi, Tecnoalimenti S.C.p.A
Frans Folkword, Open Evidence
Sergio Gusmeroli, FPM
Andrea Jester, NSB
Susanne Kuehrer, EIT Digital
Frederic Lievens, ISfTeH
Marc Lang, EHTEL
Oscar Lazaro, INNOVALIA
Francois Lupianez, Open Evidence
Angelo Marguglio, ENGINEERING
Jesus Martinez, ATOS
Alexander Nikolov, SYNYO
Luc Nicolas, EHTEL
Silvia Piai, IDC
Carmen Polcaro, INNOVALIA
Golboo Pourabdollahian, IDC
Jean-Francois Segaletto, IDC
Alena Siarheyeva, NuMINT
Rute Sofia, FORTISS
Manolis Tsantakis, ETAM SA
Tasos Tsitsanis, Suite5
Lorenzo Veronesi, IDC
Riccardo Zanetti, ENGINEERING
Ane Zuluaga, INNOVALIA

Table of Contents

List of Figures

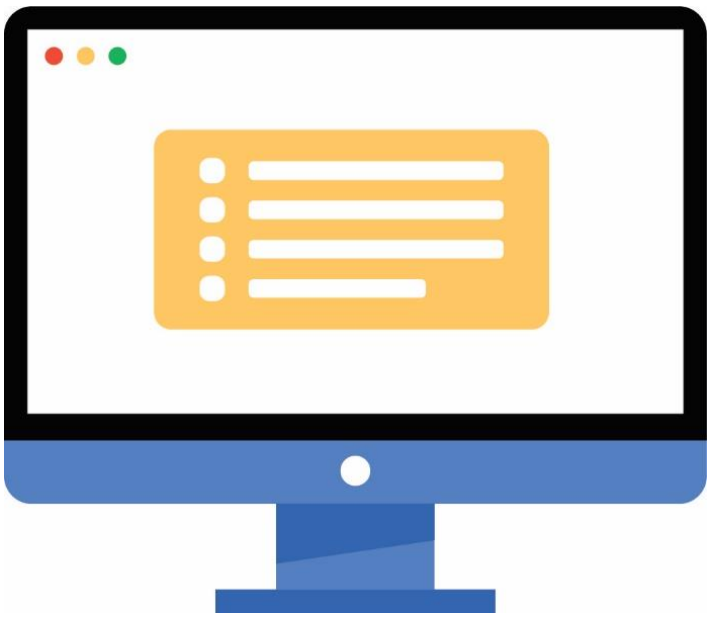
List of Tables

List of Abbreviations

Abbreviation	Full description
AHA	Active and Healthy Ageing
AI	Artificial Intelligence
API	Application Programming Interface
AR/VR	Augmented Reality/Virtual Reality
AWS	Amazon Web Services
B2B	Business to Business
B2B2C	Business to Business to Consumer
B2C	Business to Consumer
BP	Business Process
CAGR	Compound Annual Growth Rate
CAP	Common Agricultural Policy
CHP	Combined Heat and Power
CPO	Charge Point Operator
CRM	Customer Relationship Management
D2C	Direct to Consumer
DevOps	Development and Operations
DIH	Digital Innovation Hub
DSA	Digital Services Act
DSM	Digital Single Market
DSO	Distribution System Operators
DSS	Decision Support System
DTI	Digital Transformation Initiative
EASA	European Union Aviation Safety Agency
EC	European Commission
EDIH	European Digital Innovation Hubs
EFPF	European Factory Platform
EMSP	E-Mobility Service Provider
ESCO	Energy Service Companies
ESG	Environmental, Social and Governance
EU	European Union
EV	Electric Vehicle
FIHR	Fast Healthcare Interoperability Resources
FoF	Factories of Future
GDP	Gross Domestic Production
GDPR	General Data Protection Regulation
GPAP	Genome-Phenome Analysis Platform
GPS	Global Positioning System
H2020	Horizon 2020

Abbreviation	Full description
HL7	Health Level 7
IBC	International Business Council
ICT	Information and Communication Technology
IIoT	Industrial Internet of Things
IoT	Internet of Things
IP	Intellectual Property
IT	Information Technology
KPI	Key Performance Indicator
LSP	Large Scale Pilot
M2M	Machine to Machine
ML	Machine Learning
O&G	Oil and Gas
OEM	Original Equipment Manufacturer
PaaS	Platform as a Service
PV	Photovoltaic
R&D	Research and Development
R&I	Research and Innovation
RES	Renewable Energy Sources
RPA	Robotic Process Automation
SDG	Sustainable Development Goals
SME	Small and Medium Enterprise
SWOT	Strengths, Weaknesses, Opportunities and Threats
TEF	Training, testing and Experimental Factories
TSO	Transmission System Operator
UAV	Unmanned Aerial Vehicle
UX	User Experience
V2G	Vehicle to Grid
WEF	World Economic Forum

1 Introduction



Digital transformation[1] is a key pillar of the EU agenda for the near and long-term future, as clearly indicated by the European Industrial Strategy[2], the European Data Strategy[3], the Strategy on Shaping Europe's Digital Future[4], the Digital Services Act[5] and other strategic policies.

In the digital economy, digital platforms play an important role. According to the World Economic Forum's Digital Transformation Initiative (DTI), digital platforms could unlock over 8 trillion euros of value for business and wider society over a 10-year period[6]. Digital platforms have become one of the principal ways of organizing a wide range of human activities, including economic, social, and political interactions[7]. More specifically, from a business-to-business (B2B)[8] point of view, platforms can be defined as virtual environments facilitating the exchange and connection of data between different organizations through a shared reference architecture and common governance rules[9]. New platform-enabled business opportunities can be targeted through the creation of virtual buyer-and-seller communities, thus brokering interactions of makers and users with diverse but complementary interests. Platforms offer new ways of maximizing efficiency and improving profitability[10] and are therefore gaining importance for their economic brokerage and intermediation services – at both the business-to-consumer (B2C) and business-to-business (B2B) levels. Increasingly, the two worlds of B2B and B2C are blending into B2B2C models, like Amazon in the retail world, or Booking.com in the travel industry, or Moovit in the mobility as a service market[11].

As a result of digital acting as an accelerator of the platform concept, B2B platforms are flourishing across all European industries to[12]:

- Drive new data-driven business models.
- Share industry-specific industrial software applications on a common platform.
- Enable product and service innovations through commercial synergies in joint initiatives.
- Optimize B2B sell-side and buy-side processes.

[1] https://ec.europa.eu/info/sites/info/files/communication-eu-industrial-strategy-march-2020_en.pdf
[2] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy
[3] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en
[4] https://ec.europa.eu/digital-single-market/en/content/european-digital-strategy
[5] https://ec.europa.eu/digital-single-market/en/digital-services-act-package
[6] World Economic Forum Digital Transformation Initiative: Unlocking B2B Platform Value, March 2017
[7] Gerald C. Kane, Douglas Palmer, Anh Nguyen-Phillips, and David Kiron. "Is Your Business Ready for A Digital Future?" MITSloan Management Review (56:4), Summer 2015. - Asadullah, Ahmad; Faik, Isam; and Kankanhalli, Atreyi, "Digital Platforms: A Review and Future Directions" (2018). PACIS 2018 Proceedings. 248.
[8] You may find more information about the definition of B2B platforms definitions in the Annex 1 of this report.
[9] G. Cattaneo, G. Micheletti and L. Veronesi (IDC) 28TH July 2016. "European Data Market SMART 2013/0063. D3.10 Industrial Data Platforms – Key Enablers of Industry Digitization." The document is one of a series of in-depth analysis focusing on the development of the data-driven economy in Europe based on specific case studies by sector and/or by technology. It constitutes the deliverable D3.10 of the study "European Data market", SMART 2-013/0036 entrusted to IDC and Open Evidence by the European Commission, DG Connect, Unit G3 – Data Value Chain.
[10] Duch-Brown, N. (2017). Platforms to business relations in online platform ecosystems. Brussels: European Commission. doi:JRC109186
[11] You may find more information about the definition of B2B platforms definitions in the Annex 1 of this report.
[12] https://www.idc.com/getdoc.jsp?containerId=EUR146713020

Along with this increasing growth and to support European digital platforms, the European commission's approach to online platforms focuses on fostering a trusting, legally-compliant and innovation-driven environment in the EU. To this end, the Commission identified key areas of interest in its Communication on Online Platforms. The guiding policy principles are: 1) to create and maintain a level playing field for comparable digital services 2) to ensure responsible behavior of online platforms to protect core values 3) to foster trust, transparency and ensure fairness on online platforms, and 4) to keep markets open and non-discriminatory to foster a data-driven economy[13]. Indeed, the Commission adopted a proposal for a Digital Services Act (DSA) in December 2020. Together with a Digital Markets Act[14], the DSA will create a safer and more open digital space for all users and ensure a level playing field for businesses. Accordingly, through the financial and supporting mechanisms of the Commission, numerous digital platforms are being developed within the European R&I landscape programmes such as H2020.

This position paper is written through a solid collaboration among several experts in the area of digital transformation and digital platforms in Europe who are mobilized with the Task Force 4 of OPEN DEI project. It presents the work of this task force as to the analyzing the drivers and barriers for adoption of digital platforms in the four domain of manufacturing, energy, agri-food and healthcare as well as a cross-domain analysis applicable to other sectors too.

The paper is structured as follows. In chapter 2, an overview of the digital ecosystem and its increasing importance in Europe as well as the key role of digital platforms as the orchestrator of digital ecosystem is described. Chapter 3, is focused on the role of digital platforms from a commercial market perspective through analysis of digital platforms in four domains of manufacturing, energy, agri-food and healthcare from a market perspective taking into account an analysis of the status quo of the market and the future trend for digital platforms. In addition, SWOT analysis (analysis of strengths, weaknesses, opportunities and threats) of digital platforms in each domain **from the market perspective** is conducted and presented. Chapter 4 is focused on the role of the digital platforms in **European research and innovation landscape** through analysis of the status quo of the role of digital platforms to promote digital transformation in R&I landscape, providing examples of existing platforms developed within EU-funded projects and initiatives and conducting a SWOT analysis for these R&I platforms in the four domains. Chapter 5 provides a consolidated view of strengths, weaknesses, opportunities, and threats for digital platforms per domain through **integrating both market and EU R&I perspectives**. Moreover, a consolidated cross-domain SWOT is developed summarizing the common drivers and barriers to adopt digital platforms across different sectors. Finally, chapter 6 summarizes the analysis by defining main categories of drivers and barriers for uptake of platforms. The paper is concluded by providing a set of recommendations to address the barriers and thus to accelerate the adoption process for platforms.

[13] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1466514160026&uri=CELEX:52016DC0288
[14] https://digital-strategy.ec.europa.eu/en/policies/digital-services-act-package

2 Ecosystem economy and role of digital platforms

2.1 Digital ecosystem and its increasing importance in Europe

Nowadays, organizations and companies across different sectors face tremendous challenges in the months and years ahead. Complex value chains, highly competitive markets, evolving customer and citizen needs, supply chain disruptions, foreign trade uncertainty, environmental sustainability and social impact, and now the COVID-19 pandemic are common challenges that organizations from every sector, from manufacturing to healthcare, energy, financial services, agri-food, etc., deal with on a daily basis. The future enterprises' ability to generate value, will depend on scaling new ecosystem-centric business models. In fact, enterprises that embrace ecosystem innovation will deliver their Strategic goals in the next normal by providing new values, generating new revenues, and making new partners. According to IDC FutureSpace Report published in 2021[15]:

- By 2024, 80% of industry ecosystem orchestrators will mandate a uniform ESG policy for industry ecosystem participants through a governance platform and applications for initial and ongoing verification.
- By 2022, organizations that share data, applications, and operations with their industry ecosystem will realize a revenue increase of 3 percentage points higher than nonparticipants.
- By 2026, on average, 30% of Global 2000 company revenue will derive from industry ecosystem shared data, applications, and operations initiatives with partners, industry entities, and business networks.

IDC's vision of the Future Enterprise is an organization that underpins business processes with technology, is fueled by innovation, is platform-enabled and ecosystem-centric. Digital ecosystems will play a critical role in the months and years ahead for organizations and companies that realize they need to have a supporting cast of partners that function as a scalable extension of organizations, as well as a source of data and insight, co-developer of applications, and provider of shared operations.

Digital ecosystems enable strategic outcome through dynamic collaboration. According to IDC[16] in Europe, more than 30% of public institutions and private enterprises are active in ecosystems to develop new products and services, share and exchange information, share operational capabilities and expertise. Moreover, 39% of them expect to share more data after COVID-19, as executives feel the pressure to respond to competitive pressures, elevated customer expectations and regulatory requirements. Figure 1 shows the results of IDC European Industry Association

[15] IDC FutureScape: Worldwide Future of Industry Ecosystems 2022 Predictions
[16] IDC Future of Industry Ecosystems Survey, May 2021

Survey conducted in 2021 in terms of rising of digital ecosystem in Europe and across European organizations.

Figure 1. Rising importance of Digital Ecosystem in Europe (Source: IDC European Industry Acceleration Survey, May 2021 (N = 1316))

In fact, Europe provides a fertile ground for product-centric ecosystems. According to the World Bank, 15 % of European Gross Value Added comes from the Manufacturing Industry[17]. With its strength in automotive, food, industrial equipment and fashion, Europe will chart the global path for ecosystems that deliver digitally-enhanced products and supply chains agility. Moreover, 99.8% of European organizations are SMEs with less than 250 employees[18]. SMEs penetration in the region and role in solid ecosystems' creation (50% of European SMEs currently operating in at least one Ecosystem), grants that agility needed for cross-organization ecosystems to thrive.

[17] https://data.worldbank.org/indicator/NV.IND.MANF.ZS?locations=EU
[18] https://ec.europa.eu/growth/smes_en

2.2 Platforms as the orchestrator of the digital ecosystem

The future of digital ecosystem is open, dynamic, and shared, evolving like a biological ecosystem that changes in response to pressure, competition, or disruption.

In such an ecosystem, digital platforms have become one of the principal ways of organizing a wide range of human activities, including economic, social, and political interactions (Kane, 2014)[19] (Asadullah & Faik, 2018)[20]. As a result, the increasing adoption of digital platforms to organize economic and social activities has led to growing interest in research on this topic and has put the spotlight on their economic and business relevance.

The platform concept, however, is not new. For many years, large manufacturers and industry sectors have achieved efficiency gains by developing common working frameworks and shared environments. This is the case of the automotive industry, where platforms have long formed the basis for several different car models. Digital technologies are now making it possible to extend the digital platform concept to uncharted territories. New business opportunities can be targeted through the creation of virtual buyer-and-seller communities, thus facilitating interactions of users with diverse but complementary interests. Furthermore, enterprises and organizations that are willing to expand their customer and user base, or are looking for new markets, or are interested in selling specialised, niche products and services, may find new opportunities by using online platforms. At the same time, platforms offer new ways of maximizing efficiency and improving profitability (Duch-Brown, 2017)[21] and are therefore gaining importance for their economic brokerage and intermediation services – at both the business-to-consumer (B2C) and business-to-business (B2B) levels. The platforms' leadership role in today's economy, though, would not have been possible without the fundamental contribution of information technology (IT). Today, the platform concept spans software development techniques, entire technology stacks and data ecosystems, software bundles and cloud computing models (such as the platform-as-a-service [PaaS] model), and entirely new digital business and sector-specific ecosystems. Platforms relevance for the business and the economy is rapidly growing, driving the rise of the platform economy, where value added is created by the application of big data and analytics technologies, increasingly powerful cognitive computing capabilities, and ubiquitous access.

From a theoretical point of view, Koh and Fichman have defined digital platforms as a "two-sided network that facilitates the interactions between distinct but interdependent groups of users" (Koh

[19] Kane, G. C. (2014). What's Different About Social Media Networks? A Framework and Research Agenda. MIS Quarterly, 275-304

[20] Asadullah, A., & Faik, I. &. (2018). Digital Platforms: A Review and Future Directions. Twenty-Second Pacific Asia Conference on Information Systems. Japan.

[21] Duch-Brown, N. (2017). Platforms to business relations in online platform ecosystems. Brussels: European Commission. doi:JRC109186

& Fichman, 2014)[22]. In a more practical sense, a digital platform is a technology-enabled business model that creates value by facilitating exchanges between two or more interdependent groups.

Platforms also enable companies and organizations to share information to stimulate collaboration and enhance the innovation potential of products and services. By connecting two or more sides, the platform ecosystem generates powerful network effects whereby the value increases as more members participate (Rochet & Tirole, 2003)[23]. From a B2B point of view, platforms can be defined as virtual environments facilitating the exchange and connection of data between different organizations through a shared reference architecture and common governance rules[24]. By linking different actors that are interested in sharing information in the form of data, digital platforms constitute a composite business ecosystem combining players from disparate backgrounds, thus fostering the creation of new data-driven services and innovative business processes.

Scaling up digital ecosystems will require digital platforms to deliver scale and speed, as well as federate data from connected products, assets, people, and processes. According to IDC[25], when "designing" their ecosystems, European enterprises and organizations consider the two most important organizational and cultural considerations namely choosing the right partners and developing and creating structures to create trust among ecosystem partners.

Different governance models are emerging to foster trusted collaboration among partners in a digital ecosystem. The models are mainly based on the available type of roles in the ecosystem and the type of interactions among the ecosystem participants. Figure 2 shows the four different types of governance models for digital ecosystems according to IDC.

[22] Koh, T. K., & Fichman, M. (2014). Multihoming users' preferences for two-sided exchange networks. Mis Quarterly, 38(4), 977-996.
[23] Rochet, J. C., & Tirole, J. (2003). Platform competition in two-sided markets. Journal of the european economic association, 1(4), 990-1029.
[24] G. Cattaneo, G. Micheletti and L. Veronesi (IDC) 28TH July 2016. "European Data Market SMART 2013/0063. D3.10 Industrial Data Platforms – Key Enablers of Industry Digitization." The document is one of a series of in-depth analysis focusing on the development of the data-driven economy in Europe based on specific case studies by sector and/or by technology. It constitutes the deliverable D3.10 of the study "European Data market", SMART 2013/0036 entrusted to IDC and Open Evidence by the European Commission, DG Connect, Unit G3 – Data Value Chain
[25] IDC EMEA, Future Enterprise Resilience 2021

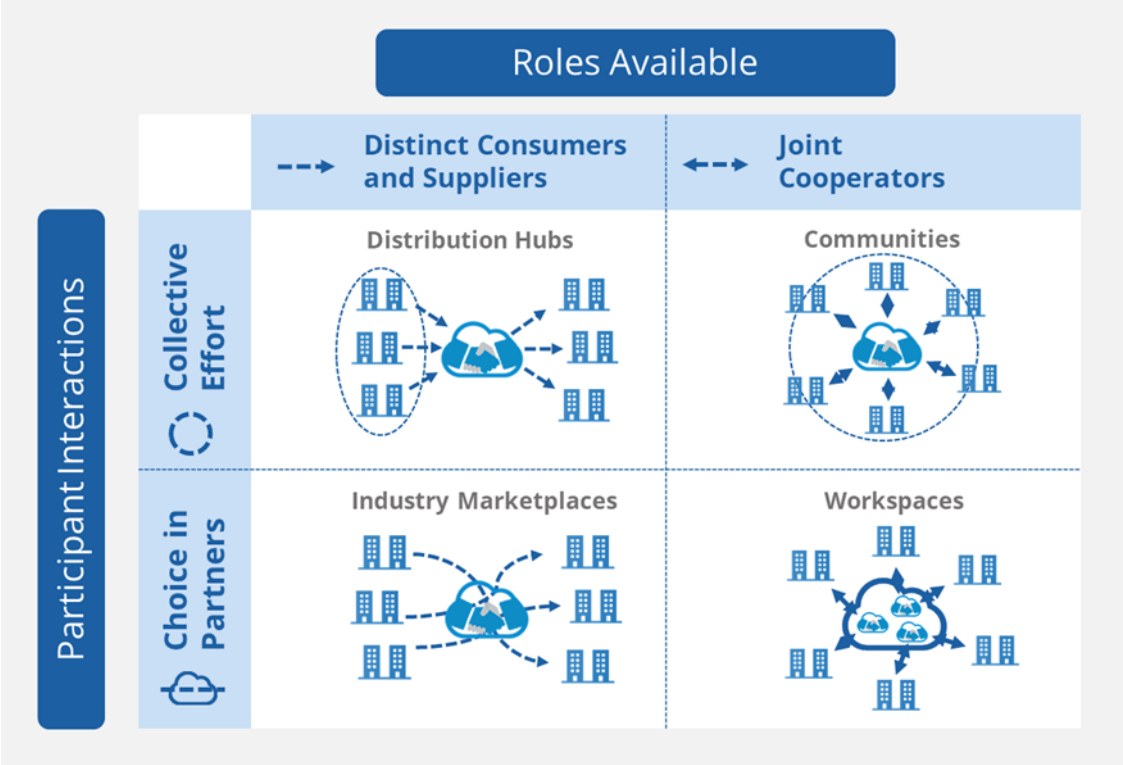


Figure 2. Different governance models to foster trusted collaboration in Digital Ecosystems

In fact, Digital ecosystems need an orchestrator to integrate several players and parts of the ecosystem. B2B platforms, act as an orchestrator for ecosystems. In the other words, digital ecosystems need B2B platforms to scale. According to IDC, B2B platforms can be seen as virtual environments facilitating the exchange and connection of data between different organizations through a shared reference architecture and common governance rules. Such a reference platform architecture includes for instance customer experience capabilities, such as omni-channel UX, customer and partner management, business process capabilities, such as pricing and payments, supply chain management, product management, service management capabilities, such as events management, identity management, orchestration and integration, and information management capabilities, such as data management and analytics, data governance and document management. Figure 3 illustrates some examples of B2B platforms reference capabilities.

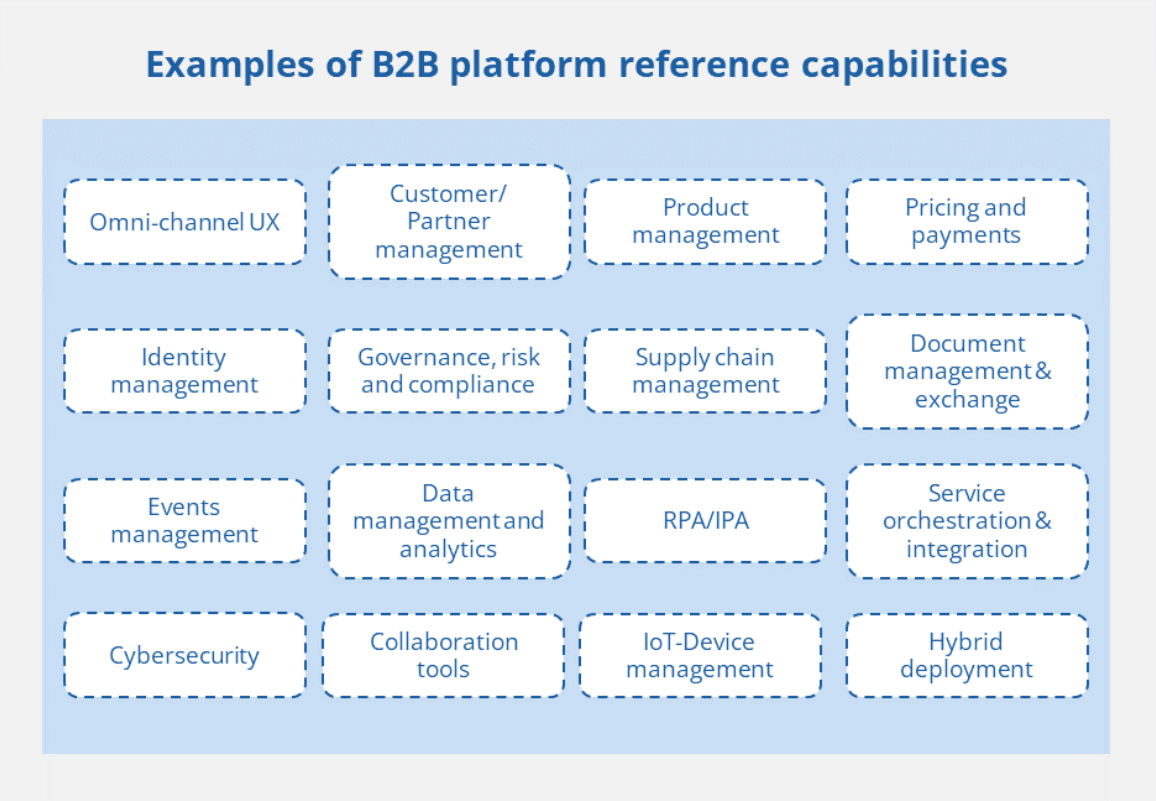


Figure 3. B2B Platforms reference capabilities

There are many examples of such B2B digital platforms in Europe. A few of them are:

- **Combient**[26] is a collaboration network in the Nordics that attracted 3500+ startup submissions from 43 countries, orchestrated the launch of 10+ joint ventures and investments, accelerated 28 of 40 commercial projects to implementation.
- **Polymore**[27] is a B2B online marketplace for the procurement and sale of compounds, masterbatches, recycled materials, and post-industrial materials in Europe. It connects compounders and plastic processors for simple and secure trade in products.
- **The Open Manufacturing Platform (OMP)**[28] is a global alliance helping manufacturing companies accelerate innovation at scale through cross-industry collaboration, knowledge and data sharing, and access to new technologies.
- **Data4Safety** is a data collection and analysis program by the European Union Aviation Safety Agency (EASA) that will support the goal of ensuring the highest common level of safety and environmental protection for the European aviation system
- **Spunta**[29] is an ABI Lab coordinated network of around 100 banks working together in an industry-specific ecosystem focused on interbank reconciliation process

[26] https://combient.com/
[27] https://www.polymore.com/en/marketplace
[28] https://open-manufacturing.org/
[29] https://www.abilab.it/aree-ricerca/blockchain-dlt/spunta-banca-dlt

3 The role of B2B Digital Platforms in the Digital Transformation of Europe: four domains' analysis

3.1 The role of B2B Digital Platforms in the Digital Transformation of Manufacturing Domain

Digital manufacturing platforms enable the provision of services that support manufacturing in a broad sense and within an ecosystem. The services that are enabled by digital manufacturing platforms are associated to collecting, storing, processing, and delivering data. These data either describe the manufactured products or are related to the manufacturing processes and assets that make manufacturing happen such as materials, machine, enterprises, value networks and factory workers. These services are provided by multiple service providers for a multitude of users of these services (in a multi-sided eco-system).

