

UNDERPIN

DATA SPACE FOR MANUFACTURING

Pan-European data space for holistic asset management in critical manufacturing industries

D5.1 Existing Business Models Assessment



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Acronyms and Abbreviations

API	Application Programming Interface
BM	Business Model
CapEx	Capital Expenditures
CDB	Communication and Dissemination Board
D	Deliverable
DaaS	Data-as-a-Service
DGA	Data Governance Act
DIH	Digital Innovation Hub
DSSC	Data Spaces Support Centre
EDC	Edge Data Connector
EU	European Union
GDPR	General Data Protection Regulation
IDSA	International Data Spaces Association
IoT	Internet of Things
KVIs	Key Value Indicators
OpEx	Operational Expenditures
RES	Renewable Energy Sources
ROI	Return on Investment
SMEs	Small and Medium-sized Enterprises
WP	Work Package

Executive summary

The deliverable D5.1 “Assessment of existing business models” (due date on M12) is a public report conducted under task “T5.2 Sustainable business models”. It provides a preliminary assessment report towards the definition of a viable, feasible and sustainable business model for the UNDERPIN Data Space, serving as a foundational guide for the development of a robust data space within the European Union.

This document provides a comprehensive overview of the current business models pertinent to Data Spaces, focusing on their structure, orientation, and monetization strategies. It aims to ensure compliance, innovation, sustainability, and stakeholder alignment, laying the groundwork for a dynamic and valuable data space that can drive significant innovation within the European data economy. In addition, the present deliverable documents the strategic components needed to deliver and sustain the project data-driven services effectively. To better understand the ecosystem, key elements such as data sovereignty and user engagement have been considered, while the UNDERPIN stakeholders were systematically categorised based on their positions in the value chain and their roles in the business sector.

The outcomes of this work will lay the groundwork to selecting business models that are not only aligned with the project's overarching goals but also tailored to effectively engage the target audience while promoting sustainable growth strategies.

The present deliverable is conceived as a living document that will be continually enriched with new insights and perspectives, ensuring that it meets the needs and expectations of the relevant stakeholders.

The Deliverable 5.1 is centered around the following underlying objectives:

- Develop a feasible and sustainable business model and a growth strategy, supported by risk assessment and practical advice