In general, digital platform for manufacturing can provide any "digital" extension of functionalities for physical assets, through adoption of ICT technologies. Digital platforms play a crucial role enabling the application scenarios of digital manufacturing[30].

In the following sections, the emerging rise of digital platforms in manufacturing sector is investigated as along with their important role as the orchestrators of ecosystem and some examples of rising European platforms.

3.1.1 New business directions in manufacturing sector and increasing importance of digital platforms

Collaboration ecosystem model is a joint initiative developed to co-create manufacturing technology, product, and (or) service by more than one enterprise for commercial synergy through innovation or new offerings. The main characteristics of collaboration ecosystem model are:

- The Key objective is gaining rapid scale.
- The parent enterprise acts like a holding company.
- Collaboration throughout value chain namely product design, development, production, and after-sales.

Nowadays there are 5 main drivers of ecosystem collaboration in manufacturing domain:

- **Operational efficiency:** the need to optimise complex operations by balancing "own" and "shared" resources (e.g. subcontractors). Another option is to reduce the overcapacity issue by "factory as a service".
- **Increasing customer value:** the need to become a trusted partner for customers is an important driver for ecosystem collaboration. In a time where global value chains are being redesigned, companies need to tie closer relationship with their key customers.

[30] EFFRA European Factories of the Future Research Association

Increase supply chain transparency: Only 20% of companies have full transparency and visibility over their value chain. Manufacturers need to share information more tightly upstream and downstream along the supply chain.

- **Ensuring business resilience**: It is essential to be able to reduce and minimize the impact of sudden disruptions on operational process and customer fulfillment. Expanding the suppliers and partner network is a way to create redundancy in operational execution.
- **Joint product innovations:** For many manufacturers today, most of the innovation happens outside the walls of their company. This is indeed happening in adjacent industries and most notably in the high-tech sector. Many companies are now reliant on high-tech in their products and need therefore to be aware of the latest developments in this space in order to ensure meaningful product innovation programs.

Figure 4 summarizes these 5 drivers with some explanations and facts.

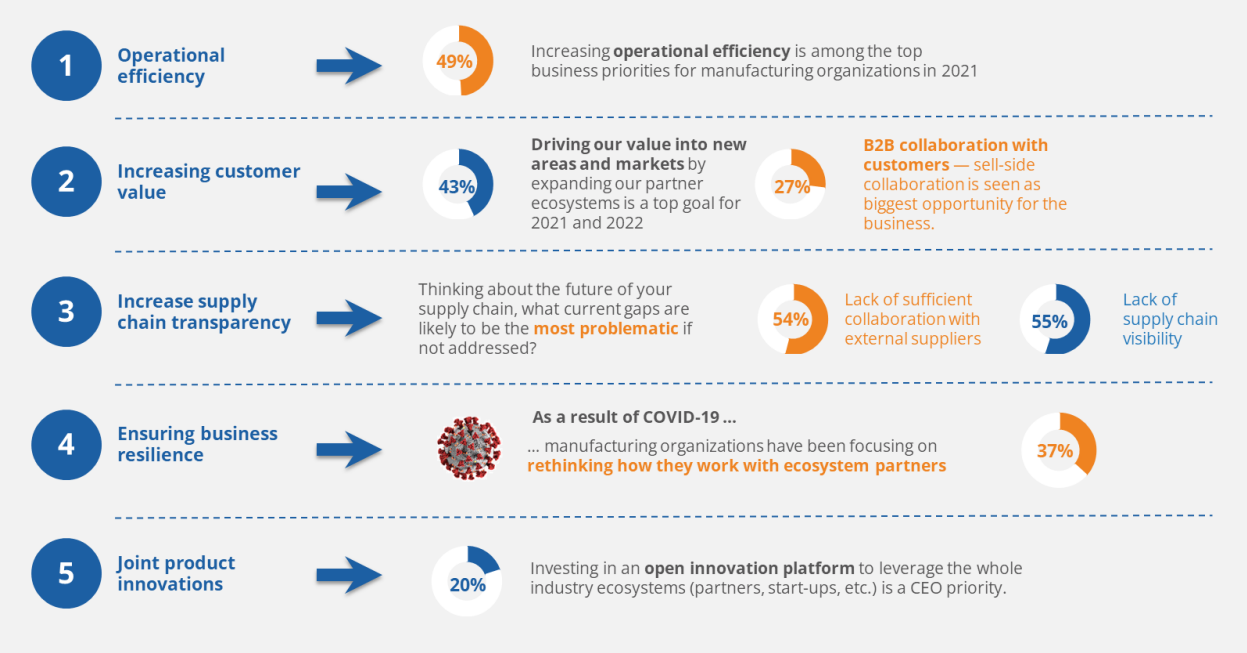


Figure 4. Tope drivers of ecosystem collaboration in manufacturing (Source: Various worldwide IDC survey data from 2020 and 2021 related to manufacturing organizations only)

Accordingly, manufacturing organizations need to integrate their operations much closer with their industry ecosystem stakeholders than they did in the past. This means integrating different players of the ecosystem such as IT providers, suppliers of raw materials, adjacent industries' stakeholders such as insurers, repair ships, payment providers; maintenance service providers; logistics providers; compliance and regulation authorities and associations; customers; engineering service providers; telco and connectivity providers and operations technology providers. Value chains will become value networks/ecosystems, underpinned by platforms. This shows a shift from ego-systems to eco-systems.

By 2025, driven by volatile global conditions, 75% of business leaders will leverage digital platforms and ecosystem capabilities to adapt their value chains to new markets, industries, and ecosystems[31]. The new business direction in the manufacturing industry highlights the importance of ecosystem paradigm. According to IDC Future Space study[32], by 2023, 20% of discrete manufacturing ecosystem participants will lead and shape ecosystems through technology innovation and vision, resulting in polarized gains within value chains.

Such a paradigm shift from ego-system to eco-system highlights the critical roles of digital platforms as the orchestrator and enabler of this ecosystem.

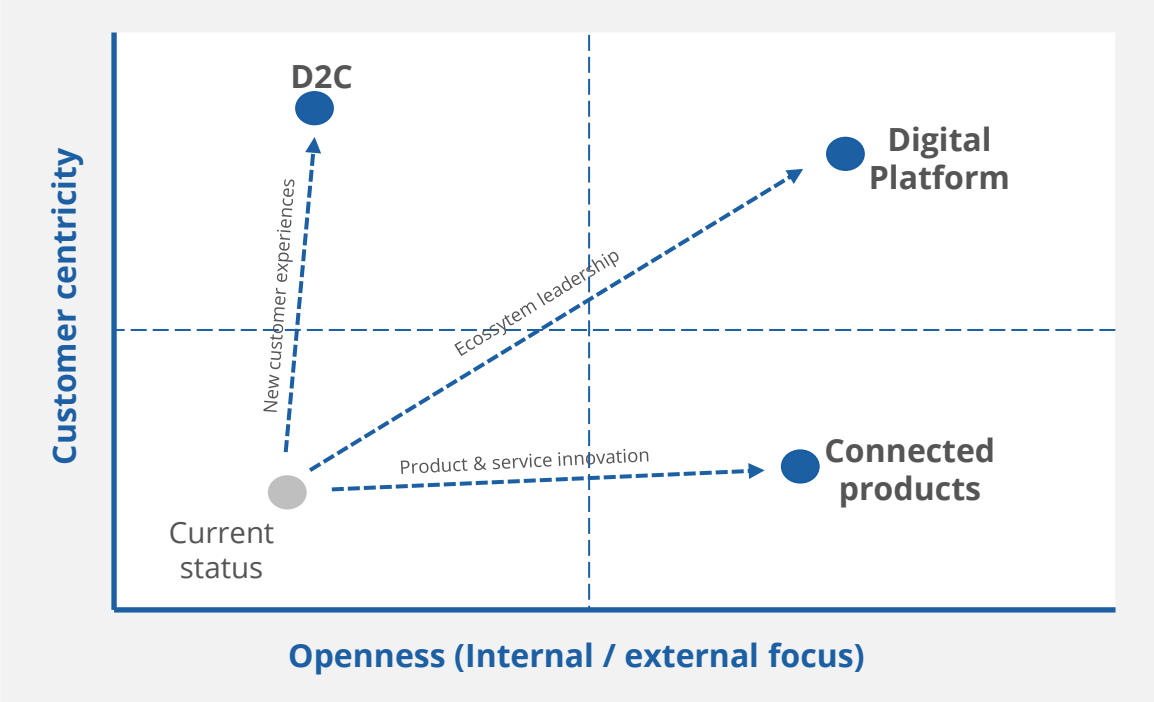


Figure 5. New business directions in the manufacturing industry and the rise of digital platforms

3.1.2 Engagement models in manufacturing

Companies in the manufacturing sector are doing the shift from the "old" world of products and services to the "new" world of emerging business models. In this new world, the innovative business models such as marketplace, data monetization, fee-transaction-based model, etc. are gaining more and more attention as the new ways of running business and engaging with the customer. Figure 6 shows the result of a survey conducted by IDC including 196 European manufacturing companies in the study to understand what the business models are they use in

[31] IDC FutureScape: Worldwide Digital Transformation 2021 Predictions
[32] IDC's Future Enterprise Resiliency & Spending Survey, February 2021

their organizations. The results depict that while the traditional models are still the prevalent ones, the numerous emerging models have a significant share as well.

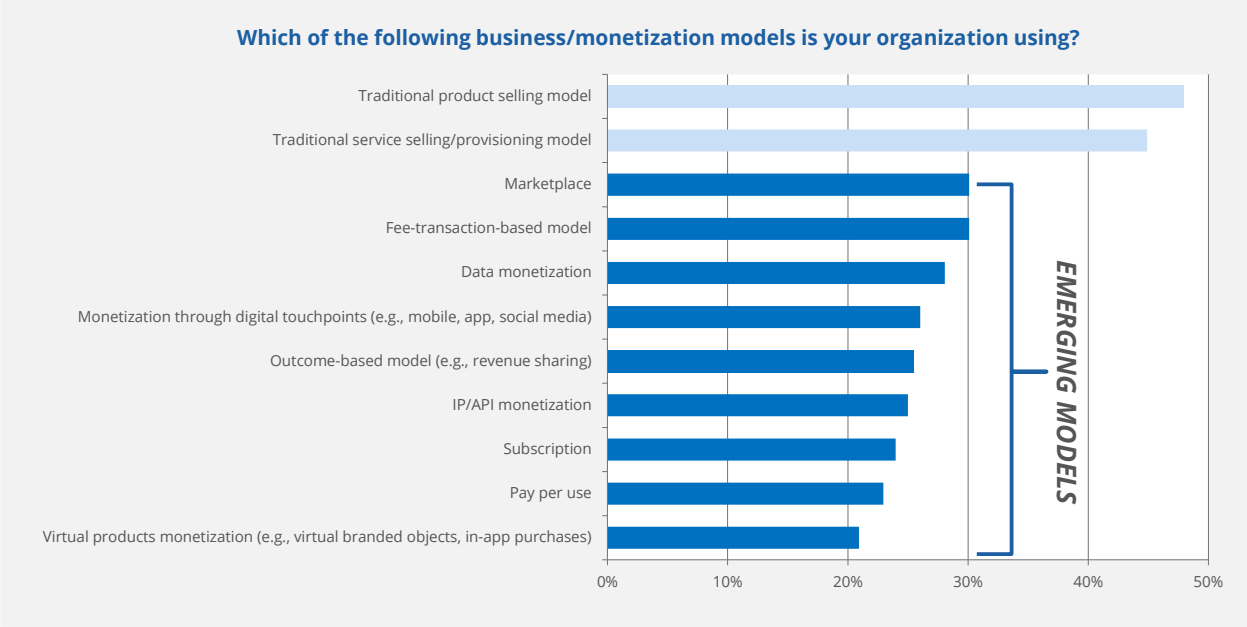


Figure 6 Emerging business models in manufacturing sector (IDC EMEA, European Industry Acceleration – Manufacturing N=196)

After studying the landscape of the existing manufacturing business ecosystem, their function and use-cases, IDC has come up with the following manufacturing ecosystem categories depicted in Figure 7 to help decision makers and policy makers in classifying and mapping their transformation path in order to support companies entering and thriving in the ecosystem business.

- Information Exchange Model
- Shared Application Model
- Collaboration Model
- MarketPlace Model

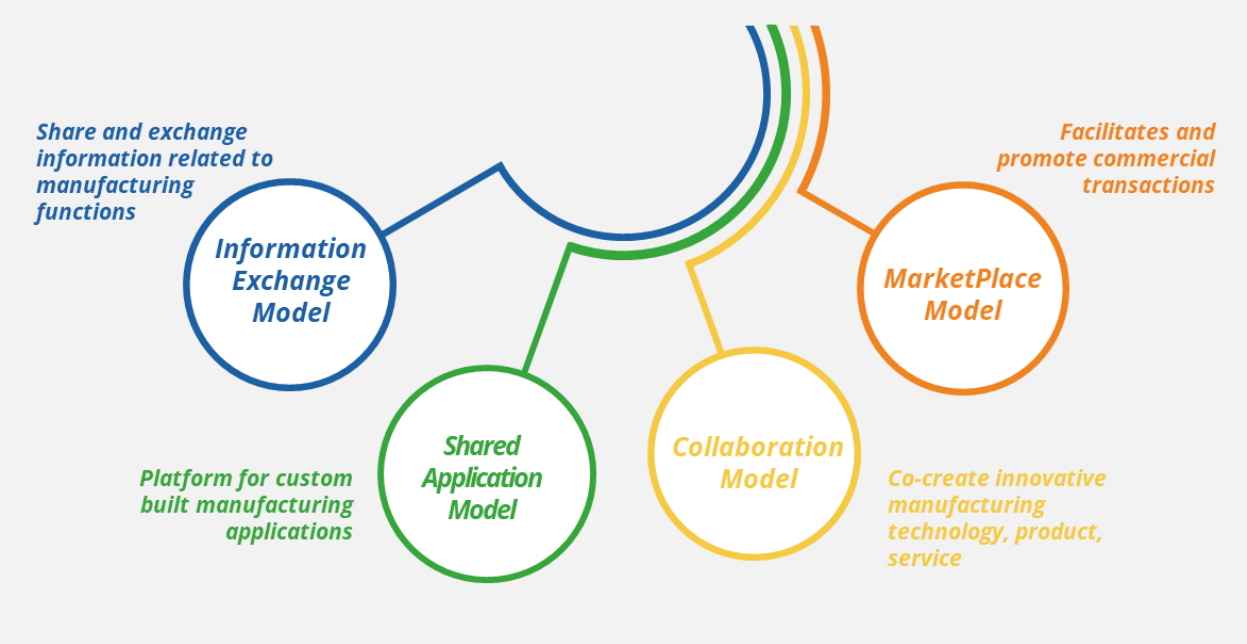


Figure 7. Engagement models in manufacturing

An explanation of each model is provided below:

3.1.2.1 Information Exchange Ecosystem Model

IDC defines Information Exchange Model as an ecosystem which main purpose is about data and information sharing. The goal is to enable participants in such an ecosystem to turn data from other participants in that ecosystem into information that enables them to generate some value. Below are the main key characteristics of this model:

- Participants in such ecosystems can be any entity that can generate value from data which is not their own. Typically, these are companies from adjacent or related industry sectors.
- Participants in information exchange ecosystems need to be properly registered. There are access and coordination mechanisms in place
- Data is only shared between agreed parties. This is important, because all participants need to agree to mutual data sharing agreements and need to comply with GDPR.
- The participation in such information exchange models can be free of charge or subject to a fee:

    a) Free of charge models do not pay money to providers of data and also do not charge consumers of this data. Those type of free of charge models are often called "open data initiatives".
    b) Information exchange models can also be based on commercial interest, where providers of data typically get money and consumers typically pay money for data consumption.

- Typically, only data is shared. There is no or only minimal additional services offered.

Technology in this ecosystem plays an important role, mainly:

- There needs to be a data repository which enables to store and manage data, typically this is a scalable cloud-based data platform.
- Data exchange requires that there is a common pre-agreed format (incl. semantics) for data exchange.
- There must be a defined interface for data provisioning, upload and consumption. Data platforms typically provide APIs to inject data into applications for specific purposes (see examples below)
- In cases where there are no 3rd party platforms involved for data collection and data consumption, blockchain technology can be used to verify and validate data transactions.

3.1.2.2 Shared Application Ecosystem Model

IDC defines **Shared Application Model** as an ecosystem which its main purpose is to share custom built application for specific purposes. The main goal of the model is to enable participants in such an ecosystem to make use of custom-built applications that have already been developed for specific purposes by other stakeholders, often IT companies, and that can enable participant with similar needs to benefit from existing application without the need to re-invent an ad-hoc solution. Typically, applications shared in such ecosystems help to address common challenges within an industry or domain.

The main key characteristics of this model areas the following:

- Participants in shared application ecosystems need to be registered in such, or even be part of a specific alliance or working group.
- Participants in such ecosystems typically are companies from adjacent or related industry sectors that have similar needs or challenges to address. They provide their own expertise in a co-opetitive (Cooperative Competitive) fashion to their industry peers.
- Common challenges can relate to gain insights from own data. Shared applications could be heavily analytics-driven, where data dashboards allow other users of this application to better utilize the data in order to optimize the efficiency of owned operations.
- Typically, the usage of such shared applications is subject to license fees for accessing the platform or for benefitting from the applications and data models created by other participants.
- Technology is essential in shared application ecosystem model, thus; Typically, such shared application ecosystems are cloud-based IoT platforms that also provide developer tools that help to develop new applications to be shared with the ecosystem members. Applications are pre-validated by the application provider and are available for download from so-called app marketplaces.
- Those platforms can be hosted by industry players themselves (e.g. manufacturing companies) or by third party non-manufacturing companies (e.g. software, hardware or automation providers).

- Platforms typically provide APIs to inject data into applications for specific purposes.

3.1.2.3 Collaboration Ecosystem Model

- IDC defines **Collaboration Ecosystem Model** as an ecosystem which its main objectives are joint initiatives to drive product and service innovations in the industry. The main goal is to enable participants in such an ecosystem to speed up the development of innovative industrial solutions and gain rapid scale by enabling knowledge exchange and utilizing a joint pool of talents.

The main key characteristics of this model are:

- The ecosystem involves significant personal interactions among member companies to align interests, goals, measures and working groups to enable the coordination among the community members.
- Collaboration can take place throughout the entire spectrum of business processes. For example, in manufacturing, product design, development, production and after-sales.
- Initiatives can focus on the development of certain technologies or on industry-specific solutions. Jointly developed solutions will be shared in the ecosystem.
- Participants in such ecosystems typically are companies from adjacent or related industry sectors that have similar needs or challenges to address.
- Typically, the participation in such ecosystem requires some membership fees.

Technology is important to enable this type of ecosystem although it does not play a central role.

- Typically, infrastructure is provided and organized by the community in order to be able to develop and test joint solutions, which will then be applied in own technology/infrastructure environments. An example of such infrastructure includes are cloud-based industrial IoT platforms.

3.1.2.4 MarketPlace Ecosystem Model

IDC defines **MarketPlace** Ecosystem Model as an ecosystem which brings together demand and supply side players to discover, promote, purchase and partner for specific manufacturing products or related services. The main goal and purpose of B2B marketplaces is to enable and optimize commercial transactions between corporate buyers and sellers thereby increasing efficiency of B2B procurement or sales operations.

The key characteristics of this ecosystem model are:

- B2B marketplace providers can either be driven by IT vendors or by manufacturing companies themselves.
- Industrial B2B marketplaces can either serve generic needs of the manufacturing industry or serve specific needs of very specialized manufacturing sub-sectors such as steel, recovered paper or timber (see examples).

- Platform participants enjoys the main benefits and challenges of the 'network effect' through referral, rating, and also potentially being banned from accessing the ecosystem.
- There are various pricing models to use these B2B marketplaces. It can range from free to time-based subscriptions, and even include commercial models based on percentage/ commission for awarded jobs, orders, or sales.

The importance and role of technology is quite high in this engagement model considering that:

- Typically, B2B marketplaces are cloud-based and (or) mobile-enabled platform that can be accessed in a very simple way.
- In order to differentiate from other similar propositions, B2B marketplaces offer additional capabilities such as data analytics, to enable their customers to make better data-driven decisions.

3.1.3 Examples of Manufacturing Platforms

Several players are in active in the digital platform market for manufacturing domain. IoT platforms, or as indicated in manufacturing domain, IIoT (Industrial IoT) platforms are the dominant ones in this domain. IoT platforms are established to reduce the efficiency and cost of new IoT solutions using various components. They design custom solutions and configuration tools for specific needs, as well as elements specific to various applications. The value generation of IoT platforms for manufacturing companies can range from very generic (e.g., generic cloud storage) to very specific (e.g., Remote update capabilities on the application level) services.

3.1.3.1 Bosch IoT Suite

Bosch IoT Suite, operated by Bosch.IO, serves as an IoT platform for Bosch internally and external customers[33]. Specifically, the Bosch IoT Suite focuses on scalable IoT services offered as PaaS, ranging from software for device connectivity and communication to device and data management. As of today, already more than ten million devices are connected on the basis of the Bosch IoT Suite. On the infrastructure level, Bosch offers its own cloud service but also enables hybrid cloud set-ups. Hybrid cloud set-ups combine third-party cloud solutions (e.g. AWS or Microsoft Azure) with IoT services provided by the Bosch IoT Suite. Also, industry- and customer-specific use cases are developed. To distinguish itself from other IoT platform providers, the Bosch IoT Suite builds on three strategic pillars: 1) developing open-source software 2) leveraging industry knowledge 3) Innovating on proven IoT solutions. Figure 8 shows the overall architecture of Bosch IoT platform.

[33] https://bosch-iot-suite.com/

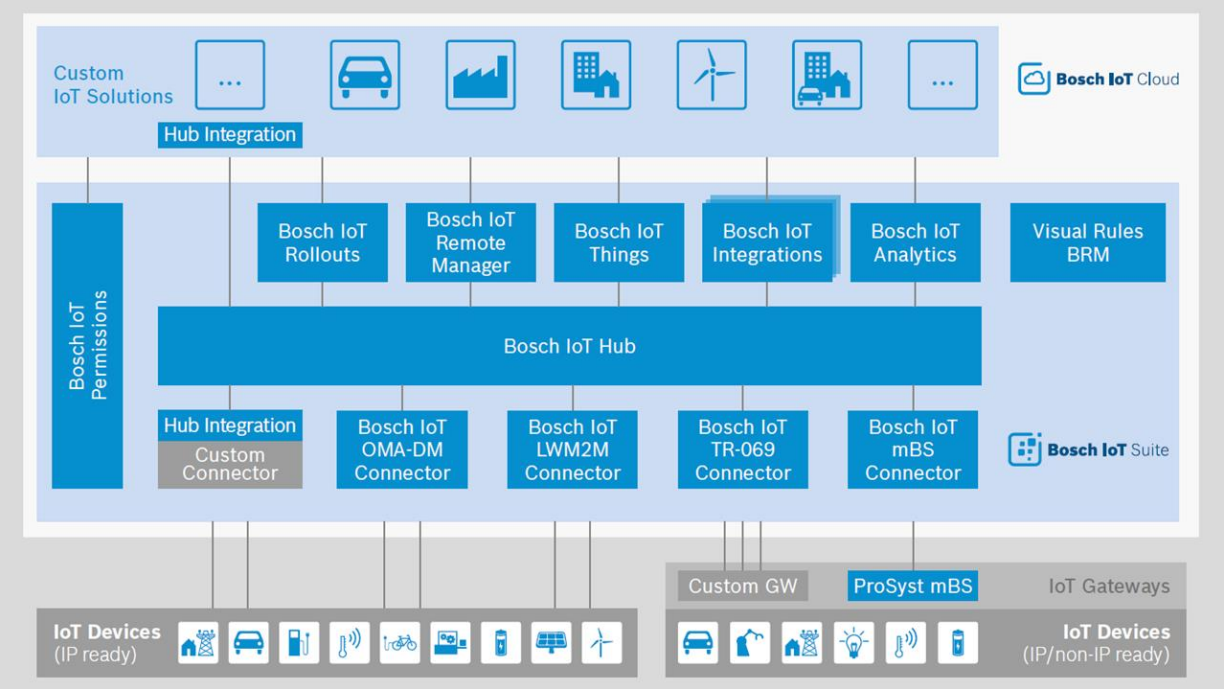


Figure 8. Architecture of Bosch IoT platform[34]

3.1.3.2 Siemens MindSphere IoT Platform

MindSphere is Siemens' cloud-based open Industrial Internet of Things (IIoT) operating system. It is capable of connecting all the equipment and systems of a production unit, extracting its data, analyzing it with algorithms and converting it into valuable information to improve the performance and profitability of your business in a personalized way. MindSphere provides the basis for the development of applications and services based on both company and third-party data in fields such as predictive maintenance, energy data management or resource optimization. It is a tool that provides multiple services designed ad hoc for manufacturing companies that want to embark on the path towards Industry 4.0. The main functionalities of Siemens IoT platform for manufacturers are: 1) interconnecting all the physical products and facilities of a plant 2) having the data generated by the plants instantly 3) carrying out planning, maintenance and process optimization tasks.

As an industrial IoT as a service solution, MindSphere collects and analyzes all kinds of sensor data in real time. This information can be used to optimize products, production assets and manufacturing processes along the entire value chain. MindSphere's open application interfaces make it possible to obtain data from machines, plants or entire fleets irrespective of the manufacturer. These interfaces include OPC Foundation's OPC Unified Architecture (OPC UA). To help customers create their own software applications and services, MindSphere is equipped with

[34] https://iot5.net/iot-platforms/

open application programming interfaces (APIs) and development tools. This allows OEMs to integrate their own technology.

Assets can be securely connected to MindSphere with auxiliary MindSphere products (e.g. Data Capture Unit, MindConnect IoT2040 or MindConnect Nano) that collect and transfer relevant machine and plant data. MindSphere is based on the concept of closed feedback loops enabling the bi-directional data flow between production and development: Real-world plants, machines and equipment can be connected to MindSphere in order to extract operational data. Valuable information (e.g. "digital twins" of machines) can then be extrapolated from the raw data through analytics and utilized to optimize products as well as production processes and environments in the next cycle of innovation.

Figure 9. Siemens's MindSphere IoT Platform

3.1.4 Overview of a SWOT analysis of digital platforms in the manufacturing domain

Analysis of the status of digital platforms market in manufacturing domain highlight the following strengths, weaknesses, opportunities and threats to be considered.

Strengths

- There is a strong push in manufacturing domain to look beyond the walls of the enterprise to seek innovation and exploit emerging business models. Consequently, Digital platforms can be considered a facilitator to satisfy this need for open innovation
- The manufacturing sector is a supra-national sector by nature, with little national specificities in terms of regulatory model, market structure, operational and distribution models. This

enables the creation of regional or "worldwide" consortia and initiatives that bypass the single national markets.

Weaknesses

- Platforms fit a limited space in an "ecosystem industry" like manufacturing where process and industry relationships change significantly across verticals. Only 1 in 4 of ecosystem models identified by IDC is totally reliant on platforms.
- Economies of scale can be a challenge for digital platforms in manufacturing domain due to the extreme granularity and "balkanization" of most verticals in the domain.

Opportunities

- Technologies for platforms are mature and ready to be used. The more cloud-based applications are used and open APIs are provided, the more manufacturers will find it easier to share and exchange data. It should be noted that data and its semantics need to be captured and managed in a common format so that it can be utilized by all stakeholders in an ecosystem.

Threats

- Manufacturing is an industry that prioritizes consistency and safety above all and has a significant amount of regulatory and heritage drag. Many manufacturing companies, particularly in the SMEs market, lag behind their peers in other industries when it comes to technology adoption and vision, and this poses a risk of stranded initiatives.

3.2 The role of B2B Digital Platforms in the Digital Transformation of the Energy Domain

In recent years, the energy domain has faced a significant transformation driven by two main forces. One is the gradual shift towards a carbon-neutral economy and clean energy and the second is the rapid development and adoption of digital technologies in many areas of the energy domain. Digital technologies have reduced the costs of collecting, sharing and using information, reducing search and transaction costs. In this respect, the costs to participate in some markets have become so little to allow peer-to-peer interactions or exchanges in collaborative economy platforms to emerge. Moreover, quick technological development and uptake push market stakeholders, particularly small and medium sized enterprises, to adapt their processes quickly and catch-up as fast as possible[35]. The Energy sector gradually reshapes into decentralized networks with lower capacity, but able to manage demand and supply in real-time.

[35] https://www.sciencedirect.com/science/article/pii/S0301421520303499

Accordingly, digital platforms could significantly affect the digitalization of the energy industry. Digital platforms increasingly propose business models that improve economic efficiency by better coordinating supply and demand under imperfect information- and attain higher efficiency levels.

In the upcoming sections the significant role of digital platforms in Energy sector eco-system is described and some existing digital platforms in this domain are mapped based on IDC's future of industry ecosystem model.

3.2.1 Eco-system approach in the Energy domain and key role of platforms

In a hyperconnected world, companies' ability to generate value is increasingly tied to their participation in a new ecosystem economy. A recent IDC study published in 2021 highlights that how covid pandemic has accelerated this paradigm shift to ecosystem collaboration (Figure 10)[36].

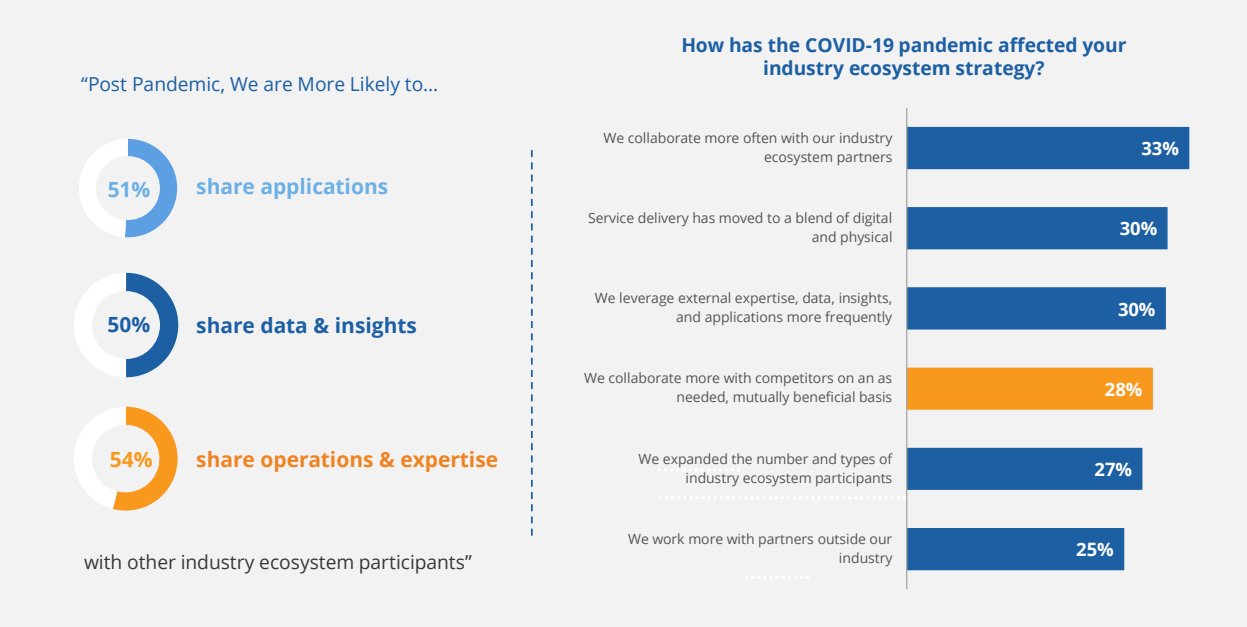


Figure 10. Post-Pandemic Increasing importance of ecosystem collaboration

According to the results of this study:

- Over half of organizations are more likely to share applications, data, and operations expertise with other industry participants;
- 28% of companies currently collaborate with competitors on a needed basis which is a quantum leap from the past;

[36] Future Enterprise Resiliency & Spending Survey, Wave 3, IDC, April 2021

- A quarter of companies are expanding their ecosystems, and crucially this includes partners outside their industry.

Focusing on European utilities and energy companies and specifically those E&U companies that consider ecosystems as one of their strategic priorities for the next years, it turns out that they own certain traits that put them ahead of the maturity curve.

First of all, according to IDC European Core Utilities Business Innovation Survey conducted in 2021[37], these companies have a very open approach to innovation. Accordingly, they have set up tech communities, they collaborate with and incubate tech startups, they do crowd-sourcing and they co-innovate with their suppliers. Such an approach becomes more important noticing that these ecosystem-focused companies have a more advanced digital technology posture. For instance, they are more likely to have developed RPA (Robotic Process Automation) and DevOps capabilities and are more likely to have a multi-cloud architecture for their core systems. This also means they are generally better at data. For instance, they are more likely to have a data governance strategy in place, they are better at data integration and processing and are more likely to be using open data sources.

Eventually, the study reveals that these companies are ahead of the game in transforming the business as they are more mature in transforming the employee experience, the customer experience, improving sustainability and risk management, service innovation, etc.

Overall, utilities and energy companies that are prioritizing the ecosystem and ecosystem innovation seem to be the most mature ones in the market in terms of digital transformation.

3.2.2 The Future of industry ecosystem model for the energy sector

In the Future of Industry Ecosystems, an organization's ability to generate value will increasingly be tied to its participation in a new digital economy. New business models will emerge, accompanied by new customer requirements and ways of operating, that will spur the creation of new, scaled up digital ecosystems that leverage software platforms to deliver scale and speed.

According to IDC, thefuture of industry ecosystem model leverages shared data, applications, operations, and expertise — expanding upon the platform, sharing economy built during the past five years.

[37] https://www.idc.com/getdoc.jsp?containerId=EUR148370721

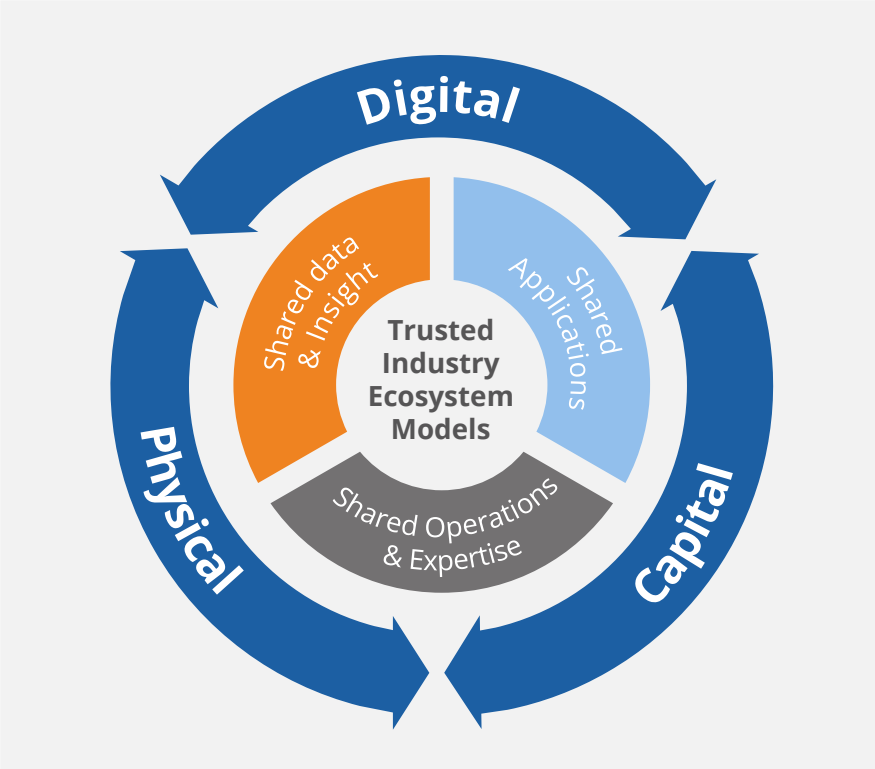


Figure 11. IDC 's Future of Industry Ecosystems

The segments of sharing across an industry ecosystem encompass the following:

- **Sharing data and insights** to ensure security, reduce fraud, improve functional safety and security, spur mission-critical innovations, and encourage cross-ecosystem reporting.
- **Sharing new applications** to enable data and insights, improve operational efficiency, and create better customer experiences.
- **Sharing operations and expertise** so that organizations can scale their capability and capacity for new products and services to meet market, customer, and consumer needs.

Each of these shared elements of the future of industry ecosystems complements and enhances the other ones, producing a multiplier platform effect that results in improved innovation, intelligence, customer experience, and trust.

Focusing on Energy domain from the future of industry ecosystem model, there are several projects in Europe that can be positioned and mapped in this model.

In terms of "shared data and insight", here are a few examples of some projects, platforms and initiatives at European level:

- **Estfeed:** Data exchange providing secure access to consumption and generation data in the electricity and gas data hubs (along with commercial register, price and weather data) for applications and market participants.

- **EU-SysFlex:** aims at expanding Estfeed to cross-border data exchange, connecting data exchange platforms, data hubs and applications in different countries.
- **ODI-Smart DCC Data for Good programme**: smart meter system free data access initiative to support more efficient energy use, net zero and local decarbonization, consumer vulnerability, and sector coupling.
- **Gaia-X Energy Data Space:** Federated data infrastructure offering access to integrated data spaces supporting European energy transition and system optimization. 8 data use cases from renewables to hydrogen, electric vehicles, and energy communities.
- Other bottom-up, cross-border data exchange platforms and initiatives covering energy such as **FIWARE, IDSA, BRIDGE.**

Moving to the second dimension of ecosystem collaboration model, "Shared Applications" where data and insights are turned into practical applications to solve real market problems, there are several organized marketplaces that have emerged over the past 3 years in Europe for transmission & distribution system operators to coordinate and procure flexibility for various use cases such as voltage control, frequency regulation, congestion management, curtailment avoidance and investment deferral.

Some examples of these platforms are:

- **Flexibility marketplace applications** for TSOs and DSOs to coordinate and procure flexibility for voltage control, frequency regulation, congestion management (and curtailment avoidance) and investment deferral. E.g., **NODES (NO), GOPACS (NL), Piclo Flex (UK).**
- **Equigy** is a TSO-led blockchain-based data exchange to enable aggregators to "crowd-balance", i.e., enable small flexibility devices to participate in electricity balancing.
- **E-mobility platforms enabling EV owners**, CPOs and EMSP to share data to solve market complexity and improve the charging experience. E.g., **Chargemap, Place to Plug, Plugsurfing**.
- **Blockchain for Energy Consortium** which is an industry collaboration initiative aimed reinventing O&G industry processes leveraging blockchain to maximize efficiencies, reduce costs, improve timelines, and drive industry transformation through collective synergies.

The third dimension of the ecosystem collaboration platform is" Shared Operations & Expertise" where companies pool actual operational capabilities and expertise to support the ecosystem.

Here are 2 very recent platforms and initiatives in this regard in Energy domain:

- **Open-es** is a collaborative ecosystem promoting sustainability of industrial supply chains through ESG data collection, performance assessment/benchmarking, development frameworks and services marketplace.
- **Global Alliance for Sustainable Energy** is a coalition of utilities, renewable OEMs, associations and innovators to achieve full sustainability of the renewable energy industry's operations and supply chain. Initial efforts: on four key themes: net-zero & CO2 footprint; circular design & international guidelines; human rights; and water footprint.

3.2.3 Examples of existing Energy Platforms

3.2.3.1 Estfeed: A digital platform for sharing data and insights

Estfeed[38] was launched in 2017 and is a digital platform designed to be a secure, compliant, one-stop-shop type of environment (one of the first of its kind in production in Europe) for energy data exchange.

Energy data refers primarily to the smart metering data of private energy consumers. Data about how much gas or electricity a household or business has consumed in a given period and with what time profile, or how much they have produced and sold back to the grid. Estfeed also gives access to other types of data such as public data like day-ahead electricity prices, weather forecasts, data from the public commercial register etc. In general it deals with all the data that an energy service provider needs to optimize the services they offer to energy consumers and design smarter and more personalized ones. Estfeed can be considered as a secure, distributed data transport layer based on a homegrown technology called X-Road with a consent management system built on top that enables the consumer (which is the data owner in case of smart metering data) to be in control and have full visibility of whom they share their data with.

The platform was designed and is operated by Elering (the Estonian electricity and gas transmission system operator) that acts as the neutral enabling party and is in charge of managing data access and offering first and third-party applications. There are five basic first-party applications on the platform, enabling consumers to keep track of their own usage. There are also several 3rd-party applications, from building energy efficiency to personalized energy tariff comparison.

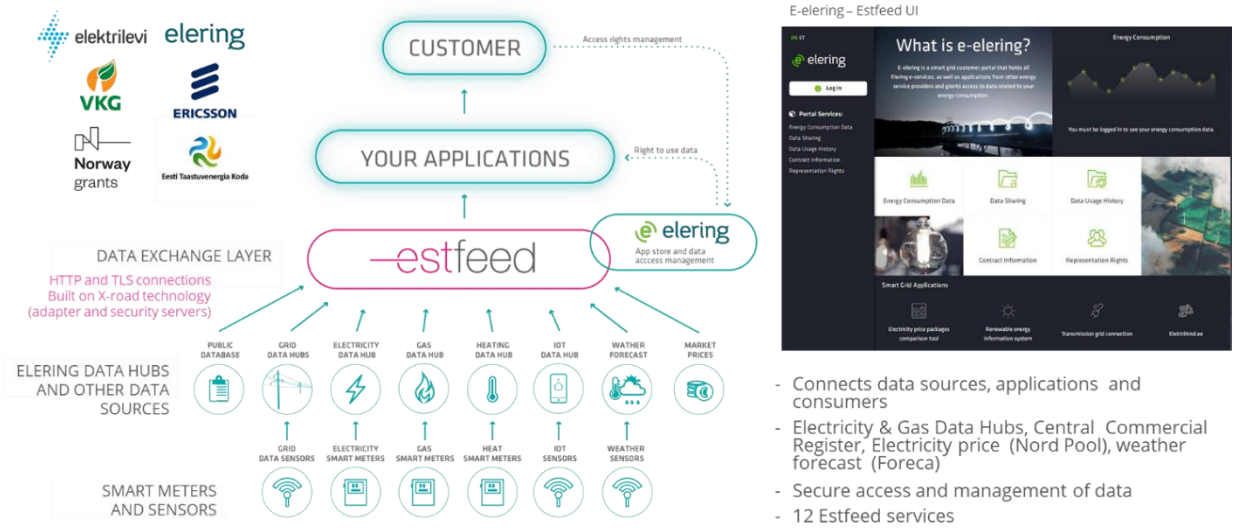


Figure 12. Estfeed Platform

[38] https://www.estfeed.eu/en/home

3.2.3.2 Equigy: A digital platform for sharing flexibility applications

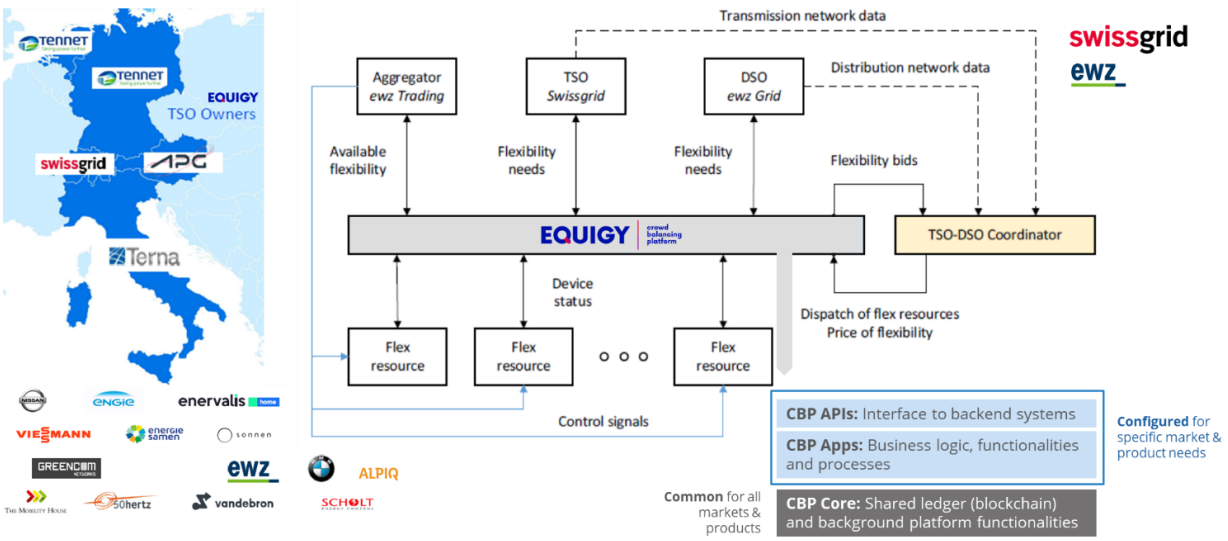
Equigy[39] is a blockchain-based platform developed and promoted in joint venture by four European power transmission system operators (Terna, Swissgrid, TenneT and APG).

This "crowd-balancing platform" has the objective of accelerating the use of small, flexible distributed energy resources to help balance power grids. The basic idea is that despite cross-country differences in energy markets, flexible resources (i.e. EVs, like home batteries, heat pumps, etc.) can, in any case, contribute to balancing the system and managing grid congestion with limited upfront costs (representing non-wire alternatives to investing in the grid).

Equigy uses blockchain to automate the business processes involved in exchanging flexibility and links the various interested parties in the flexibility market namely power transmission and distribution companies which are responsible for balancing the grid, the owners of the resources that can be used to provide flexibility (e.g., a small-scale CHP plant or an EV), the equipment manufacturers that are needed to physically connect to these resources, and finally, the aggregators that are responsible for pooling these small-scale resources into a single larger controllable one that can participate in the market.

The consortium has completed 3 pilot projects over the past year focusing on larger resources participating in primary markets. A new pilot is recently launched in Switzerland that focuses on smaller scale resources (i.e. domestic batteries, PV systems, heat pumps and EVs) offering less mission-critical services through an aggregator.

This will offer a glimpse of how small-scale energy consumers like citizens can soon participate in energy markets and be paid for the flexibility that they provide helping to improve the business case to invest in a PV or storage system, or an EV.



[39] https://equigy.com/

Figure 13. Equigy Platform

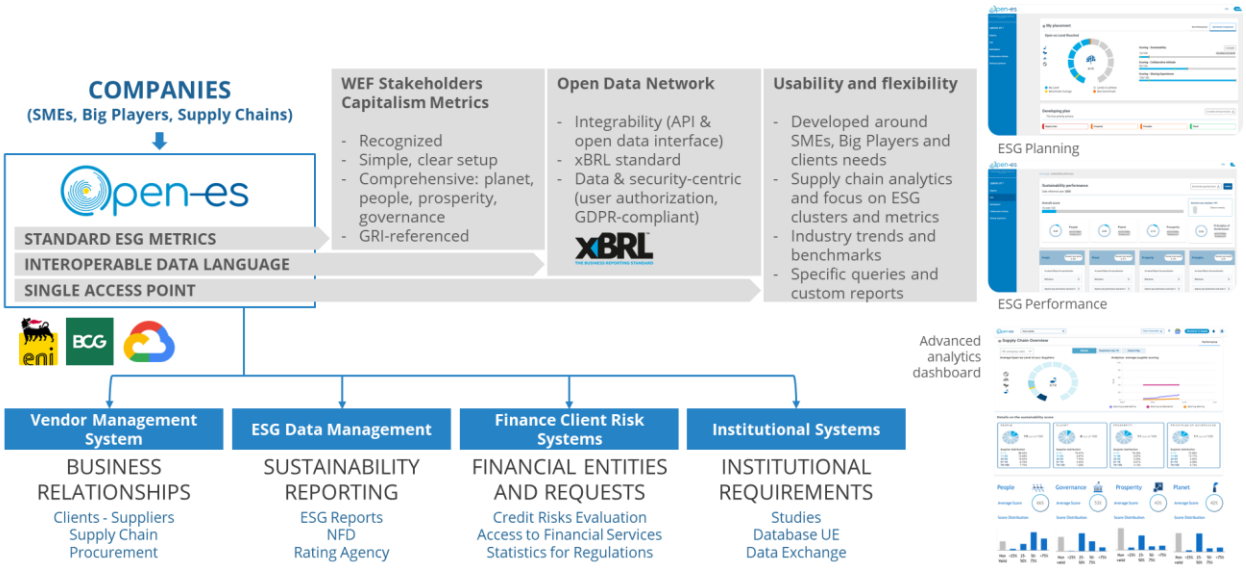
3.2.3.3 Open-es: A digital platform for sharing operations and expertise

Open-es[40] is a digital platform for sharing data on the sustainability of production chains, established through the partnership between Eni, Boston Consulting Group (BCG) and Google Cloud. It is an innovative, inclusive and open tool for all companies engaged in the energy transition process, which intend to grow and improve their economic performance by following sustainability principles.

The energy transition is a path of continuous transformation where collaboration between companies along production chains plays a key role. By accessing open-es platform, a company, whether an SME or large industrial player, becomes part of a real community promoting the development of collaborative and non-competitive processes to build a future based on four key pillars, the Planet, People, Economic Prosperity and the Principles of Corporate Governance. These form the basis of the environmental, social and governance (ESG) "Stakeholder Capitalism Metrics", defined by the World Economic Forum and the International Business Council (IBC).

Going live, Open-es had around 1,000 member companies and other 'sector-leading' companies from major industries are now joining the community, involving their suppliers and supply chains.

The Open-es ESG data model is based on the core metrics defined in the WEF's 'Stakeholder Capitalism Metrics' initiative and, with a simple and flexible approach, will allow all companies, from SMEs to big players, to align themselves against a pathway of growth and development based on sustainable values with a view to promoting a widespread awareness throughout the value chain.



[40] https://www.openes.io/

Figure 14. Open-es Platform

3.2.4 Overview of a SWOT analysis of digital platforms in the Energy domain

Analysis of the status of digital platforms market in energy domain highlight the following strengths, weaknesses, opportunities and threats to be considered.

Strengths

- Platforms fit well to an "ecosystem" like energy & utilities where participants are naturally linked by complex market processes
- With millions of energy consumers in every national market, economies of scale is not a significant challenge for energy domain.

Weaknesses

- The energy and utilities domain is local by nature, with significant national specificities in terms of regulatory model, demand and supply mix and market structure.
- A "one-platform-fits-all" concept is challenging for energy domain, while a layered approach of core functionality, applications and APIs suits more to the domain characteristics and needs.

Opportunities

- As energy systems decentralize and business models shift from pure commodity, there is a need to move from linear, sequential value chains to distributed platforms enabling broader market participation and transparency.

Threats

- Energy is an industry that prioritizes safety and reliability above all and has a significant amount of regulatory drag.
- Technology adoption in energy domain is typically slow which poses a risk of stranded initiatives and technology leapfrogging.

3.3 The role of B2B Digital Platforms in the Digital Transformation of Healthcare

The rising Covid-19 pandemic has created situations of uncertainty in medical practices and made visible at scale how poorly integrated and often unreliable information negatively impact healthcare systems. For healthcare systems to deliver high quality, personalized and integrated care services along the patient journey, the key players of the health value chain need to rely on digital platforms. These platforms provide the technological infrastructure and capabilities to support the delivery of healthcare services and drive innovation across the health ecosystem. These platforms should be able to leverage more informative and up to date quality information, with a high degree of trust among patients and healthcare service providers and their partners on the lawful and ethical use of data.

3.3.1 Patient-value and the transformed post-covid healthcare ecosystem

Healthcare systems are evolving towards the value-based healthcare paradigm that aims to shift business models from volumes of activities and single patient encounters, toward patient value, defined as the ratio between clinical outcomes and experiences, measured against the related costs, across the whole patient journey.

Accordingly, healthcare systems are moving into providing care services that are more personalized, and at the same time more integrated across the whole patient journey. Thus, each organization in the value chain has a role in creating value for patients and needs to work with the other stakeholders to maximize this value. This convergence on patient value is a key driver for healthcare providers to work closely with:

- governments and other healthcare payers to define new reimbursement models that rewards care quality, patient experiences and performance;

- public health authorities to help in planning and implementing interventions for specific populations and timely monitoring these interventions;
- the life science sector to develop innovative treatments as well as to measure the safety and the effectiveness of new products and devices to increase care quality and implement outcome-based payment models more at scale.

Collaboration and integration are necessary to act on a complex ecosystem of determinants that shape healthcare challenges. For example, to address the so called "silent pandemic" of antimicrobial resistance there is the need to further increase collaboration and information exchange on medicine prescription appropriateness, patients' adherence to treatment, animal health and farming practices, development of targeted antibiotics. Because of the complex and interdependent nature of the determinant of health, governments have been investing in the creation of common digital infrastructures, as well as the development and the deployment of interoperability and security requirements, that enabled the growth of digital platforms aimed at sharing data and insights, capabilities, skills and processes. The development throughout the years of shared electronic healthcare records, health information exchange networks, public health registries, as well as solutions for electronic identity and trusted data services have been laying the foundations (and the rules) for the growth of digitally enabled healthcare ecosystems. Efficient and prompt health information sharing standards and infrastructures, as well as the enablement of secondary use of health data are strategic pillars of healthcare systems resiliency. This has been proved during the COVID-19 pandemic, which has further accelerated the case for ecosystem collaboration. Significant growth in the number of organizations joining digitally enabled industry ecosystems for life sciences reinforces the need to get access to external expertise, data, insights, and applications for healthcare enabling collaborative care models. According to an IDC study[41], COVID-19 has resulted in 47% increase of collaboration with industry ecosystem partners for healthcare providers and 54% increase in leveraging external expertise, data, insights and applications for life sciences organizations.

Indeed, COVID-19 has not only been a pandemic, but also a syndemic (Synergistic epidemic). Syndemic outcomes are influenced by biological and social interactions and require an integrated care approach (Figure 15). This approach needs to act upon both the biological/ clinical interface and the socioecological interface. Therefore, it requires addressing factors such as hypertension, obesity, diabetes, cardiovascular and chronic respiratory diseases, and cancer and their complex determinants related to factors as education, employment, housing, food, and environment.

[41] IDC EMEA, European Industry Acceleration Survey, April 2021; IDC European Industry Acceleration Survey, October 2021

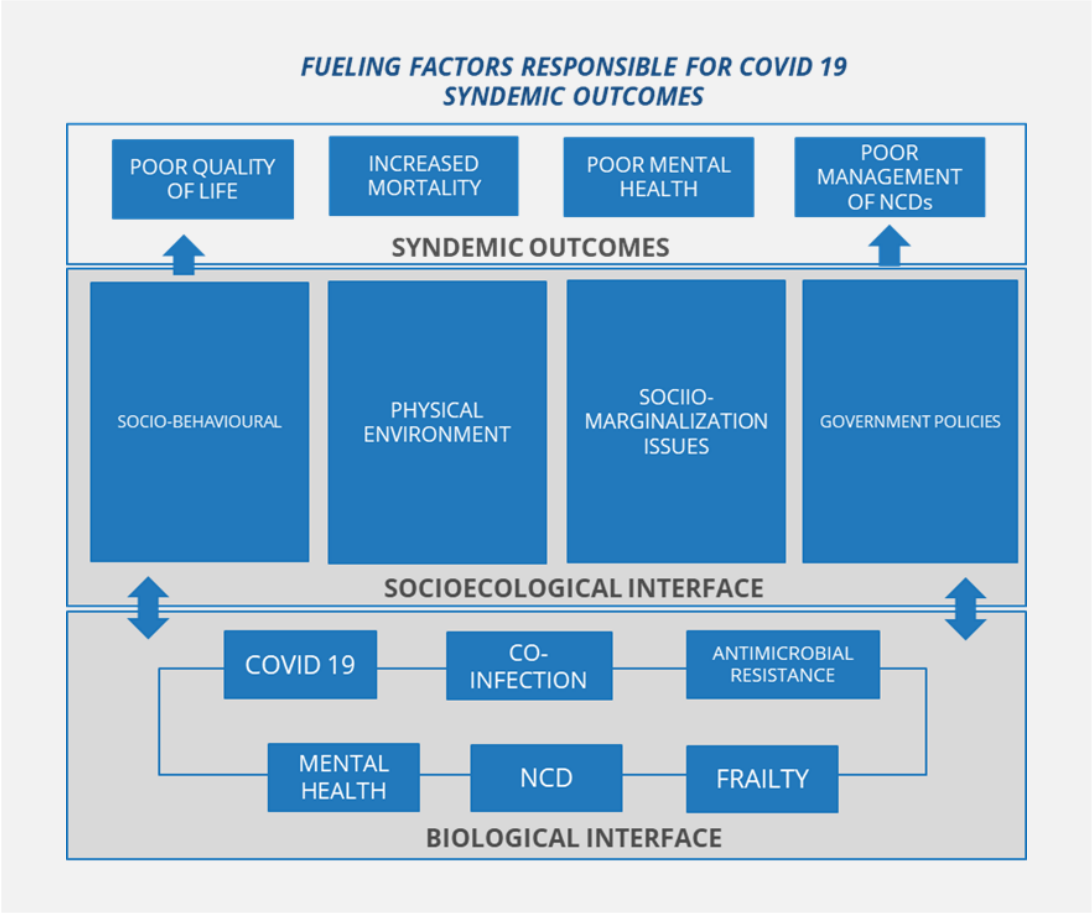


Figure 15. Fueling factors responsible for COVID-19 syndemic outcomes

Adapted from: A Syndemic Perspective on the Management of Non-communicable Diseases Amid the COVID-19 Pandemic https://doi.org/10.3389/fpubh.2020.00508

An example of the significant impact of COVID-19 in integrated care approaches can be seen in the @HOME platform[42], which is supporting home care programs in the province of Trento (Italy) where healthcare (APSS- Azienda provinciale per i servizi sanitari) and local government (Provincia autonoma di Trento) worked together to integrate data sources (as patient records, CRM, connected medical devices, mobile apps for patient) and workflows to create the 360° view of the patient that has allowed to rapidly scale and diversify services adapting to different patient needs. The project was launched in 2017 and was based on a cloud first and mobile first strategy;. The flexibility and the modularity of the platform allowed them to rapidly adapt to the pandemic scenario. The local health authority and its partners developed a front-end app for patients that did not require hospitalization integrated on the back end with the @HOMEplatform for the continuous monitoring of patients. In 2020 the project scaled from 40k patients to 100k patients.

[42] https://www.ufficiostampa.provincia.tn.it/Comunicati/Home-azzera-la-disuguaglianza-tra-cure-domiciliari-ed-ospedaliere

COVID-19 has driven life sciences to collaborate at a near-global scale to enhance their crisis response. Co-innovation has become particularly urgent to fast-track R&D efforts. Data driven collaboration at scale is built through standardized secure environments to enable real-time sharing of multisource data, as well as findings and analytics capabilities and compute across broader R&D networks. Two significant examples are the European Bioinformatic Institute (EBI) and AWS Diagnostic Development Initiative.

The European Bioinformatics Institute launched the European COVID-19 Data Platform, connected to the European Open Science Cloud, to provide an open, trusted, and scalable platform and a shared computational space for secure data exchange, access to advanced data analysis and visualization tools and global collaboration.

Amazon Web Services (AWS) launched its Diagnostic Development Initiative to support collaboration among its customers working on diagnostic solutions for COVID-19. AWS offered AWS Promotional Credits to use its range of cloud-based services (AWS compute, storage, database, ML, AI, analytics, containers, robotics, quantum services, etc.) and technical expertise to develop projects by selected institutions and companies in four program areas: early disease detection, diagnostics, prognosis, and public health genomics. Within this initiative organizations were also able to leverage third party data through the AWS Data exchange, giving healthcare, academic and life sciences organizations access to de-identified data from multiple sources in machine-readable formats. This is the case of the project "AIforCOVID"[43], run by a public private partnership including pharma company BRACCO, diagnostics centers company CDI, the Italian Institute of Technologies and Campo Biomedico University in Rome. With AIforCOVID Imaging Archive, they created a repository with almost 1,000 chest X-rays and anonymized clinical data of COVID-19 patients. Images and clinical data were analyzed using three machine learning approaches developed by the research organizations and performed on AWS. Based on these analyzes, the consortium developed a model that is able to predict the clinical outcome of COVID-19 patients from chest X-ray images and clinical data. All data collected by the AIforCOVID network is available for download to members of the international scientific community from the project's website. According to IDC[44], half of new business value created in global life sciences market by 2026 will be driven by cloud-based digital ecosystems and federated learning. This highlights the key role of digital platforms in healthcare domain and that Life sciences organizations' ability to generate value will increasingly rely on their participation in agile ecosystems that leverage cloud-based platforms to enable sharing of data and insights at scale.

3.3.2 Data as a core of the healthcare ecosystem examples of platforms

According to IDC European Industry Acceleration Survey conducted in 2021, data, operational capabilities, and new digital products are the primary focus areas for European Healthcare and Life Sciences when taking parts to digitally enabled ecosystems. Healthcare providers show

[43] https://aiforcovid.radiomica.it/
[44] IDC FutureScape: Worldwide Life Sciences 2022 Predictions

greater focus toward enabling data and information exchange, while Life Science are keener in leveraging digital platforms to share operational capabilities and expertise. For what concerns the development of digital products and services, while healthcare providers are looking to develop solutions that they will be able to use in their organizations, life science companies are more focused on creating new commercial solutions. Almost half of the life science companies and organizations and 40% of healthcare organizations and companies consider these three areas as the primary focus of the digital platforms (Figure 16).

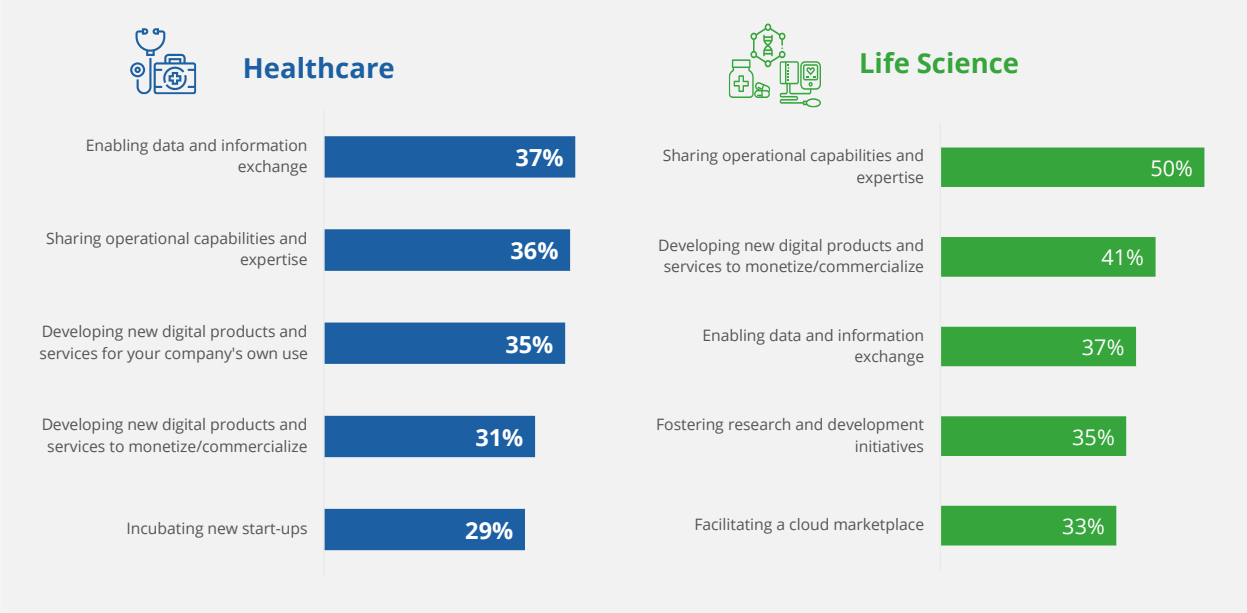


Figure 16. Primary focus of digital ecosystem in Health & Care organizations[45]

Such a focus on data by health ecosystems is due to several reasons:

- Data in healthcare is scattered among multiple databases and incentives to share data are limited
- Complex procedures exist for accessing health data, governed by different legal frameworks and rules
- Tools and skills needed to process data securely are costly and often inaccessible to small research teams or start-up

Accordingly, many governments across Europe have been working towards creating hubs of dedicated infrastructure resources, services and skills for facilitating data sharing and the secondary use of data. These health data hubs are meant to provide trusted environments for healthcare data management, governance and use mitigating the barriers to data sharing. Through these initiatives governments aim to:

[45] IDC EMEA, European Industry Acceleration Survey, April 2021 (Healthcare and Life sciences)

- enhance data quality, interoperability and portability through greater standardization and common data management and data quality audit technologies and services;
- increase transparency and visibility on available healthcare data, driving new opportunities for innovation as well as for better informing population health management policies;
- mitigate the reputational and regulatory risks defining procedures and lawful and ethical health data processing, as well as providing advanced cybersecurity and privacy enhancing technologies as a service;
- provide economically affordable, innovative, and trusted data environments for research and start-up to innovate (data sandboxes, AI capabilities and expertise, etc.);
- foster a data sharing culture by aligning incentives between data creators and users with specific programs and fundings.

A good example is the French Health Data Hub[46] which is a platform to gather, organize and make securely available the data of the National System of Health Data for research and development purposes. The platform, named Oncodatahub (ODH), is the first real-world cancer data platform in France which is born through a collaboration between Unicancer (National Federation of French Cancer Centers) and Roche. The platform, which is a real-world cancer data platform, contains a set of high quality, longitudinal data representative of cancer patient care in France that will be available for research on targeted therapies as well as for population health management to the whole French healthcare system. So far 1600 projects have been submitted to the hub.

Another example is the Isaacus project Digital Health Hub Project) led by Sitra in Finland that ran officially from 2015 to 2018. The Isaacus project was led by Sitra and it prepared a new operating model for a one-stop shop focusing on the better use of Finnish health and well-being data. All work was aligned with preparations for a new permit authority and new legislation for the secondary use of data. The objective of the Isaacus project was to enable the data-secure use of well-being data for various purposes. This document recounts how the new model for a one-stop shop for the better use of well-being data was built in Finland. In this document we refer to it as the "Digital Health HUB", which in other contexts is also referred to as the "service operator". The Isaacus project played an essential role in building an innovation ecosystem and new legislation for the secondary use of well-being data drawn up by the Ministry of Social Affairs and Health. The Isaacus project helped to fulfil the national-level objectives, redefine the organizational processes and responsibilities, and forge a commitment from all parties involved. The project's main accomplishments were the creation of a prototype for the one-stop-shop service model, the building of new technical infrastructures and greater expertise in the use of new technologies and multi-stakeholder collaboration[47].

[46] https://recherche.unicancer.fr/en/programs/onco-data-hub/
[47] https://www.sitra.fi/en/publications/a-finnish-model-for-the-secure-and-effective-use-of-data/

3.3.3 The technology foundation of the digitally enabled healthcare ecosystem

Healthcare ecosystem digital platforms are based on key solutions enabling technologies such as:

- **Data management and governance** technologies to foster the transition toward systems of trust, that enable and accelerate research and innovation, and that allow expand healthcare services delivery through digital. These technologies create a shared infrastructural layer for data integration, access, protection and governance to manage the behaviors of people and processes using the data enhancing privacy protection and regulation compliance;
- An **intelligent core** which includes cognitive, artificial intelligence, and machine learning solutions;
- **Agile cloud based architectures**, allowing ecosystems to scale rapidly and efficiently and to include new technologies and partners when needed;
- **Standardization, interoperability and API strategies** to orchestrate exchange of data across the ecosystem, across the different applications and use cases. Data integration strategies need also to take in consideration the specific requirements and rules that govern healthcare data to ultimately ensure quality and safety for patients

These platforms need to support core-edge- ecosystem technology continuum for each of the stakeholders participating to the ecosystem. Therefore, they need to be able to scale with ease to all locations; support interconnected architectures; operate with a high level of autonomy and security across all the locations served by the ecosystems; and being able to maximize the use of resources. All these key elements for health ecosystem platforms are illustrated in the Figure 17.

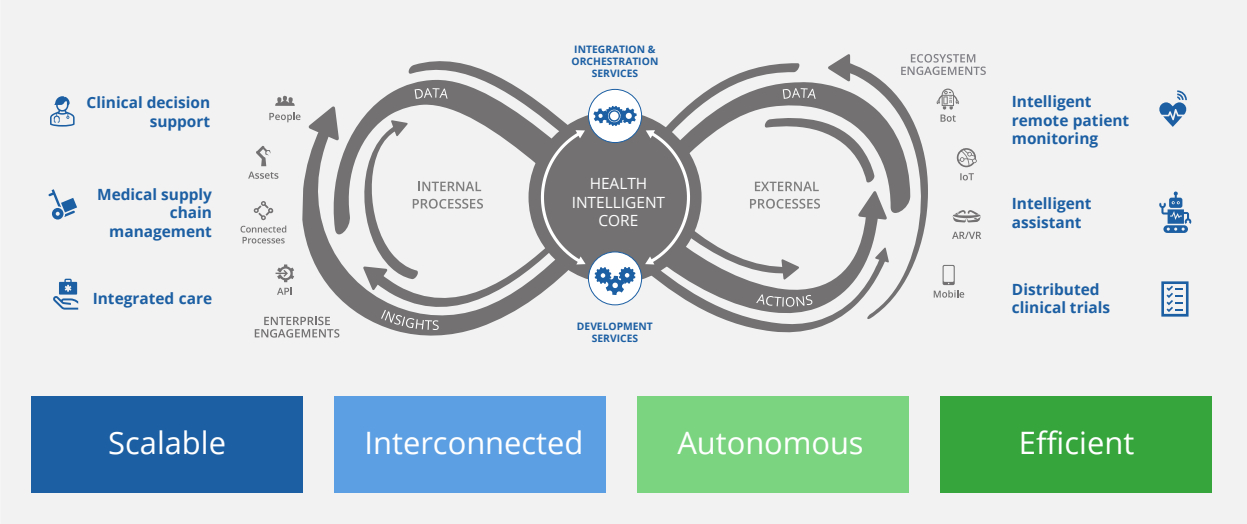


Figure 17. Main technological building blocks for health ecosystems

3.3.4 Overview of a SWOT analysis of digital platforms in healthcare domain

Analysis of the status of digital platforms market in healthcare domain highlight the following strengths, weaknesses, opportunities and threats to be considered.

Strengths

- Digital platforms support well the convergence of healthcare ecosystems on patient value as they offer a coherent digital space for integration across the value chain
- Digital Platforms offer the required flexibility to include the different stances and needs that characterize a complex and dynamic sector as healthcare.
- The pandemic offered the opportunity to scale the use of digital health tools and service and the break of several long-established barriers (acceptance by clinicians and patients, reimbursement models, critical mass etc.) demonstrating the benefits in terms of patient value of these digital platforms.

Weaknesses

- Digital readiness is not homogeneous across healthcare and life sciences organizations. Adoption of truly cloud based architectures is still low, posing a challenge also in terms of establishing critical mass.
- Industry stakeholders need to better engage with cloud technology providers and develop a healthcare specific value proposition, taking into consideration critical aspects as data residency and privacy compliance requirements.
- Procurement models for healthcare providers are still very much capex centric.
- Complexity of "end-user applications" that should transfer data to platforms is still a huge barrier, especially if we consider that the most relevant "data provider" are elderly people / patients.

Opportunities

- As the system slowly but surely evolves toward value-based healthcare, Digital platforms are key enablers of transformational use cases as population health management and networked R&D, allowing to share not only data, but also industry specific capabilities and skills. With trusted essential building blocks made available by platforms and widely used, investment is more prone to focus on real innovation, this will open the opportunity for further innovation around specific digital products that serve new business and care delivery models.

Threats

- Healthcare is a very fragmented market, with stringent regulations on data use, and patient safety and complex governance models to address ethical aspects. The evolution of platforms will most likely evolve towards a "systems of systems" scenario, to accommodate this

complexity and bypass the difficulties to reach economies of scale and critical mass of partners and customers, stemming from this fragmentation.

- Precondition to a wider development of platforms is a stronger focus on data and technology interoperability, further accelerating the adoption of international **healthcare interoperability standards (**HL7, FIHR, Snomed CT), API integration models, **open-source** tools and standardized architecture.
- Leveraging **national and regional health data hub** initiatives for compliant access to data, skills and capabilities are also paramount for digital ecosystems to succeed

3.4 The role of B2B Digital Platforms in the Digital Transformation of Agri-food

Agriculture is the oldest industry in the world and still represents 9% of global GDP[48], however its path towards digitization is still slow compared to many other industries and sectors. The role of agri-food in the EU Green Deal is represented by the Farm 2 Fork strategy[49] highlighting that the use of digital platforms is essential to use resources in an efficient and competitive way. Smart Farming aims to optimize the production in farms by using the most modern means in a sustainable way, thereby increasing the production and delivering the best products in terms of quality while maximizing the return. It makes use of a wide range of technologies including IoT sensors, wearables, GPS services, UAVs, robots and drones operating in the field which provide real-time data to systems helping to monitor the production line and support decisions. This enables less waste and maximum efficiency in operations.

Digital platforms are considered a key-point for achieving sustainability and digitalization in agri-food allowing improvements in land and water management, reduction in the usage of agrochemicals, increasing the productivity and the quality of the crops, avoiding food waste, and supporting the production of healthy and quality-monitored food.

Furthermore, COVID-19 pandemic evidenced how the usage of digital platforms in the agri-food sector is relevant not only for big players but also for smallholders and rural communities, allowing them to better compete on the market and to align with the future CAP requirements based on SDGs.

A recent study by McKinsey[50] shows that there are specific types of digital platforms and technologies that can significantly impact the digital transformation of agri-food domain:

- Agri-food data platforms that create transparency and improve baseline for statistics by building a joint-access agri-food data platforms.

[48] https://data.worldbank.org/indicator/
[49] https://ec.europa.eu/food/horizontal-topics/farm-fork-strategy_en
[50] https://www.mckinsey.com/industries/agriculture/our-insights/how-digital-tools-can-help-transform-african-agri-food-systems

- E-extension platforms that improve farmer practices by providing farmers which customized e-extension advice on an easily searchable platform.
- Market information system that provides farmers with regular crop market prices from geo-located markets nearby to reduce market information asymmetries.
- Digitized storage and logistics facilities that increase the efficiency of storage facilities through capacity planning and inventory-optimization analytics.
- IoT platforms that increase transparency and efficiency in production and logistics of agri-food.

3.4.1 Digital transformation in Agri-food ecosystem

The significant growth of advanced digital technologies is changing the way different sectors of the economy and industries operate and function. Digitalization has also made its way into the agri-food industry, even though the adoption and use of the technology is still in its early stages. Nevertheless, it is expected that digital technologies will lead to the next agri-food revolution. Digital transformation and thorough adoption of new technologies could bring significant benefits not only in terms of improvement of agri-food sector productivity, but also for alleviating some of the most pressing global problems related to climate change and biodiversity loss. Current technological advances in the sector are rooted in the concept of precision agriculture, but at the same time go far beyond it. with the advent of Big Data, i.e., huge amounts of digital data coming at high speed from a variety of sources and in different formats, new opportunities have been opened up for the agri-food sector. Thanks to the Internet of Things, cloud computing and machine learning, Big Data can be analyzed in real time or near real time to provide new insights and create economic value that benefits virtually all players in the agri-food value chain. These opportunities could transform agriculture farming practices into smart farming and smart businesses. Nevertheless, there are also several obstacles that could hinder digital transformation in the agri-food industry. In addition, questions also arise about the ethical and social implications of digitalization, as new smart technologies are largely based on artificial intelligence and systems beyond direct human control. Therefore, a discussion on fundamental opportunities and challenges related to digital transformation is essential to avoid possible lock-in effects on the way to a smart, data-driven agri-food economy[51]. According to IDC, by 2023, 45% of the world's largest agri-food companies will have implemented a blockchain-based food traceability solution to provide customers with transparency from farm to table[52].

In Europe, digital transformation in agri-food ecosystem initiated to spread mostly in the last decade and has significantly boosted due to the COVID-19 pandemic as many other sectors.

There are several aspects that are contributing to the diffusion of digital technologies in agri-food domain such as:

[51] https://www.researchgate.net/publication/324992360_DIGITAL_TRANSFORMATION_IN_THE_AGRI-FOOD_SECTOR_-_OPPORTUNITIES_AND_CHALLENGES
[52] IDC FutureScape: Worldwide Agriculture 2021 Predictions

- **Climate change** is impacting dramatically the soil, water availability and seasonal rotation. Digital technologies are capable to mitigate the impact of these changes.
- The EU's Common Agricultural Policy (CAP) aids to farmers will be oriented to a more **sustainable agriculture**. The need for reporting these practices is mostly covered by digital technologies that can monitor and certify these newly required parameters in crop management.
- **Value chain** will enhance the value of the food production providing detailed information on the quality, the processes, and the transformation to the end users. Citizens' awareness on quality and sustainability is growing and they are starting to ask for accountability on the value chain as the EU Commission evidenced in the Farm2Fork strategy.
- Sustainability is the core of the **EU Green Deal** and thus economic, environmental and social sustainability can be reached, improved and measured thanks to the digital platforms.

Digital technologies in the agri-food are not just a technological update of this sector, they have a disruptive impact on the business model of the value chain actors. Farmers, for example, need to switch from a traditional approach to a computer aided optimization of the processes and to a new way to take decisions on the yearly planning. Digital technologies are forcing a change of mindset in the sector that will bring to a more resilient, optimized and sustainable agriculture, capable to satisfy future needs of the global population.

3.4.2 Examples of digital platforms in Agri-food

3.4.2.1 Agricolus: making agritech sustainable

Agricolus[53] is an example of digital platform for the agricultural sector that developed several tools for farmers, associations of farmers and agri-food industry allowing them to optimize agricultural activities, improve the efficiency of the daily work and to measure and reach farm sustainability.

Agricolus adopted since the beginning FIWARE[54] technologies to promote data interoperability with other platforms and along the value chain. Agricolus is also part of the DEMETER H2020[55] large scale pilot project and was partner of the IoF2020 project[56].

[53] https://www.agricolus.com/en/
[54] https://www.fiware.org/
[55] https://h2020-demeter.eu/
[56] https://www.iof2020.eu/

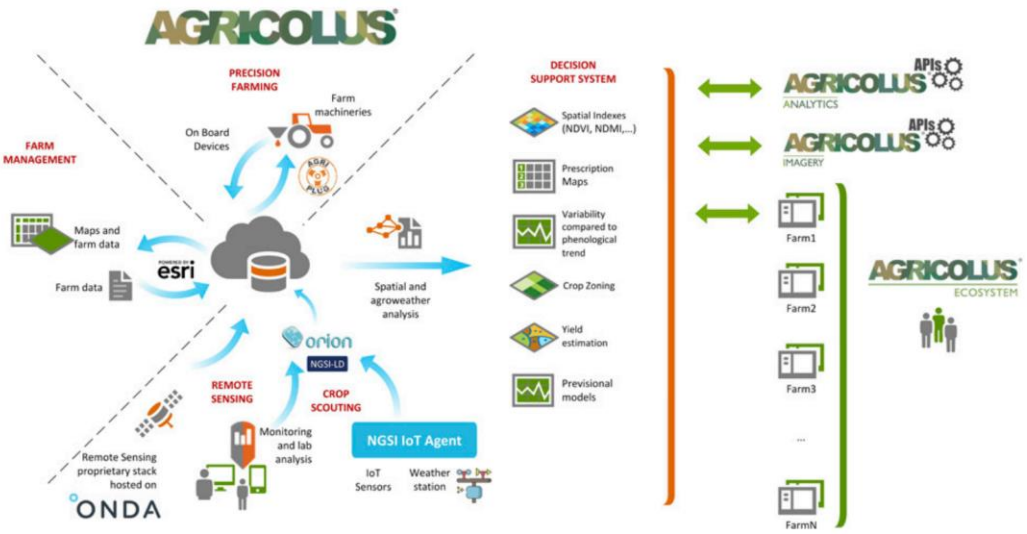


Figure 18. Overview of Agricolus digital platform structure

Agricolus platforms promotes the development of precision farming, smart farming and sustainable agriculture with the development of Decision Support Systems (DSS).

One of the key factors for the proper management of a farm is the decisions to be taken to respond to any changes in cultivation interventions to be made. DSS help farmers to make "smart" choices based on the real needs of crops and their relationships with their surrounding environment, with the aim of limiting the use of water, treatments and fertilizers.

Agricolus is a platform composed of Smart Farming applications DSS, forecast models, smart pest and disease control, and remote sensing, based on FIWARE's Open Source technology. FIWARE allows data harmonization, standardization of the IoT interface and common data between software modules and systems. The scalability of FIWARE components allows for diverse and more specific challenges to be addressed at the same time

3.4.3 Overview of a SWOT analysis of digital platforms in the Agri-food domain

Analysis of the status of digital platforms market in agri-food domain highlight the following strengths, weaknesses, opportunities and threats to be considered.

Strength

- Digital platforms offer a coherent digital space for integration across the agri-food value chain.
- Digital platforms facilitate the scalability of digital solutions for agri-food domain.
- Digital platforms entail required flexibility to adjust according to end users' needs.

- Platforms provide the opportunity for service personalization to the target groups which is crucial considering the diverse nature of agri-food ecosystem stakeholders.

Weaknesses

- Limited level of interoperability and standardization in platforms is a challenge for their quick adoption.
- Economies of scale of digital platforms per se could be a problem.
- In general making the shift towards a digital ecosystem and platforms require a high investments and risks which could be challenging to afford in particular by SMEs in agri-food domain and end-users (i.e. farmers).

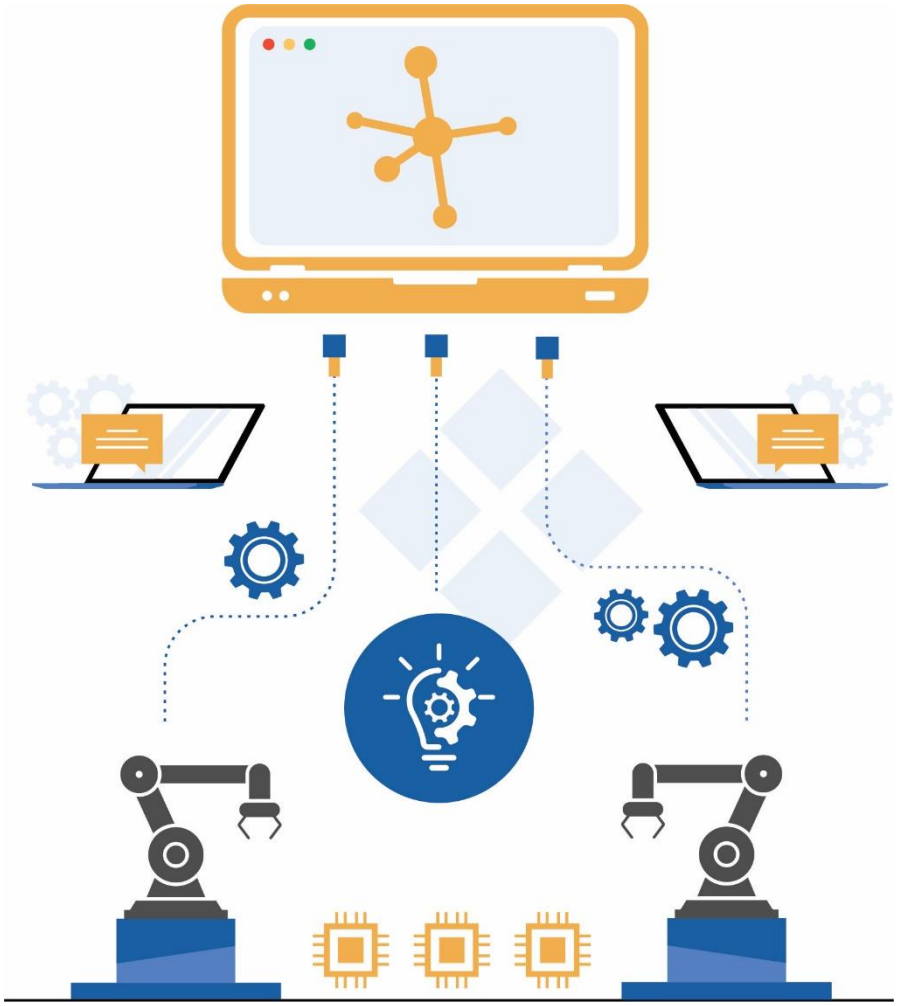
Opportunities

- Digital technologies such as Cloud, APIs, AI, etc. are mature enough and ready to be used.
- There is a strong trend of digitalization and open innovation in the agri-food domain especially due to impact of COVID-19 pandemic.Favorable policy agenda / policy environment initiated and promoted by European policy makers is a key driver.
- Despite the fact that agri-food lags behind the other domains in terms of digital transformation, this provides a big opportunity for a rapid uptake rate in close future thanks to existing market trends and potential.
- Increasing popularity of smart and mobile applications in agri-food domain could enhance the adoption of ???digital platforms.
- Increasing awareness and skills improvement for digital transformation in farming is increasing and opens up new opportunities for digital platforms adoption in the sector.

Threats

- Many agri-food companies, particularly in the SME market, lag behind their peers in other industries when it comes to technology adoption and vision, and this poses a risk of stranded initiatives as many products and technologies with high potential, not reaching the market, i.e., unsuccessfully overcoming the so-called “Valley of Death”.
- Agri-food value chain is quite fragmented with different types of stakeholders.
- The number of closely competitive products in the market is increasing and the pricing / cost estimations becomes more challenging for platforms providers.

4 The role of Digital platforms in European Research and Innovation Landscape for Digital Transformation of industry: four domains' analysis



4.1 European digital platforms in the Manufacturing domain

Digital manufacturing platforms play an increasing role in dealing with competitive pressures and incorporating new technologies, applications and services. Advances are needed in digital manufacturing platforms that integrate different technologies, make data from the shop floor and the supply network easily accessible, and allow for complementary applications. The challenge is to fully exploit new concepts and technologies that allow manufacturing companies (especially midcaps and SMEs) to fulfil the demands from changing supply and value networks.

The integration of different technologies and extensive experimentations driven by mid-caps and SMEs allows to develop and establish platforms for the connected smart production facilities of the future including their supply chains, driven by EU actors and safeguarding European interest in an area of key importance for the European economy.

Accordingly, the **ConnectedFactories (2016-2019)** and **ConnectedFactories2 (2019-2022)**[57] projects aim to develop pathways towards advanced digitalization of manufacturing processes from different perspectives. One of the main goals of the project was to develop forward-looking scenarios or pathways of how the different platforms and architectures will co-exist, cooperate and compete in a concrete environment.

These 'scenarios and pathways' play a central role. The scenarios and pathways should become practical tools for the development of company-specific innovation strategies in the context of digitalization of manufacturing and the deployment of digital platforms for manufacturing.

A pathway is composed of different levels of digitalization that are associated to a number of milestones. These milestones indicate practices of digitalization that, while evolving to the right-hand side of the pathways, become more advanced. Ultimately, the milestones on the right fit within the vision of digital manufacturing.

As seen in Figure 19, Level 5 encompasses real time optimization on factory or machine level. The deployment of digital platforms for manufacturing is situated on this level.

[57] https://www.connectedfactories.eu/

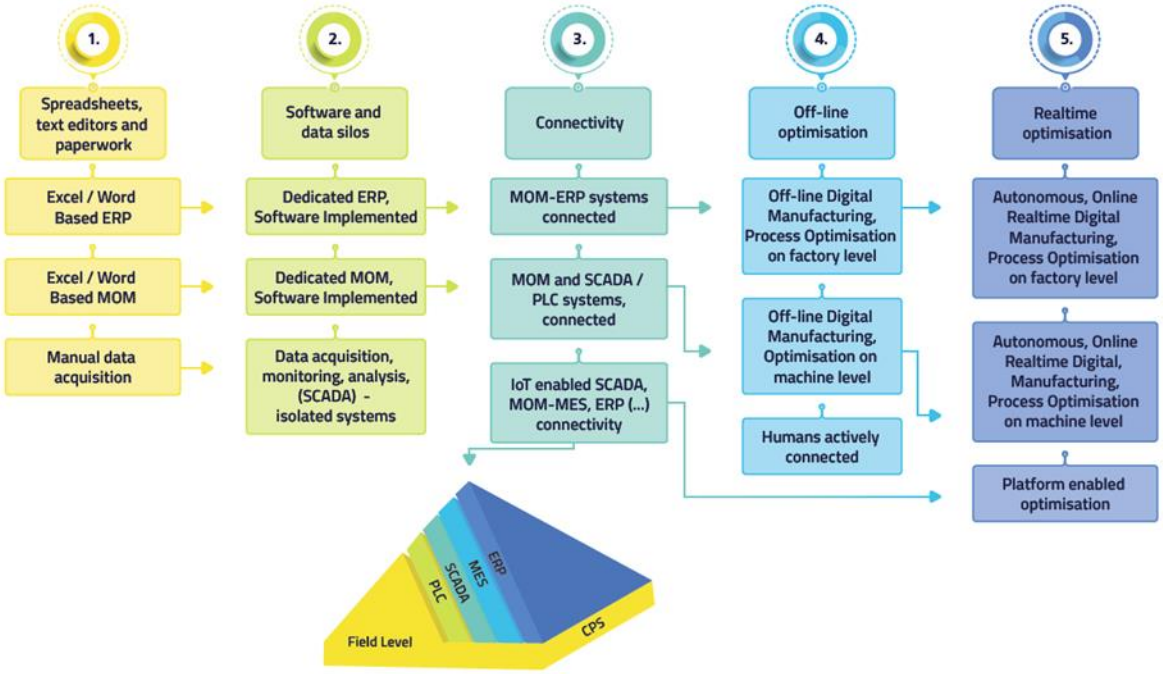


Figure 19 Autonomous & Smart Factories pathway

4.1.1 Examples of European digital platforms in Manufacturing domain

In this section two examples of existing digital platforms for manufacturing domain developed with the European research and innovation landscape are presented.

4.1.1.1 Digital Factory Alliance (DFA)

The Digital Factory Alliance (DFA)[58] initiative is born under the umbrella of the EC QU4LITY project[59] and enriched by the results of other relevant European projects, aiming at modernizing and digitalizing the assets of the factories of the future (FoF), with the strong conviction that these actions will have a critical influence in the way these factories will be operated and managed in the years to come, by promoting the use of Artificial Intelligence Technologies and Data Intelligence to strive for Zero-X Manufacturing Environments. This initiative allows its members to get access to the most updated knowledge, trends and "ready-to-implement" products in the field and, at the same time, gain exposure to a growing Zero-X Manufacturing marketplace, with the added brand recognition and access to new business opportunities.

[58] https://digitalfactoryalliance.eu/
[59] https://qu4lity-project.eu/

The goal is to deliver a fast and intelligent response to manufacturing issues by using data-driven intelligence and digital systems integration, thus supporting the improvement of three key manufacturing capabilities: resilience, sustainability and efficiency.

The DFA will facilitate the creation and access to new market opportunities in Zero-X Manufacturing by integrating and exploiting results coming from solutions generated in related initiatives. In this scenario, the DFA is positioned to complement the efforts done in other initiatives such as:

- Public and Private Partnerships like **BDVA (Big Data Value Association)**[60] and **EFFRA (European Factories of the Future Research Association)**[61], whose roles plays an important impact on the definition of needs and challenges from the digital and manufacturing point of views.
- A conglomerate of interconnected projects such as **IDSA (International Data Space Association)**[62], **FIWARE Foundation** [63]and **GAIA-X**[64], playing an important role in defining standards, interoperability, developing of open source-based solutions and providing operated and managed services.

The DFA will build upon these efforts, leveraging these results and adding value through a **Zero-X Marketplace** of validated digital-based and ready to implement solutions for manufacturing companies, in a user-friendly "search and implement" environment.

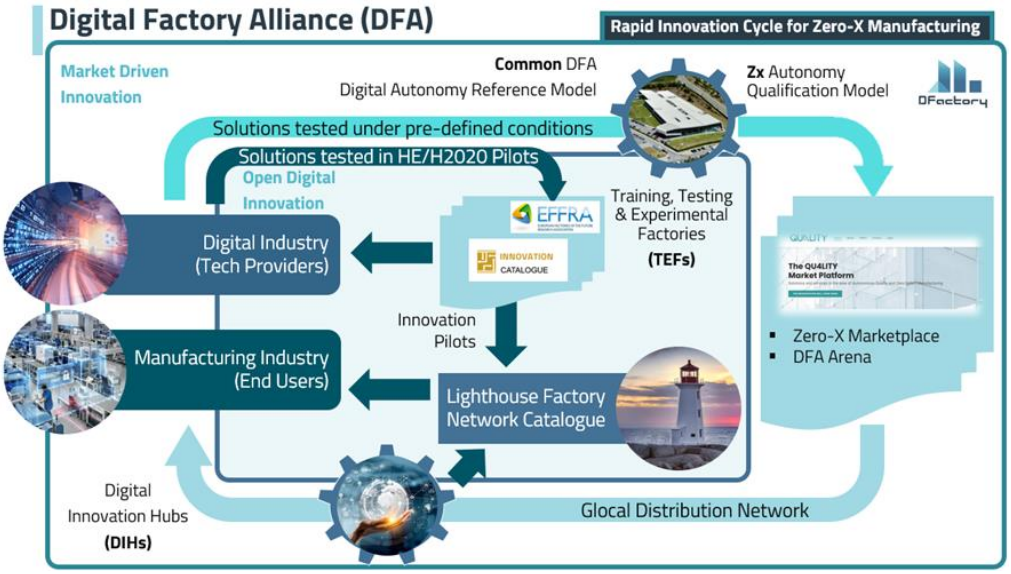


Figure 20. Main operating cycles within the DFA

[60] https://www.bdva.eu/
[61] https://www.effra.eu/
[62] https://internationaldataspaces.org/
[63] https://www.fiware.org/foundation/
[64] https://www.data-infrastructure.eu/GAIAX/Navigation/EN/Home/home.html

Figure 20,shows the main operating cycles within the DFA. There are two main loops of operation for achieving a Rapid Innovation Cycle for Zero-X Manufacturing: Open Digital Innovation (internal loop) and Market Driven Innovation (external loop). In those loops, 4 key stakeholders can be tracked and identified: Technology Providers; End Users; Training, testing and Experimental Factories (TEF); and Digital Innovation Hubs (DIH).

DFA pillars and services

The DFA is grounded on four main pillars that encompasses the whole spectrum of activities to be carried out in the initiative and the services to be offered (Figure 21).

- **Body Of Knowledge - *Search for knowledge*.** Expertise available in the community on topics of interest in digital manufacturing to support stakeholder activities and participation in the DFA network.
- **Innovation Campus - *Be part of a community*.** Get to know the open community of stakeholders involved in the field of Digital Manufacturing Innovation, build connections and partner with the DFA.
- **Flagship Initiatives - *Search for solutions*.** To find the products within the Zero-X Manufacturing environment that will improve the levels of Zero-X Autonomy in factories.
- **Business Network - *Search for business*.** To create new business opportunities within the Zero-X Manufacturing environment.

Figure 21. DFA main pillars and services

4.1.1.2 European Factory Foundation (EFF)

Established in 2019 in Vienna (Austria), the European Factory Foundation (EFF)[65] is an association of research and industry organizations from the manufacturing, logistics and ICT sectors. It aims to facilitate stakeholder collaboration across manufacturing and logistics sectors through the

[65] https://efactoryfoundation.org/

development and promotion of innovative solutions from Industry4.0, Internet of Things (IoT), Artificial Intelligence (AI), Big Data and Digital Manufacturing domains.

The association provides an open platform for multi-stakeholder interactions and collaborations and it is keen to promote the development and uptake of innovative solutions. Therefore, it allows users to access and use a wide range of solutions from ecosystem partners, including Industry4.0 solutions such as shop-floor connectivity, production monitoring and data analytics, to more advance solutions such as agile collaboration between supply chain partners and blockchain based smart-contracting. Hence, the main objective is that the European companies take advantage from smart manufacturing solutions and increase their competitive level.

EEF ecosystem is particularly focused on transforming systems and processes, addressing the challenges concerning digitalization using innovative and interoperable ICT solutions. By bringing together and offering from different platforms, tools and services in an interoperable approach, the EFF ecosystem enables users to access and utilize a wide range of digital solutions that address most commonly faced digital manufacturing scenarios.

Figure 22. EFF Founding Members[66]

All in all, the vision of the EFF is the creation and the ongoing development of an ecosystem in the areas of Smart Factory, Industry 4.0 and Digital Manufacturing, and it follows these objectives:

- Improving the networking of stakeholders including the solutions providers, users, vendor and user communities
- Increasing the use of existing and future technology, product and service offerings through the provisioning of EFPF platform
- Improving the integration and interoperation of existing and future technology, product and service offerings through the provisioning of Data Spine
- The promotion of technical, economic and legal innovation within European manufacturing sector
- The organization of events and to promote the latest offerings of association members in the mentioned fields of application

Regarding the stakeholders, they range from individuals and research organizations to SMEs and large companies that are interested in achieving development and uptake of innovation digital

[66] https://www.efpf.org/eff

manufacturing solutions through the EFPF ecosystem. They are not only contributors to the EFPF platform, but they also contribute in building the EFPF ecosystem and making it sustainable over time.

In particular, the entities with the following interests are of primary interest to EFF:

- Individuals or organizations that are interested in making use of Industry4.0 and digital manufacturing solutions through the EFPF platform.
- Individuals and organizations that are interested in developing innovative solutions and/or offering their products/solutions/services through the EFPF platform.
- Individuals and organizations that are interested in establishing interoperability of their solutions through the EFPF Data Spine.
- Individuals and organizations that are interested in the experimentation and validation of EFPF solutions.

4.1.2 SWOT analysis of European digital platforms in Manufacturing

Analyzing the status of digital platforms in European research and innovation landscape within manufacturing domain, the following strengths, weaknesses, opportunities and threats are identified.

Strengths:

- Digital platforms in manufacturing favor more open innovation such as the emergence of new business models (e.g., servitization) and new business opportunities.
- Digital ecosystems and digital platforms as orchestratotrs of these ecosystems are usually much less hierarchical than traditional supply chains, so the power of the members is quite well balanced and based on the added value
- Digital ecosystems and platforms promote the concept of "doing things together" and favor new trends and virtuous activities which ego-systems cannot achieve alone in manufacturing domain, e.g., sustainability, green transition, circularity and environmental impact need a common approach typical of an ecosystem
- Digital ecosystems and platforms favors gender equality and equal opportunity with a more democratic and participative approach to business thanks to their extensive and flat inclusion

Weaknesses:

- Harsh industrial environments in manufacturing domain (steel metal) could hinder an extensive digitalization and thus the creation of digital ecosystems and uptake of digital platforms
- Manufacturing ecosystem is usually dominated by Large Enterprises which might result into a disguised ego-systems, where the balance of power is not very well distributed among different stakeholders of a digital platform.

- The creation and effectiveness of digital ecosystems and platforms depend not just on the size of the enterprise, but also on its geographical location and application domain. In some countries, innovation ecosystems which potentially could support adoption of digital platforms do exist since years (i.e. Basque Country, Italian Districts) especially in certain high-margin sectors (Cosmetics, Fashion). In other countries or lower margin sectors, the consolidation of digital ecosystems is more difficult.

Opportunities:

- There are many initiatives at EU level to boost inter-regional collaboration (i.e. I3 program[67]) and thus creation of digital ecosystems and adoption of digital platforms.
- New standards have been recently created to support the adoption of digital platforms and ecosystems, addressing for instance Data Sovereignty, Edge-Cloud Continuity and privacy confidentiality security preservation
- The creation of ecosystems and development of digital platforms are unique opportunities to rationalize production processes (Business Process (BP) re-engineering) and also for the upskilling and re-skilling of personnel. It is an unprecedented boost for socio-economic progress
- Confrontation and cooperation allow enterprises to create self-awareness of their assets in terms of market and competition, increasing their competitiveness
- DIHs are an important opportunity especially in EU to facilitate the uptake of digital platforms

Threats:

- A too technical and technology-driven approach could nullify the benefits of digital ecosystems and hinder the uptake of digital platforms. Just developing technology on top of old-fashioned organization and structure could be a threat.
- Digital platforms might expose manufacturing companies to security risks such as cyber-attacks. Data security and cyber security and safety are common concerns for manufacturers to shift towards digital platforms
- The risk of losing competitiveness by sharing data and confidential information is always there, despite the technological enforcement of Data Sharing. Mechanisms for trust building and preservation are always needed as well for fraud detection in the digital era

4.2 European digital platforms in the Energy domain

The electric and energy systems in Europe are at a turning point. The achievement of European Green Deal objectives is the overarching goal of the European energy sector, leading to the deployment of Clean Energy Package[68] which is the new set of rules defined to update the current energy policy framework, to ease the transition from fossil fuels towards cleaner energy sources.

[67] https://ec.europa.eu/regional_policy/en/policy/themes/research-innovation/i3/
[68] https://energy.ec.europa.eu/topics/energy-strategy/clean-energy-all-europeans-package_en

The installation of distributed renewable energy sources is transforming the traditional power networks in Europe, from a traditional, fully centralized to a highly decentralized system. Within this transformation, the grid operators need to evolve the classical operative business and to accommodate for faster reactions and adaptive exploitation of flexibility, by making use of the technical and social opportunities from digitalization solutions.

To foster the digital energy transition, clear and harmonized frameworks need to constitute the foundation of systematic platforms, whose pilots allow the implementation of energy marketplaces supported by a vital data economy. In doing so, each actor within the energy value chain should be involved in the data exchange process, by adopting efficient mechanisms to best exploit the value of data (e.g. for renewables integration, flexibility services or optimal energy management).

The challenges identified in the digitalization of Energy sector are mainly related to the deployment of data models and architecture components, for which the domain is well positioned even if some technical aspects need to be faced, as well as new needed business models and governance, still requiring major research effort. Moreover, the electricity sector cannot manage all these challenges alone, hence an effective sector coupling is of the foremost importance.

4.2.1 Examples of European digital platforms in the Energy domain

In this section two examples of existing digital platforms for energy domain developed with the European research and innovation landscape are presented.

4.2.1.1 BD4OPEM

BD4OPEM platform is developed within the H2020 funded project BD4OPEM[69] which aims at setting the Open Innovation Marketplace by designing, developing and running this Analytic Toolbox as a scalable and replicable tool for the energy market.

BD4OPEM is building an analytic toolbox that acts as an interface between data providers and analysts. Data providers are those agents that are feeding the platform with data (for instance, they could be DSO's). In contrast, data analysts are processing this data and offering services to improve the monitoring, operation, maintenance, and planning of electrical distribution grids. Some of the services that we are developing include grid topology, grid observability, fraud detection, V2G, generation forecasting, demand forecasting and flexibility estimation.

The business model approach is a two-sided market which offers huge flexibility adapting the marketplace to different markets and countries. Figure 23 shows the overall architecture of BD4OPEM platform.

[69] https://bd4opem.eu/

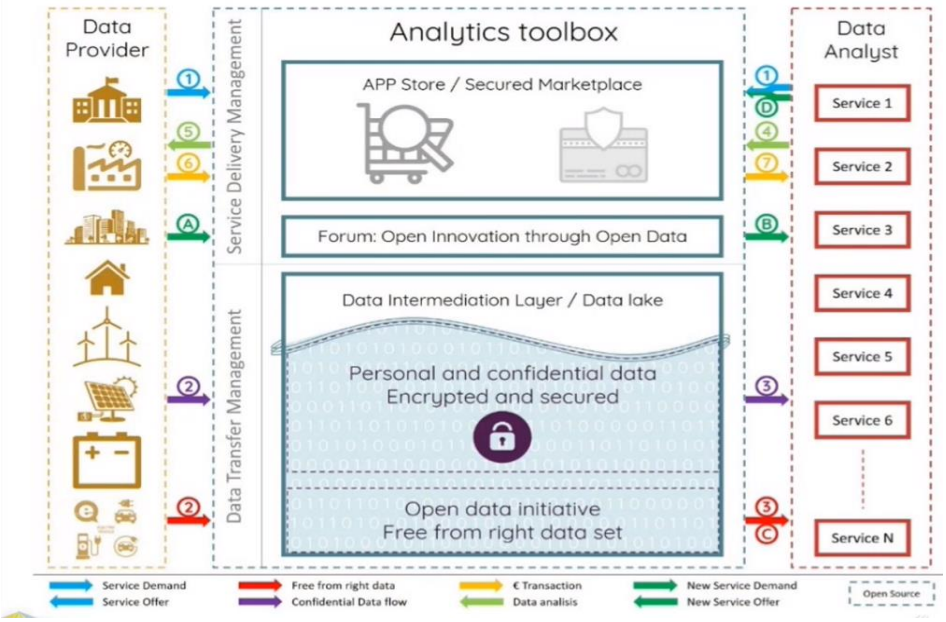


Figure 23. BD4OPEM overall architecture

4.2.1.2 SYNERGY Platform

SYNERGY[70] introduces a novel framework and reference big data architecture that leverages data, primary or secondarily related to the electricity domain, coming from diverse sources (data APIs, historical data, statistics, sensor / IoT data, weather data, energy market data and various other open data sources) to help the electricity value chain stakeholders to simultaneously enhance their data reach, improve their internal intelligence on electricity-related optimization functions, while getting involved in novel sharing / trading models of data sources and intelligence, in order to gain better insights and shift individual decision-making at a collective intelligence level.

In this context, SYNERGY aspires to unleash the data-driven innovation and collaboration potential across currently diversified and fragmented electricity actors, acting as multiplier of the "combined" data value that can be accrued, shared and traded, and re-conceiving real-time data sharing against traditionally bilateral contracting applied in the electricity sector, to enable holistic optimization of the operation of electricity networks and the energy performance of their constituent components (RES plants, buildings, districts). In this way, SYNERGY enables the transition from traditional master/slave schemas to more complex synergies (enabled by the SYNERGY Big Data Platform and AI Analytics Marketplace) to deliver added value analytics applications and innovative energy services to the involved stakeholders towards serving their individual interests, while realizing common electricity sector goals for de-carbonization, power quality and security of supply.

[70] https://www.synergyh2020.eu/

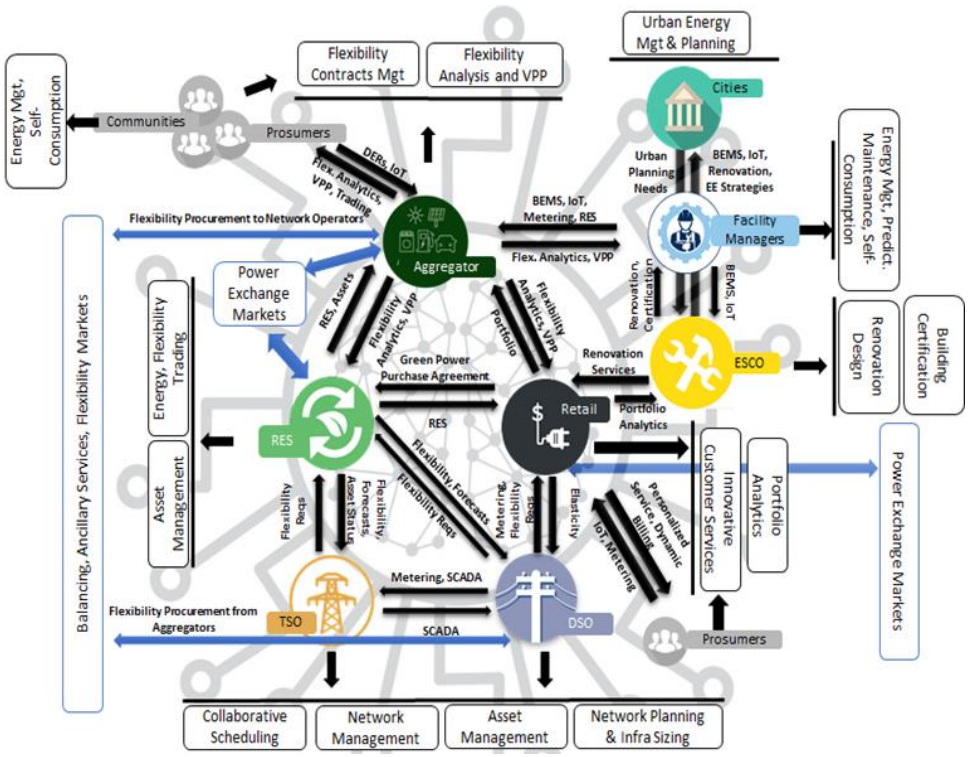


Figure 24. Conceptual Representation of the SYNERGY Framework integrating the electricity value chain into a unique data sharing and data intelligence-driven ecosystem

In SYNERGY, unveiling and sharing the intelligence emerging from a plethora of diverse, yet disperse data assets that carry valuable electricity-related information requires a novel approach that bears 5 Core Data Services Bundles: (i) Data Collection Services Bundle (Data Ingestion, Curation, Mapping, Linking and Update); (ii) Data Security Services Bundle, that is responsible for safeguarding and securing any data asset (and app) that becomes available or pass through the SYNERGY platform; (iii) Data Sharing Services Bundle which lies at the core of the SYNERGY platform as it handles the adopted sharing / trading mechanisms, the effective remuneration approach and the multi-party data contracting lifecycle; (iv) Data Matchmaking Services Bundle bringing a demand-driven mentality to the SYNERGY platform as opposed to the typical supply-driven operation of the data marketplaces; and (v) Data Analytics Services Bundle that essentially allows for exploratory data analysis, designing and executing analytics workflows, and running pre-trained analytics to generate new insights and knowledge.

On top of the SYNERGY Big Data Platform and AI Analytics Marketplace, a bundle of innovative energy applications and services is configured, addressing the business and optimization needs of the variety of stakeholders involved in the electricity value chain to demonstrate (at a large-scale) and validate the value created for each different stakeholder through processing, analyzing, enhancing intelligence and sharing of diverse data assets with the use of SYNERGY. Such applications will provide intra-stakeholder optimization functions, while (most importantly) facilitating collaborative functions that are expected to lead to new business models through the provision of innovative energy services. In this context SYNERGY promotes a new ecosystem of

data-driven intelligence for the provision of innovative synergetic services, accompanied by respective business models for the electricity value chain actors, which are based on the principles of the data sharing and exchange approach introduced and enable the collaboration between TSOs-DSOs, TSOs/DSOs-Aggregators, Retailers-Aggregators, Retailers-ESCOs, Aggregators-Prosumers, Cities-ESCOs-Facility Managers and Prosumers themselves (organized in local communities) for the realization and satisfaction of individual and common business and operational goals and the democratization of respective benefits across the whole value chain through data value creation and monetization.

4.2.2 SWOT analysis of European digital platforms in Energy

Analyzing the status of digital platforms in European research and innovation landscape within energy domain, the following strengths, weaknesses, opportunities and threats are identified.

Strengths:

- In the energy sector, massive market digital platforms facilitate the involvement of prosumers, providing a great amount of data to be integrated in different mechanisms/solutions. Prosumers role is further promoted by the emerging Energy Data Spaces (facilitating the prosumer engagement in data sharing).
- While usually at national level in Europe, there are limited data providers (customers, DSO, EV infrastructures) and many solution providers (technology companies)., at European level, the data sources increase and data availability is large enough to deploy digital platforms effectively.
- Ability of digital platforms to facilitate transparent data sharing across energy sector stakeholders, to effectively integrate the value chain and to enable the creation of a collective knowledge and intelligence ecosystem for the holistic optimization of the energy system, through the utilization of (currently unreachable) data generated across its edges is a key strength to accelerate the adoption of platforms.

Weaknesses:

- Currently, there are still different regulations (such as GDPR) at national level to be considered, despite the upcoming adoption of the emerging Data Governance Act and Artificial Intelligence Act, which are setting the scene at Pan-European Level for a common European regulation. Thus, at European level it is difficult to harmonize all the regulations (particularly considering the integration of associated countries like Israel, Turkey, etc.).
- Interoperability is a key challenge for digital platforms in energy domain. A specific focus shall be given on semantic interoperability and harmonization of various data models that are currently being used.
- Lack of a clear process for allowing data providers to share or process data owned by other stakeholders is a barrier that could hinder adoption of platforms. A clear example is the case

of DSO vs consumers, where DSOs can act as data providers of the consumer-owned data only for specific purposes (e.g. sharing to retailers for energy invoicing). A more flexible framework for data sharing is missing to allow sharing for further purposes.

Opportunities:

- The existing market trend in energy domain in terms of business models shift (change of roles of distributed energy resources) is a key opportunity for adoption of digital platforms considering that several companies in the sector are investigating the deployment of new business models knowing that missing of this opportunity would result in their significant lag in the energy market.
- A massive opportunity arises from the decentralization of the energy system and the new involved actors, highlighting the need for the value chain integration. Digital platforms can play a key role in the future smart energy system, by mainstreaming and facilitating data collection across the edges of the system and enabling data sharing (under novel data remuneration schemes and business models), ensuring the operational efficiency and resilience of the system. In this ecosystem all actors of the energy value chain (even prosumers) can behave as data providers (with profound benefits), but also obtain the opportunity to become active players in energy markets and offer flexibility to the system (following the path from data provision to data analysis and from flexibility extraction to flexibility offering and activation).
- Despite the initial assumptions indicating a slow pace for the digital technologies adoption in energy domain, the digital transformation and role of ICT technologies is becoming more and more important in the sector and this generate a big opportunity that can be seized by digital platforms.

Threats:

- A key risk is related to the existing entry barriers in the market even though the ownership of the data facilitates the entrance (i.e. the solution provider needs data availability).
- Security in energy grids is becoming more and more critical due to the huge amount of generated data and available information from shared data. This could impose a threat and must be addressed.
- Cultural threats in terms of data sharing concerns is a risk to be mitigated. In many cases data owners are reluctant to share their considering their data as their core competence and power and thus have concerns to lose their competitive advantage by sharing their data.
- Prosumers' concerns regarding data privacy and security, together with lack of trust to traditional energy market players is an important threat for adoption of platforms in energy domain.

4.3 European digital platforms in the Healthcare domain

Compared to platforms in other domains, healthcare platforms are usually both more complex and more fragmented. The platform landscape in the healthcare domain also presents a wide diversity in their scope. No specific platform can be considered today as being a major uncontested player. For the sake of simplification, platforms can today be classified in the following categories: pure data platforms, platforms with horizontal integration, platforms with vertical integration, and integrated meta-platforms[71]. Many of those platforms are however hybrid and cannot be formally categorized in any of those categories. End-users are usually faced with a large number of single-solution providers offering different services with various business models. Platforms are also developed for specific eco-systems with a particular focus for example on ageing population or chronic conditions.

Pure **Data Platforms** collect and analyze large amounts of data with the objective to improve diagnoses and generate personalized treatment plans, as well as better and more tailored products and services, ultimately leading to better outcomes. The increase reference to Artificial Intelligence has significantly increased the attractiveness of those platforms as access to a large amount of quality and structured data is a prerequisite for its actual use.

Platforms with **horizontal integration** are generally use case and patient centered based and focus either on a specific indication, for example cancer or diabetes as prominent focus, or on a specific treatment setting. Many European projects developed since a decade can be listed under this category which usually include a strong patient empowerment component.

Platforms with vertical integration do not focus on specific indications but integrate different steps along the value chain or patient journey with often a specific emphasis on multidisciplinary care coordination

Integrated meta-platforms operate on a larger scale and are meant to support different types of finalities and use cases with the involvement of a large spectrum of actors. They interlink most of the players in a specific healthcare system and are both vertically and horizontally integrated.

One expects that this wide heterogeneity of platforms will subsist for quite a while although different platforms will probably cooperate more and more closely with each other leading to the development of "platforms of platforms" or "platform networks". Within this complex landscape, players that succeed in owning the customer (patient/citizen) interface will be at an enormous competitive advantage as whoever controls this access will then be in a position to push the patient/citizen triggered information to providers. Patients/citizens will indeed increasingly be in control of their data and thus decide by themselves who may use them and how. Usability is due

[71] Classification proposed by Roland Berger GMBH, Munich, Germany in "Future of health 2 |The rise of healthcare platforms, 09.2020"

to become as important as trust from this respect. Players who will succeed in finding a way to "hide" the complexity of healthcare processes while ensuring a high level of trust, legal compliance and transparence to the patient will achieve a real competitive advantage

Patient-centered healthcare is now the driving force behind most of the reforms of healthcare systems. This new paradigm requires **collaborative ecosystems** supported by platforms with different entry points, depending upon the individual's needs (prevention, diagnosis, treatment) and connected to secured and increasingly open data spaces. Patients and citizens will also increasingly consume analog and digital services in a different and flexible mix with is bringing new requirements for to eb successful platforms. It is noticeable that, beyond the premises of projects limited in scope and time, still few initiatives are taken to evaluate the efforts needed to connect different services in practice.

From another perspective, focusing on the sub-domain of Active and Healthy Ageing (AHA) domain, platforms can be investigated through their impact for the different categories of stakeholders aiming to identify the key factors that could drive or hinder their uptake by the stakeholders' clusters, and also the evolution of their ecosystems and stakeholder network. Table 1 lists the main clusters and stakeholders under this perspective.

Table 1. Platforms and main clusters of stakeholders in Active and Healthy Aging sub-domain

	Cluster Name	Stakeholders
1	Primary end-user	Elderly people
2	Secondary end-user	Healthcare organization Home care / community support Residential care home Professional caregiver Informal caregiver Volunteer
3	Authorities and facilitators	Public authorities Social security system Insurance companies Policy makers
4	AAL/AHA solution developer/provider	Hardware manufacturer Software/app developer
5	Open platform provider	EU funded platform Commercial open platform

Under this light, PlatformUptake project has analyzed the EU funded platforms in 48 representative research projects. The project has concluded an in-depth analysis of a number of those platforms[72] such as UniversAAL IoT, Activage_AIOTES, Ekosmart, Reach2020, Sensinact, UNCAP, FiWare, Onesait. The study of these platforms made it possible to lay the foundations for the definition of stakeholder clusters, domains and related KPIs.

4.3.1 Examples of European digital platforms in the Healthcare domain

There are many examples of pure data platforms within the European research and innovation landscape. Important examples are related to the public controlled platforms (data hub) which aims at organizing the sharing of public data sets collected by various health data registries at national/European levels. In this regard, Healthdata.be[73] in Belgium is one of the most advanced platforms. In the private domain, three significant examples of these platforms are 23andMe[74] (DNA analysis targeted at citizens), IQVIA[75] (Real data evidence to support innovation targeted at Industry) or Amazon WS (in cooperation with Cerner).

AT the European level, the 1million+ genomes initiative is an interesting example of a platform with vertical integration[76]. The platform aims to provide cross-border access to 1+Million high quality whole genome sequence datasets as reference (by 2022) with 24 signatory countries (and 4 observers). The mission of the platform is to create a Genomic Data Infrastructure sustained among European Health Data Space, European Open Science Cloud, Digital Europe National infrastructures & genome-based health programmes.

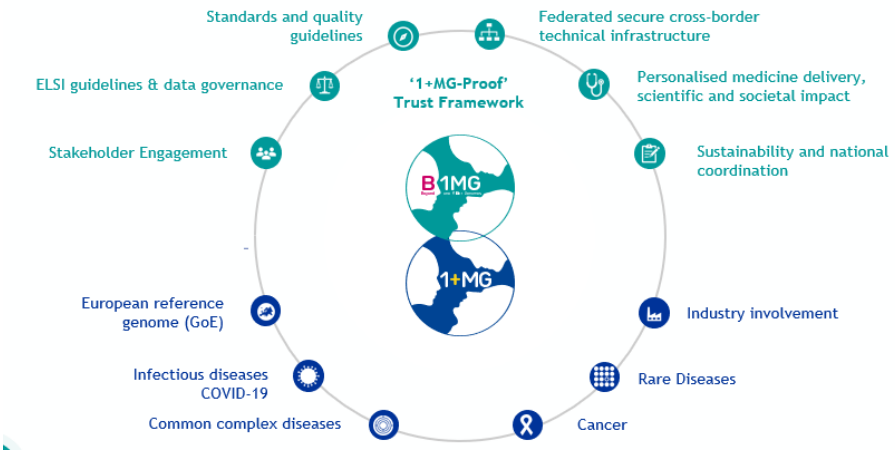


Figure 25. Overview framework of 1million+ genomes platform

[72] https://www.platformuptake.eu/platforms
[73] https://healthdata.sciensano.be/
[74] https://research.23andme.com/
[75] https://www.iqvia.com/
[76] https://digital-strategy.ec.europa.eu/en/policies/1-million-genomes

The platform relies on local installations based on RD-Connect GPAP which enables data collation, sharing, analysis, and interpretation and is based on a federated model (data remains in the country / region).

Most of the platforms developed to support Active and Healthy Ageing can also be listed in this category. Deeplens[77] platform and Varian (bought by Siemens) platforms are two examples in private sector for the cancer use case. Many others have been developed to support use cases such as diabetes, multiple sclerosis[78], rare diseases etc., as well as platforms aiming at prevention/well-being (i.e. sharecare platform[79]). In this case Mobile Apps are often the key entrance aspect to for operationalization of these platforms.

Regarding vertically integrated platforms, most of the Large-Scale Pilots projects represented in the OPEN DEI healthcare cluster and some of the active platforms are falling into this category while at national level, many countries and organizations have developed multiple platforms to support either the continuity of care service or a specific type of information exchange. There are also other examples such as telemedicine services integrated with hospital systems. The platforms developed by Health Management Organizations are part of this category as they connect insurers and care providers.

At European level, the eHealth Digital Service Infrastructure (eHDSI)[80] is an infrastructure that aims at ensuring the continuity of care for European citizens while they are travelling abroad in the EU. The infrastructure connects the national infrastructures to give EU countries the possibility to exchange health data in a secure, efficient, and interoperable way. Citizens can easily recognize the availability of the services under the brand "MyHealth @ EU". It facilitates the cross-border exchange of health data including patients' summaries and e-prescription. Through 'core services', the European Commission is providing a common ICT infrastructure and crosscutting services (terminology, interoperability etc.) to EU countries. They can then set up 'generic services' to connect national eHealth systems through 'National Contact Points for eHealth (NCPeH).

Integrated meta-platforms are still rare but are increasingly part of eHealth development roadmaps. Findata[81] can be considered as the most successful integrated platform developed in Europe so far. Although it has its own governance and rules related to secondary use of data, there are clear and transparent links to data created in the context of continuity of care. The high level of trust of Finnish citizens in their public authorities has been a major enabler for its successful deployment.

[77] https://www.deeplens.ai/
[78] https://www.wordreference.com/enfr/multiple%20sclerosis
[79] https://www.sharecare.com/
[80] https://digitalhealtheurope.eu/overview/
[81] https://findata.fi/en/

4.3.2 SWOT analysis of European digital platforms in Healthcare

Analyzing the status of digital platforms in European research and innovation landscape within healthcare domain, the following strengths, weaknesses, opportunities and threats are identified.

Strengths:

- Digital platforms are instrumental to develop attractiveness and interest for new digital services.
- There is already a large documented experience of the use of platforms in the sector including different approaches related to data (decentralized versus centralized) with a strong trend now to combine them. Flexibility is thus a documented asset of the domain.

Weaknesses:

- Lack of interoperability is a significant challenge. Precondition to a wider development of platforms is a stronger focus on data and technology interoperability, using international healthcare interoperability standards (HL7, FIHR, Snomed CT), API integration models, open-source tools and standardized architecture.
- There are some challenges to be addressed by the industry stakeholders in healthcare domain including:
    - They should better engage with cloud technology providers
    - They need to learn to design with the (eco)system they are interacting with and avoid creating proprietary platforms in silos.
    - They need to develop healthcare specific value proposition, taking in consideration critical aspects as data residency requirements.
- Inexistent or embryonic business model to support active use of platforms offering innovative but disrupting services is a main barrier for uptake in healthcare domain.
- Platforms with advanced functionalities are usually best accepted/used when developed at Community/regional level. This is largely related to the capacity to establish a circle of trust.
- GDPR is ensuring protection to European citizens but it has led to many different interpretations- even for basic functionalities- limiting use cases and economies of scale and slowing deployment.

Opportunities:

- Platforms are changing roles and structures and require new competencies in healthcare organizations, however they can support critical change management process in the domain
- The increasing importance of patient-value is an opportunity to accelerate the adoption of platforms in healthcare domain. While healthcare organizations and professionals were initially seen as the main target of platforms, they increasingly put now the patient/citizen as

their main focus with a major impact on use cases and geographical scope (e.g., prevention and not only care, rare diseases, genomics, contribution to research etc.)
- The fact that platforms address both Patient/Citizen and Healthcare Professionals provides unique opportunities for the development of new services and use cases.
- Platforms can be used as enablers of new pilot projects. Once there will be a platform it can be a foundation to focus on new applications and service.

Threats:

- Lack or complexity of governance process to govern interoperability and maintain it over time at national level and even more at European level.
- Lack (or weakness) of national infrastructures in several European Member States to access critical resources (such as those related to Eid) and absence of synergies between domains (e-Gov) in the public domain.
- Lack of Global compulsory IoP implementation reference framework at EU level and Incentives attached to it.
- Lack of transparency and communication on the purposes of use of platforms to increase trust in the ecosystem.

Cultural differences and archetypes could play an important role in hindering the deployment and acceptance of the platforms across different countries.

4.4 European digital platforms in the Agri-food domain

Advanced digital technologies can play a key role to increase the efficiency and effectiveness of processes in agri-food domain and across value chain. Many use cases have demonstrated that using innovative digital solutions can help control cattle mineral intake, increase milk production and enable the early detection of diseases in livestock. By relying on crop sensors and ear tags, farmers can increase production while reducing their environmental impact.

Developing digital farming platforms, agricultural machine builders, and smart water management systems has demonstrated the significant role that emerging digital solutions can play in supporting farmers in the field. Under the Horizon 2020 programme, approximately €1 billion of EU funding was made available for efforts research and innovation under the European Commission's initiative for Digitalizing European Industry (DEI).

Major investments have been set out in establishing large-scale pilots (LSPs) to provide answers to societal challenges in several areas. This includes building agricultural digital platforms and supporting digital innovations in the agricultural sector.

4.4.1 Examples of European digital platforms in the Agri-food domain

DEMETER is a large-scale deployment of farmer-driven, interoperable smart farming-IoT (Internet of Things) based platforms[82]. The project ambition is to facilitate and speed-up the deployment of interoperable data driven smart farming solution providing decision support and control systems for the agricultural sector that empower farmers to take better decisions, allowing them to harness the full value of their own data and knowledge as well as those shared with others, therefore improving the functioning of the agricultural knowledge and innovation systems and fostering the DSM based on innovation in the sector.

Figure 26. Overview of DEMETER ecosystem

DEMETER aims to put digital means at the service of farmers through:

- using a human-in-the-loop model that constantly focuses on mixing human knowledge and expertise with digital information;
- focusing on interoperability as the main digital enabler, extending the coverage of interoperability across data, services, platforms M2M communication, and online intelligence but also human knowledge, and the implementation of interoperability by connecting farmers, advisors and providers of ICT solutions and machinery;

[82] https://h2020-demeter.eu/

- transforming the sector by building the solution on an array of digital technologies: Internet of Things, Earth Observation, Big Data, Artificial Intelligence, and of digital practices: cooperation, mobility and open innovation.

4.4.2 SWOT analysis of European digital platforms in Agri-food

Analyzing the status of digital platforms in European research and innovation landscape within agri-food domain, the following strengths, weaknesses, opportunities and threats are identified.

Strengths:

- Farmers and food companies start looking beyond the walls of their organization to seek innovation and thus digital ecosystems facilitated by platforms could boost this type of innovation. This is indeed demonstrated by the strong involvement in the ecosystem of projects of numerous end-users who are participating in Pilots (as project partners or through open calls) and attending dissemination events organized specifically for farmers.
- Results of platforms within EU Innovation Actions demonstrated the flexibility of platforms considering that different types of Digital Platforms can be developed, also exploring different architectural choices, for instance centralized vs decentralized or monolithic vs service-oriented ones
- Digital Platforms offer a coherent digital space for integration across the value chain
- Platforms can increase the number of services offered to end users. This is important for agri-food domain which has a large number of its users located in rural areas.

Weaknesses:

- Agri-food domain is characterized by its specific features such as a fragmented value chain and end-users in rural areas. This could be a challenge since; the size and type of exploitation target is an aspect to be taken in account for digital platforms.
- Interoperability and Standardization are still an issue for theadoption of platforms. Data and its semantics need to be captured and managed in a common format so that it can be utilized by all stakeholders in an ecosystem.
- There are limitations in terms of digital and ICT skills in many agri-food organizations considering that some of them are very small family businesses.
- Fragmentation of agri-food system could generate difficulties for platforms to penetrate this market, and introduce significant changes in the product currently offered
- There is a lack of concrete and proper business model to uptake digital platforms, while on the other hand many agri-food companies are not ready to exploit emerging new business models and often not mature enough to seize their value.

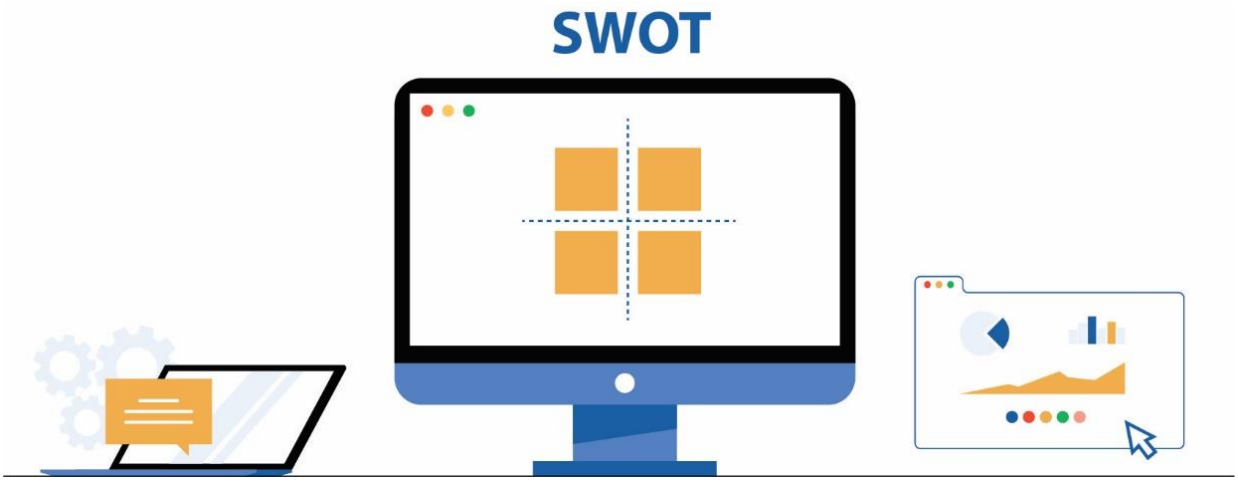
Opportunities:

- There are both market pulland technology push which favor Digital Platforms. "Precision agriculture", "Precision Farming", "Agritech" are all on the rise as farmers and food producers increasingly need information on the exact conditions of their crops and on the agri-food value chain.
- Technology is mature enough and ready to be used through the adoption of platforms. IoT, Cloud, drones and satellites, Robotics and Automation; Big Data & Analytics are all mature technologies that can be exploited thanks to the orchestrating role of platforms.
- There are several financial supporting mechanisms and funding opportunities at EU level to support the uptake of digital platforms in agri-food domain
- The existing favorable policy agenda and policy environment to accelerate digital transformation in agri-food domain through programmes such as Digital Europe and Green Deal is a big opportunity to foster the adoption of platforms.

Threats:

- Agri-food sector is characterized by a low digital maturity which slows down such process of digitalization. Compared to other domains, many agri-food companies, particularly in the SME market, lag beyond their peers in other industries when it comes to technology adoption and vision, and this poses a risk of stranded initiatives. Such consideration is more valid for agriculture, and less for agri-food production, however it could vary from one case to another.
- Adoption of digital platforms is cost-intensive and this generates a barrier for the SMEs operating in the agri-food domain.
- Cultural barriers and lack of trust in data sharing among stakeholders of agri-food domain is an important threat to be addressed in order to encourage them to share their data through using of platforms.

5 Consolidated domain-based and Cross-domain SWOT analysis of the role of digital platforms in Digital Transformation



In Chapters 3 and 4 an overview of domain-based SWOT analysis was provided considering two perspectives. The first perspective presented in chapter 3 was the market perspective and the second perspective presented in chapter 4 was European research and innovation perspective. In this chapter, the two perspectives are merged to provide a consolidated SWOT analysis for each domain which will covers both market and European R&I points of view. Moreover, our analysis of the domain-based SWOT revealed that there are drivers and barriers which are common across different domains and thus could be considered as cross-domain factors for digital platforms. Thus, the final section of this chapter will present a cross-domain SWOT analysis which could be applicable across different, the ones analyzed in this paper as well as other domains.

5.1 5.1. Manufacturing domain

Analysis of manufacturing domain and digital platforms in previous chapters highlight that manufacturers in Europe, and also globally, are rebooting their approach in product and process innovation to scale new opportunities through adoption of advanced technologies via digital platforms. In fact, manufacturing companies need to integrate their operations much closer with their industry ecosystem stakeholders than they did in the past and the shift towards digital platforms is the way forward for them. However as described in previous sections, there are drivers and barriers for such a shift. Figure 27 shows a consolidated SWOT analysis that summarizes the main drivers and barriers for uptake of digital platforms in manufacturing domain in Europe.

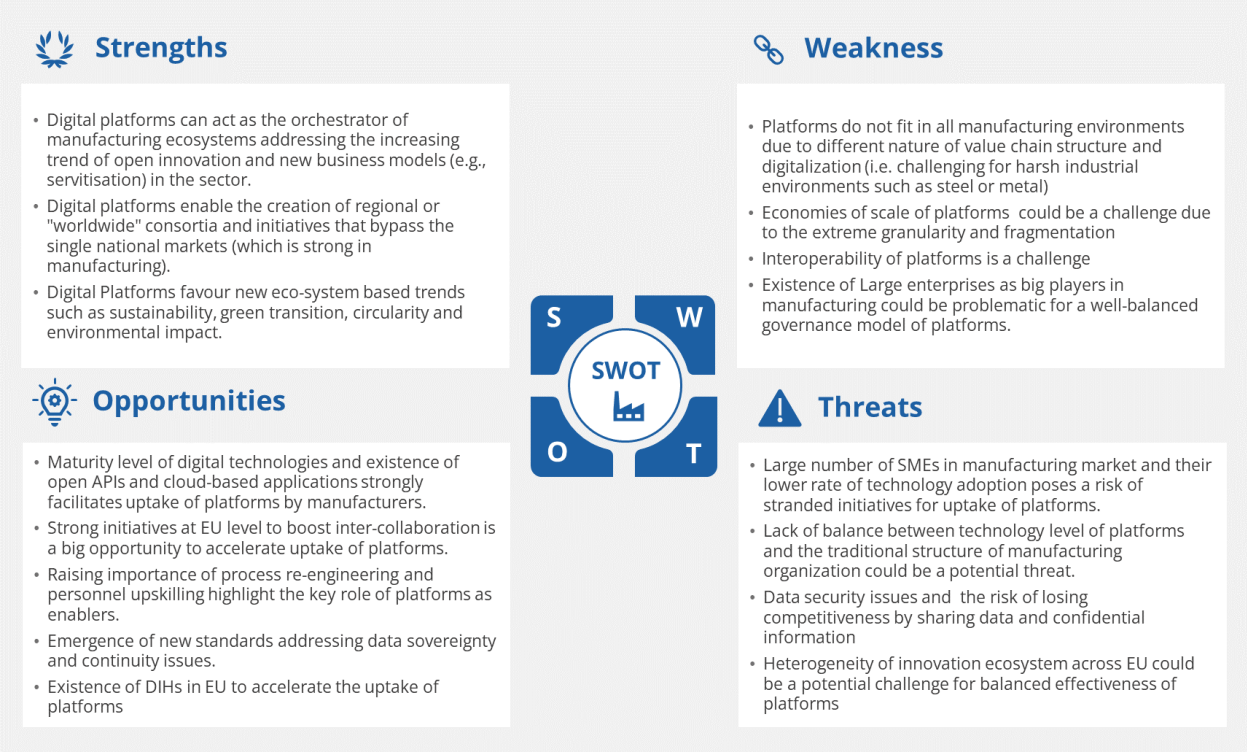


Figure 27. Consolidated SWOT analysis for manufacturing domain

One of the main strengths of digital platforms to boost digital transformation in manufacturing domain relates to their capabilities to integrate the manufacturing value chain, which in some cases is quite fragmented in the sector. Accordingly, this results in another important advantage of platforms to facilitate the generation of a European and world-wide value chain engaging different stakeholders of the ecosystem. Seen from an external environment point of view, there are several factors that can be considered as opportunities for adoption of digital platforms in manufacturing. From a technological perspective, the increasing availability and maturity of technologies such as cloud and artificial intelligence will drive the utilization and exchange of data, both internally and externally, and thus uptake of digital platforms. From an operation perspective, the rising importance of process re-engineering and personnel upskilling in manufacturing domain is a big opportunity for digital platforms to enhance their role as the enabler of this shift. From a political perspective, the existing initiatives and supports at EU in the form of funding mechanisms (i.e. programmes such as Digital Europe) or shared infrastructure (e.g. DIH) is a driver to support European manufacturers, in particular SMEs, in their journey towards adoption of digital platforms and thus digital transformation.

Despite of the existing strengths and opportunities for digital platforms in manufacturing domain, there are still weaknesses and threats that slow down the adoption. Looking at the weaknesses, a major issue relates to interoperability. Utilizing common data models across manufacturing ecosystems remains a challenge and they are often limited to a certain industry (e.g., automotive, chemical, tool manufacturing). Moreover, economies of scale still is a key challenge for digital platforms in manufacturing considering that due to the fragmentation and diversity in the domain, it's quite difficult to have a "one-fits-all" solution. In addition to these internal issues, there are external factors that could hinder the adoption of digital platforms the domain. From a market point of view, digital maturity level of European manufacturer varies significantly from Large enterprises to SMEs. While Large manufacturers are usually the pioneers in digital transformation and uptake of platforms and advanced digital solutions, SMEs usually struggle with a lower digital maturity level which hinders the shift towards platforms and digital ecosystems. Considering that 99% of European manufacturers are SMEs, this imposes a key risk to the sector. Moreover, security and data protection are still two major issues for many companies in the domain. There are major concerns related to IP protection, data ownership, and data privacy and there is currently a perceived lack of appropriate, trusted platforms that address these concerns. Finally, from a cultural perspective, innovation ecosystem are very heterogenous across Europe in terms of collaboration ecosystem and thus it would be challenging for platforms to have a harmonized effectiveness across different ecosystems.

5.2 Energy domain

In recent years, the EU energy sector is going through increasing decentralization and decarbonization processes. Digitalization, in this context, is a key enabler, as it unlocks opportunities for actors across the value chain (i.e. consumers, prosumers, retailers, traders,

producers, network operators), providing them with new solutions. At the moment, digital technologies are already playing an important role in the energy sector. Internet of Things, Artificial Intelligence, Big Data, Cloud, 5G and Blockchain technologies are influencing changes both in energy companies' value creation strategies and in customer behavior. They have an impact on longtime established roles, particularly by creating trust and empowering consumers. In this regard, the role of digital platforms as enablers of digital transformation is crucial in Energy domain. Figure 28 shows a consolidated SWOT analysis that summarizes the main drivers and barriers for uptake of digital platforms in Energy domain in Europe.

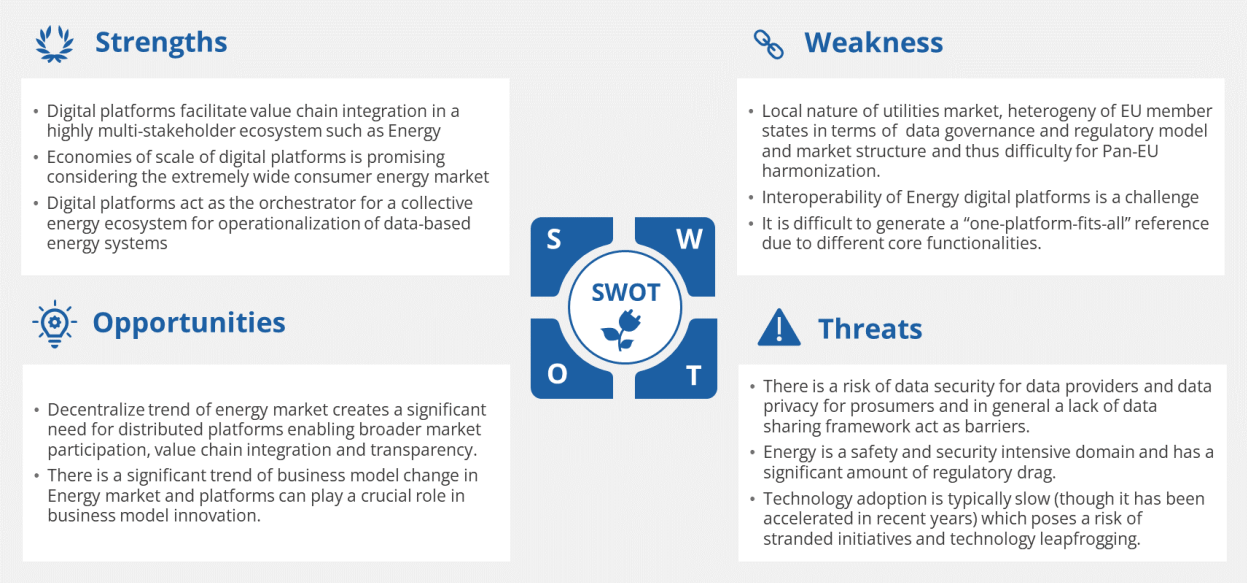


Figure 28. Consolidated SWOT analysis for energy domain

According to the analysis, the main strength lies within the fact that the energy industry (particularly the utilities industry) is almost a naturally occurring ecosystem industry. Considering as examples the complex data and messaging exchange involved in electricity settlement or customer switching, digital platforms fit well in this industry and can have notable economies of scale. Moreover, digital platforms can integrate the complex energy value chain and dozens of partners in the ecosystem. From an external market perspective, the opportunity relates to the fact that, as energy systems decentralize and there is a need for broader market participation (for example of distributed energy resources), there is almost a natural need to move from linear/sequential value chains to platforms. Accordingly, the trend of business model change provides a big opportunity for digital platforms to play the key role for such a shift.

Looking at the weaknesses and threats for digital platforms in Energy domain, the main weakness lies within the local fragmentation of energy and utilities markets in terms of regulatory model, demand and supply mix, market roles and number of participants. This implies that, a "one-platform-fits-all" platform approach does not work, in most cases in energy domain. Moreover, from a technical perspective, interoperability is still a major challenge for energy platforms which hinders their uptake and effective implementation. From an external market point of view, data

security and privacy are major challenges for energy market to accelerate its shift toward a data economy orchestrated by digital platforms. Another main threat is related to the slow technology adoption process that is typical of this industry where safety, reliability and compliance is the name of the game so to say. This poses a risk of stranded initiatives and technology leapfrogging.

5.3 Healthcare domain

COVID-19 has pushed healthcare players worldwide to collaborate at a near-global scale to enhance crisis response. Co-innovation has become particularly urgent to fast-track R&D efforts. This urged the need for creating standardized secure environments to enable real-time sharing of multi-sourced data and findings and analytic capabilities and compute across broader R&D networks. In fact, healthcare organizations' ability to generate value will increasingly rely on their participation in digital and agile ecosystems that leverage digital platforms to enable sharing of data and insights at scale. This will drive a systemic industry change. Nevertheless, adoption of digital platforms in healthcare domain is not straightforward and despite of existing drivers there are a couple of weaknesses and threats to overcome. Figure 29 shows a consolidated SWOT analysis that summarizes the main drivers and barriers for uptake of digital platforms in healthcare domain in Europe.

Figure 29. Consolidate SWOT analysis in healthcare domain

The main strengths of digital platforms in healthcare domain are linked to their capability to provide a wide range of innovative digital services to the various stakeholders and actors of healthcare value chain and integrate such a fragmented multi-stakeholder value chain through data sharing and exchange. In fact, digital platforms (both centralized and decentralized ones) offer the required flexibility that is needed in the complex healthcare value chain. The experience of an inevitable shift towards digital platforms during Covid-19 pandemic has highlighted the strength of platforms as a game changer in healthcare domain and demonstrated their effectiveness. In the other words, Covid-19 accelerated the adoption of digital platforms in healthcare domain and pushed the market forward for future uptake. Apart from the pandemic which brought out a significant opportunity to reinforce the key role of digital platforms, another major external opportunity that can act as accelerators of platforms adoption is the rapid shift of healthcare domain towards patient-based and citizen-based services which are mainly enabled through advanced digital technologies such as IoT, wearables, AR/VR, etc. Such a shift changes the role of the patients and citizens as a sole end-user to an integrated part of the value chain and such integration can be realized though digital platforms.

On the other hand, the challenges that hinder the adoption of platforms in healthcare domain are impactful. A main weakness of digital platforms is related to the issue of data quality and interoperability. Standards and data models are widely developed in the healthcare domain but are not yet sufficiently aligned and governed with also IPR issues which still somewhat slow down wide acceptance. In addition, a number of platforms are still developed today with a focus on specific use cases while an important part of the functions needed (i.e. cyber-security, identification/authentication, privacy, interoperability, etc.) are not use-case related. These platform risk to fail to be able to "plug-in" with other platforms. Aligned with this, there is also the trust challenge regarding digital platforms and data sharing in healthcare domain. The sensitive nature of data in the domain and the concerns on risk and security as well as fragmented legislative frameworks around secondary use of data and concerns about ethical use of data are significant barriers to overcome. In this regard, the attempt of the European Commission to guide the implementation of the concept of "data altruism" is an important initial action to address this challenge. Moreover, there is still a lack of proper business model to uptake platforms which requires establishment of critical mass of stakeholders and users and a transition from activity based to outcome-based reimbursement models. As long as platforms will not be built with the potential of the maximum reuse of existing widely validated building blocks and data sources, the business model will probably remain erratic. Besides, there are also external factors that might slow down the uptake of platforms. A major threat is linked to the heterogenous regulation, legislation and governance frameworks across healthcare market that directly raises the concern about data privacy and ethic. Such a heterogeneity exists at cultural and technological levels as well. From a cultural perspective, differences and gap among different healthcare ecosystems raises the issue of trust for data sharing and generates external barriers to implement the platforms. From a technological perspective, despite of the considerable move of healthcare domain towards digital transformation, there is still a non-homogenous level of digital maturity

among market players in particular small and medium sized organizations that still struggle with their journey towards digital transformation. Such an imbalanced level of digital maturity could be a risk for a shift towards platforms. This involves the digital infrastructure readiness as well which in some countries are limited and difficult to access. Thus, to foster the shift, healthcare organization need platform-centric architectures (such as cloud) to accelerate their move towards the digital platforms.

5.4 Agri-food domain

Digital technologies have the power to transform agri-food systems in emerging markets by accelerating the work of participants across the value chain, including input players, producers, and retailers. This shift towards digital transformation and digital platform is inevitable for agri-food domain, however historically, the agri-food industry has not been a pioneer in terms of technology adoption due to several factors such as traditional culture of the sector and fragmented value chains. Taking into account the analysis in chapters 3 and 4, Figure 30 shows a consolidated SWOT analysis that summarizes the main drivers and barriers for uptake of digital platforms in agri-food domain in Europe.

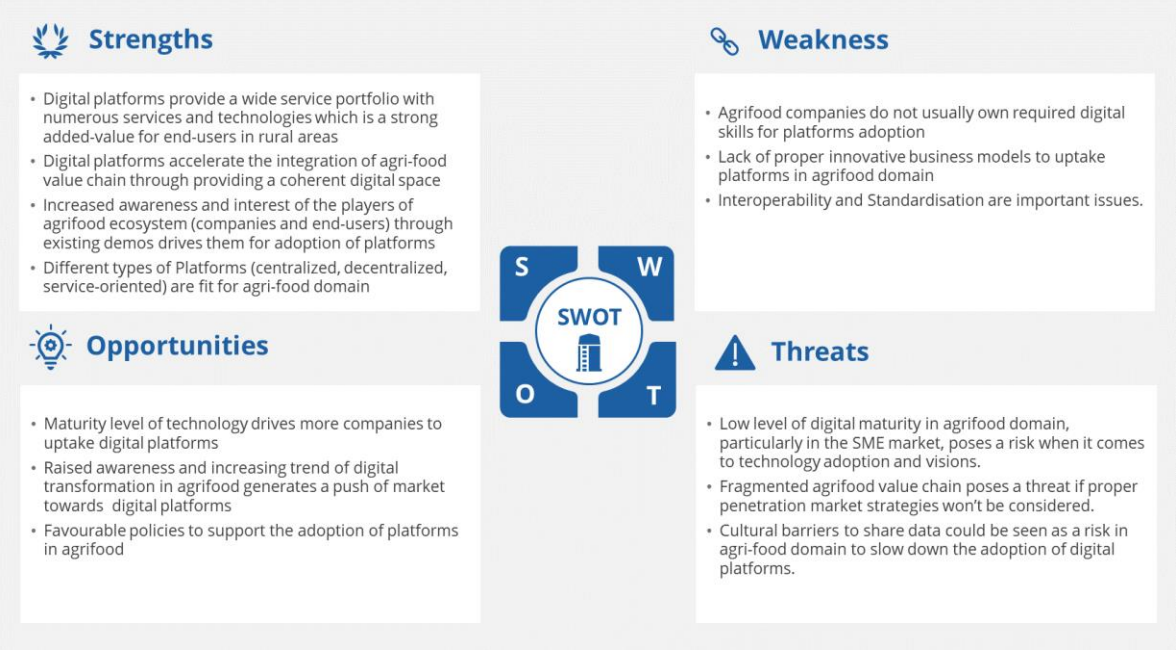


Figure 30. Consolidated SWOT analysis for agri-food domain

The main strength of digital platforms in agri-food domain is related to the wide number of services that can be provided to different stakeholders across the agri-food value chain which is traditionally a fragmented value chain with actors in remote and rural areas. This eventually results in another significant strengths of the platforms in terms of integration of the value chain and transform it to a more connected chain of actors. In fact, these factors have also generated a significant opportunity to accelerate the adoption of the platforms in the domain thanks to the

raised awareness across the value chain and in particular the end users in the agri-food sector (i.e. farmers). Such an awareness will push faster the stakeholders towards the implementation of platforms taking into account the increased maturity level of technologies that could overcome the reluctancy and uncertainty of the companies and farmers to adopt them.

On the other hand, there are still challenges and barriers for digital platform stemming from both internal and external ecosystem of platforms. From an internal perspective, the main weaknesses lie within the three dimensions of lack of proper business models to ensure data monetisation, lack of proper digital skills in agri-food companies and the technological issue of platforms in terms of interoperability and standardization considering that data and its semantics need to be captured and managed in a common format so that it can be utilized by all stakeholders in an ecosystem. From an external perspective, the low digital maturity of agri-food market, in particular SMEs operating in agri-food, hinders their shift towards digital platforms since they still lack some of the basic capabilities in terms of digital transformation. Another major threat relates to the traditional nature of the agri-food domain and thus reluctancy to move towards open innovation and share data with other players in the value chain.

5.5 Cross- domain SWOT analysis

Our analysis and observation of the four domain-based SWOT presented in previous section show commonalities among the analyzed domains. As a result, while there are factors which are domain-based, there are other factors which are common across different sectors and thus can be considered as cross-domain drivers and barriers for adoption of digital platforms. Due to their relevance, we expect that these factors are not only relevant for the four analyzed domains in this position paper but also in other domains which have not been a part of this study. We have shaped these factors in the format of a cross-domain SWOT analysis which could be considered as a reference SWOT for digital platforms in different sectors.

Strengths:

- Digital platforms act as an **orchestrator** and **integrator** of the value chain in different domains supporting the convergence of digital ecosystem.
- Digital platforms **accelerate** the adoption of a data-based economy acting as the crucial building block to **bridge the demand and supply market**.
- Digital platforms support the enhancement of added-value and innovative services for end-users through providing a **wide service portfolio** integrating a wide range of technologies.
- Digital platforms support **scaling of the value chain globalization** and creation of inter-regional and pan-European value chains and markets.
- **Flexibility** of digital platforms (centralized vs. decentralized) is a driver to facilitate their adoption across different domains.

Weaknesses:

- **Interoperability** and **standardization** are still significant challenges across different domains. There is a lack of common data models and standards for data sharing and exchange.
- **Economies of scale** of platforms is a challenge across different domains (even though some domains such as Energy are ahead) due to the extreme granularity and fragmentation.
- Lack of concrete and proper **business models** to facilitate the adoption of digital platforms is a key issue across domains.
- Lack of proper and effective **governance model** for digital platforms slows down their adoption.
- Generation of proper **reference architectures** and a "one-platform-fits-all" is a major challenge.

Opportunities:

- **Maturity level of technologies** (i.e. APIs, cloud platforms) is at the level that strongly facilitates the adoption of platforms by companies and organizations.
- Strong **initiatives at the EU level** to boost inter-regional and pan-EU collaboration and also support adoption of platforms (i.e. DIH, Digital Europe Programme, etc.) is a big opportunity for uptake of digital platforms.
- The rising trend of **data economy** and **value-based** services is a driver for a faster pace of adoption of platforms.
- The **increasing awareness** among ecosystem stakeholders in terms of digital transformation pushes the market for faster adoption of platforms.
- **Covid-19 pandemic** demonstrated the effectiveness of digital platforms and fostered the pace of digital transformation pace across different domains.

Threats:

- **Low digital maturity** level of the demand market (especially SMEs) hinders the uptake of platforms.
- **Data security, privacy** and safety are major concerns and risks that could slow down the adoption of platforms.
- **Fragmented value chains** (especially in domains such as healthcare, manufacturing and agri-food) impose a risk for adoption.
- **Heterogeneity of innovation ecosystems** across Europe and cultural barriers poses a risk towards tendency of data sharing and digital platforms adoption.

Figure 31 summarized all the above mentioned factors in a frame.

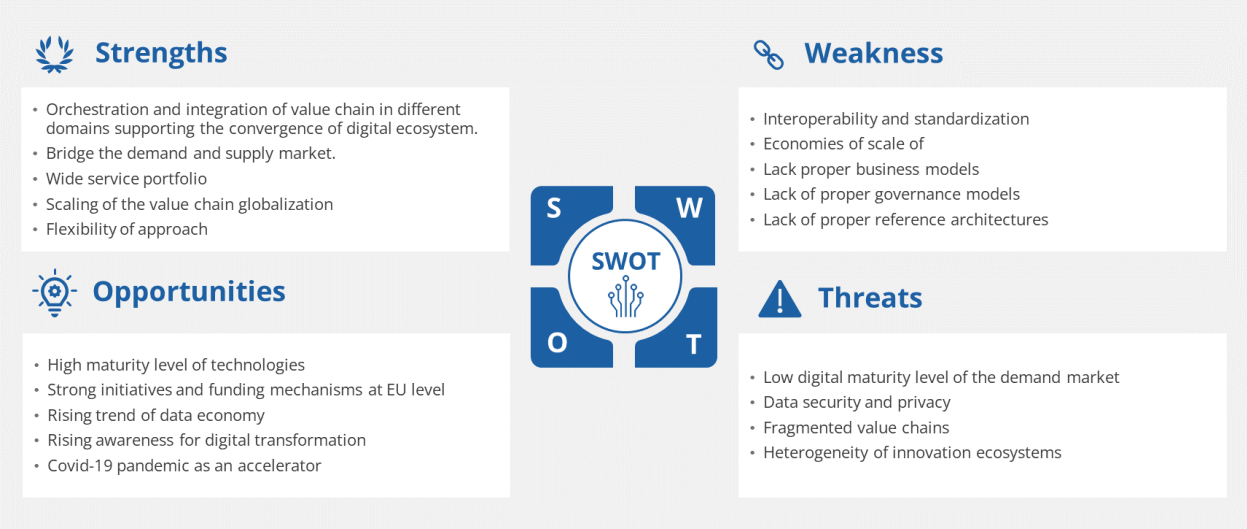
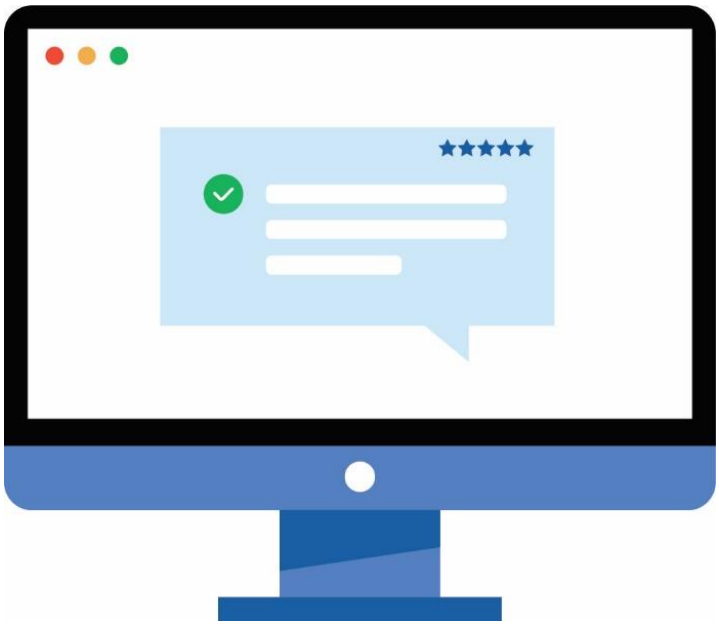


Figure 31. Cross-domain SWOT analysis for digital platforms adoption

6 Highlights and Recommendations



In this chapter, based on the analysis presented in the previous chapter, the main drivers and barriers for adoption of digital platforms in Europe are defined and a set of top-level recommendations as an initial input for further actions are provided.

6.1 Drivers for adoption of Digital Platforms

The key drivers to uptake of the digital platforms can be categorized into three main categories namely 1) Technology drivers 2) Market drivers 3) Operational and value chain drivers, and 4) Policy drivers. Technology drivers refer to the depths and breadths of technology solutions and applications that are on the one hand making digital platforms a working and interoperable reality and, on the other hand, allow digital platforms to deliver the requested services to their final users. In parallel, the increasing adoption and uptake of critical advanced technologies such as Cloud computing, Big Data and Analytics and Artificial Intelligence contributes to the creation of a favorable market environment that pushes the overall process of digital transformation even further and constitutes a powerful driver for the deployment of digital platforms. What is more, "platform revolution" is already reshaping how industries are defined, how ecosystem participants interact, how stakeholders' needs are met, and how value is created and shared. Companies and organizations alike are therefore pursuing new ways of achieving operational efficiency while changing significantly the composition of traditional value chains. This leads to the search for more and more effective and adaptable digital platforms that are capable of working at specific industry levels and across value chains highlighting the third category of drivers as operational and value chain drivers. Finally, European policymakers are also helping to accelerate digital platforms diffusion and uptake by fostering an environment where online platforms thrive, treat users fairly and take action to limit the spread of illegal content.

Technology drivers:

Digital technologies have gone through a significant evolution in recent years. Technologies such as IoT, AI and Cloud became much more mature, diffused, and operational. The following drivers could consider key technology factors to accelerate the uptake of digital platforms in Europe:

- **Exploitable level of technology maturity:** Increasing use and adoption of cloud-based applications and open APIs is a compelling driver for companies and organizations to use digital platforms to share and exchange data. This resulted in accelerated cloud adoption with both traditional organizations and digital service providers increasing the use of IaaS (Infrastructure as a Service) for their technology platforms. Moreover, other advanced technologies such as AI, analytics, blockchain and IoT are at a much more mature level compared to a few years ago and are more diffused and adopted in different sectors. This drives more organizations towards the implementation of these technologies through digital platforms.
- **Emerging generic and domain-based technologies:** while some technologies are generic in nature and show a marked horizontal spread, other technologies clearly show a more niche

or industry-specific orientation. However, this does not mean that they do not provide opportunities for investments outside their main industry field. In the next few years, factors such as new features, price levelling, enhanced ICT infrastructure and evolutions in terms of digital maturity will lead to higher uptake of all the technologies identified, across the board**.** while more mature general-purpose technologies such as connectivity, cloud and security show homogenous uptake across all industries, new emerging technologies are more niche and industry specific. Examples include Blockchain, which has gained a foothold in the finance sector, and micro- and nanoelectronics and nanotechnologies, which, together, show high levels of verticalization, particularly in the manufacturing domain. Digital platforms will act as a vehicle and accelerator for the uptake of these emerging technologies both domain-based and cross domain.

- **Flexibility and agility of digital platforms:** Digital platforms provide adequate flexibility in terms of their approach to be applied either in a central or decentralized way in different domain and thus could be adapted to different requirements.

Market drivers:

Business leaders, experts and practitioners have been warning about the impact of digital transformation on both the supply and demand-side of the market for the past few years. One of the most prominent elements of this transformation is in fact embodied by the creation of a vast, interconnected ecosystem enabled precisely by digital platforms. In addition, the impact on the market is huge: Research conducted by the World Economic Forum's Digital Transformation Initiative (DTI) indicates that digital platforms could unlock $10 trillion (approximately € 9 trillion) of value for business and wider society over the next 10 years. McKinsey, in turn, has suggested that as much as $60 trillion (approximately €55 trillion) – making up 30% of the global economy – could be mitigated by digital platforms in five to six years' time worldwide[83]. The European market makes no exception and is rapidly getting up to speed and adapt to the platform revolution. The following drivers could be considered as key market factors to accelerate the uptake of digital platforms in Europe:

- **A market shift towards customer centricity and value-based economy**: Increasing importance of value-provision to customers and end-user in particular in many domains such as Healthcare is a major driver for organizations to uptake digital platforms.
- **The definitive emergence and consolidation of the data sharing economy:** The more companies and organizations experience value from analyzing and sharing data, the more they will be moved towards the implementation of digital platforms. On the other hand, the more people and end-users become confident about the value of data and the benefits it can bring, they will become more open to use new sources of information and be a part of the digital ecosystem orchestrated by digital platforms.

[83]https://www.mckinsey.com/~/media/mckinsey/featured%20insights/europe/central%20and%20eastern%20europe%20needs%20a%20new%20engine%20for%20growth/the-rise-of-digital-challengers.ashx

- **A favorable environment for the deployment of digital platforms.** Europe with its strength in industries like automotive, food, industrial equipment and fashion, offers a **fertile ground** for digital platforms that deliver digitally-enhanced products and supply chains agility.
- **The pandemic impact on acceleration of digital transformation:** While on one hand, the pandemic led to severe economic damage to organizations, on the other hand it gave them a new awareness of their digital transformation maturity levels. The crisis not only changed and accelerated industries' digital trajectories, but also dramatically tested their digital strategies and maturity, touching some 'sensitive nerves' and highlighting some latent challenges in organizations' digital backbones. This led to a more realistic self-assessment of in-house digital maturity and capabilities and is behind the year-to-year change. In fact according the analysis show that the proportion of organizations that identified the need for digital transformation is 50% higher compared to before Covid-19 pandemic[84].

Indeed, market opportunities are there: capturing a piece of the digital transformation opportunity is at the center of business strategies today and digital platforms are the key instrument to make this opportunity real. Across all industries worldwide, this could amount to an increased annual economic value of $18.5 trillion, or nearly 25% of global GDP according to IDC[85]. Furthermore, IDC estimates that industrial digital platforms have already reached a significant market value (estimated at almost $2.8 billion in 2019, approximately €2.5 billion) – one that is poised to grow at a compound annual growth rate (CAGR) of around 18% through to 2023[86].

Operational and value chain drivers:

- **Operational efficiency:** The increasing need for operational efficiency and ensuring the business resilience (i.e in cases such as Covid-19 pandemic) is an important driver that highlights the role of digital platforms since platforms play a key role in increasing efficiency of industrial and business operations through cost optimization, improved quality and reduced time to market.
- **Value chain integration:** Today value chain in different domains is characterized by strong supply-side and demand-side disruption that requires ecosystem collaboration to be successful in a volatile, uncertain and complex market. Generation of a consolidated and inter-connected value chain is a key for European organizations and companies and this drives them towards implementation of digital platforms since platforms significantly facilitate value chain integration in a digital ecosystem and increase supply chain transparency. Digital platforms not only bridge the gap between demand and supply market but also enhance customer experience through seamless integration of all relevant stakeholders during the entire product lifecycle (e.g. closer customer engagement, better integration of service and maintenance).

[84] ATI Final Report on technology trends and technology adoption.pdf (europa.eu)
[85] IDC FutureScape: Worldwide Manufacturing Business Ecosystems 2019 Predictions
[86] "Advanced Technologies for Industries: Monitoring B2B Industrial Digital Platforms in Europe", https://ati.ec.europa.eu/reports/eu-reports/monitoring-b2b-industrial-digital-platforms-europe

- **Business resilience:** In order to thrive today's disruptive and turbulent market situation and move towards the "next normal", organizations need to transform into resilient entities. In this context, competitiveness is determined by how data is transformed into insight to create high-value differentiators for products, customers and markets; and how effectively organizations deliver meaningful, value-added learning, predictions and actions that improve engagement, processes, enterprise decision making, resilience competitive advantage. Accordingly understanding and provisioning the platforms that will sustain, advance, and scale business and operations, and exert strategic control is essential for every business.

Policy drivers:

In its communication on online platforms[87] back in 2016, the European Commission laid down the guiding policy principles to regulate the current and future uptake of digital platforms in the EU, namely:

- to create and maintain a level playing field for comparable digital services;
- to ensure responsible behavior of online platforms to protect core values;
- to foster trust, transparency and ensure fairness on online platforms;
- to keep markets open and non-discriminatory to foster a data-driven economy.

These principles have inspired the work of the European Commission over the past few years to make digital platforms a secure and safe reality in the EU. Some examples of policy drivers implemented by the European Commission are as follows:

- **Communication and recommendations on illegal content and online platform economy:** In September 2017 a Communication on tackling illegal content online displayed the EU political commitment in the field, although in a non-binding legal form. This was followed by a Recommendation on measures to effectively tackle illegal content online in March 2018 and by the setting up in 2019 of an Observatory on the Online Platform Economy monitoring the evolution of the online platform economy to advise and support the Commission in its policy making in relation to online platforms.
- **Digital Services Act (DSA):** the Commission adopted a proposal for a Digital Services Act (DSA) in December 2020. Together with a Digital Markets Act, the DSA will create a safer and more open digital space for all users and ensure a level playing field for businesses and will continue to mark the European way of informing the digital economy and society by protecting consumers and their fundamental rights, establish and reinforce transparency and accountability rules, and foster Europe's innovation, growth and competitiveness within the single market.
- **European Digital Innovation Hubs:** European Digital Innovation Hubs (EDIHs) function as one-stop shops that help companies dynamically respond to digital challenges and become more competitive. By providing access to technical expertise and experimentation as well as

[87] Online Platforms and the Digital Single Market: Opportunities and Challenges for Europe (COM(2016) 288 final)

the possibility to 'test before invest', EDIHs help companies improve business/production processes, products, or services using digital technologies.

- **Financial mechanisms through funding instruments such as Digital Europe Programme[88]:** Digital Europe Programme is the first EU programme that aims to accelerate the recovery and drive the digital transformation of Europe. Worth €7,6 billion (in current prices), the Programme is a part of the next long-term EU budget, (the Multiannual Financial Framework), and it covers 2021 to 2027. It will provide funding for projects in five crucial areas: supercomputing, artificial intelligence, cybersecurity, advanced digital skills, and ensuring the wide use of digital technologies across the economy and society.

6.2 Barriers for adoption of Digital Platforms

Barriers for the adoption of digital platforms can be categorized into four main categories namely 1) Regulatory barriers 2) Economic efficiency barriers 3) Technology barriers and 4) Business model and organizational barriers. While regulatory barriers refer to the perceived lack of appropriate, trusted platforms that address mutual trust and transparency, the economic efficiency barrier includes the significant gap between SMEs and large enterprises in Europe in terms of access and usage of digital technologies. The technology barriersare mainly related to lack of interoperability and challenges for cloud-platform adoption, while the organization barriers include lack of concrete business models, governance models and also cultural barriers. In the following, each barrier category is described in more detail.

Regulatory barriers:

Platforms create two potential types of regulatory challenges:

- **Insufficient level-playing field for security and data protection**: Platforms require clarity around data ownership, access and overall governance, to build and maintain mutual trust between the parties involved. Currently, data exchange between different companies is often regulated by bilateral contractual agreements between the parties. These agreements do not come in standard formats and offer different levels of data transferability and data access depending on the sensitivity of the data forming part of the exchange.
- **Fraud and Safety risks**: Collaborating with a broad ecosystem where not all buyers and sellers know one another also requires setting up mechanisms to establish and maintain mutual trust from a consumer protection, financial risk, contract risk and health & safety risk perspective. T

[88] https://digital-strategy.ec.europa.eu/en/activities/digital-programme#:~:text=The%20Digital%20Europe%20Programme%20(DIGITAL,businesses%2C%20citizens%20and%20public%20administrations.&text=How%20to%20make%20Europe%20greener,them%20will%20define%20our%20future.

Economic efficiency barriers:

Platforms can have varying degrees of impact on the economic efficiency of allocating scarce resources, such as government subsidies, labor, capital investment in innovation. The main challenges related to economic efficiency are listed below:

- **Labor market disruption:** Platforms have both generated new jobs and caused job losses. They have also changed models of employment, raising questions about the status of workers' relationships with platform providers with regard to health insurance, employment insurance, wage stability, paid annual leave, worker safety regulations, international labor rights and standards, the rights to unionize and bargain, training, certifications and licenses.
- **Balancing scale with fair competition:** B2B platforms lead to a better allocation of economic resources if they generate collaborative innovations among supply and demand. Realizing the benefits of collaboration requires platforms to scale the number of buyers and sellers that participate; the earlier stages of development of the B2B platform market are characterized by a significant fragmentation, if compared with the traditional B2C landscape.
- **SMEs inclusion:** Digital platforms can enable SMEs to more easily access markets, strategic resources and networks, by pooling resources, reducing information asymmetries, by connecting demand and supply[89]. However, there is still a divide between SMEs and larger enterprises in Europe in terms of access and usage of digital technologies and skills that limit the potential positive impacts of SMEs participation in the platform economy

Technology barriers:

Modern digital platforms thrive on continuous technical innovation that makes it affordable to scale business models rapidly, to collect and analyze data and reimagine customer experiences. The openness of platforms and widespread usage of cloud are key elements of such transformation. Technology platforms that are instead built upon closed systems limit innovation. The main technology barriers are described below.

- **Data quality and interoperability:** Openness of platforms and widespread usage of cloud are key elements of such transformation. Technology platforms that are instead built upon closed systems limit innovation. Data quality and interoperability are the most important technical challenges in this regard. Enterprises can maximize the value of participation in the B2B platform if they integrate the platform's workflows with the ones existing within the boundaries of the enterprise, from design, to marketing, to product life-cycle management, to sales and after sales support.
- **Cloud barriers:** The (perceived or actual) lack of security, scalability, privacy, portability, and interoperability of cloud services, make it difficult for many European enterprises to embrace Cloud computing, especially for mission-critical and information-intensive processes. That is a problem, because Cloud computing is the native environment for many B2B platforms.

[89] https://www.oecd.org/industry/smes/SME-Outlook-Highlights-FINAL.pdf

Business model and organizational barriers:

Platforms have a disruptive impact on industry value chains and companies. Enterprises impacted by these transformations need to have mature organizations that can take advantage of the opportunities and control the risks of change, by adapting their commercial processes (sales, marketing, data-driven customer segmentation and pricing), redesigning the customer journey (in terms of convenience, speed, flexibility and transparency), expanding into new channels (by cutting out intermediaries and building direct relationships with customers), and creating entirely new businesses (for example by enriching products with data-centric services, based on advanced analytics). Companies that resist the move from a product centric paradigm to an outcome-centric one that revolves around long-term customer engagement and ecosystem collaborations will fail to realize the benefits of platforms. If only few enterprises can realize the benefits of digital platform, the positive economic and social impact will be limited.

- **Lack of proper Business models:** many enterprises are yet unable to monetize the data and use it to transform their business processes. Companies are exploring new revenue models, such as platform sharing, risk/reward sharing, economic sharing, mixed advertising and subscription models and/or data monetization sharing. But so far, no clear model has scaled.
- **Lack of proper governance models:** B2B platforms require aligning incentives of all participants on funding development and operations, prioritizing the development of new services, and pricing of services. The more platforms are built through joint efforts across complex supply chains, the more it is necessary to establish collective decision-making processes and governance structures.
- **Cultural barriers:** These barriers pertain to stakeholders' reluctance to innovate and their lack of confidence and entrepreneurship in changing the way they work, which must move from a company-driven approach to an ecosystem-driven concept. Cultural barriers vary from one ecosystem to another considering factors such as type of sector, geography, etc.

It should be noted that the above-mentioned barriers are often interdependent, thus creating an amplified effect. For example, the lack of interoperability standards can drive higher switching costs, thus amplifying the effect of non-transparent contractual conditions. Platforms that use open architectures can instead create a virtuous cycle of network effects for third-party developers that create new services on top of the platform, thus growing the platform core business, as well as the developers' own market reach and success90. The lack of data interoperability and portability may undermine platform market contestability, but "excessive" portability can lead to increasing privacy concerns. Cloud barriers are not only a technological constraint but are also related to both data protection concerns and organizational immaturity. All these interdependencies make regulatory decisions more complex because policymakers need to balance many trade-offs.

[90] MIT Sloan Management Review – Three Lessons From Germany's Platform Economy, August 2019

6.3 Recommendations

As a result of the joint work of the contributors to this position paper, a set of recommendation are defined to address the identified barriers and accelerate the adoption of digital platforms across the different domain in Europe.

Recommendation for regulatory barriers:

- Promote the development of technical solutions, such as homomorphic encryption, blockchain/smart contract and expert systems to **automate governance, risk and compliance**. Additionally promote the exchange of best practices across the EU Member States for dispute resolution mechanisms for data governance.
- Promote the development of technical solutions that can automate blocking/removal from listing of banned products and content and promote **best practice sharing on peer reviews and ratings** that are widely used by platforms as trust-building mechanisms.

Recommendations for economic efficiency barriers:

- Evaluate the trade-offs between strict employment protection that may prevent enterprises from adjusting capacity to rapid demand fluctuations and the need to guarantee workers' rights. **Consider regulatory sandboxes** as testing grounds for new business models that are not protected by current regulation or supervised by regulatory institutions.
- Closely **monitor high market concentration and its persistence** over time and then enforce open competition policies, including promoting cost reduction technical and business requirements, such as data portability, multi-homing and best price clauses.
- Ensure that the implementation EU SME Strategy for a sustainable and digital Europe includes measures that support SME inclusion in B2B platforms. For example by setting up Digital Innovation Hubs (DIHs) dedicated to digital platforms.

Recommendations for technology barriers:

- Disseminate the usage of open-source tools and common technical standards and architectural approaches (e.g. APIs) for **data portability and interoperability**. Consider that "excessive" portability could pose privacy concerns.
- It is recommended that a specific focus shall be given on semantic interoperability and harmonization of various data models that are currently being used. Rather than the introduction of new data models, the extension and harmonization of existing ones across the energy value chain and coupled sectors (mobility, buildings, etc.) shall be promoted.
- **Collect and disseminate cloud best practices**, such as cloud migration, multi-cloud and hybrid cloud management, digital sovereignty and cloud skills, in particular **for SMEs**. Encourage academia and industry associations to support the effort.

Recommendations for business model and organizational barriers:

- Create regulatory sandboxes for the experimentation of new business models. **Regulate the industries, timeframe, and responsibilities for executing and auditing projects in the context of the sandboxes**
- Encourage enterprises and industry associations to define **codes of conduct** on the transparency of contractual condition. Monitor the impact of this self-regulation approach, before taking further actions.
- Scan current **national and international initiatives** to identify pre-existing ecosystems, or partners to build projects with **critical mass and identify best practices**.
- **Strengthen the role of intermediaries** (e.g. DIHs, competence centers, etc.) as enablers to bridge the demand-side (end user) and offer-side (technology / ICT provider) of the value chain.

  Exploit the **successful cases from market and R&I projects** and communicate them as success stories to overcome the cultural barriers and accelerate the uptake.

Contact on behalf of the OPEN DEI Project

IDC 4EU

idc4eu@idc.com

@IDC4EU

IDC4EU

https://www.idc.com/eu/for-eu

IDC Italia Srl,
Viale Monza 14 Milan, MI 20127 Italy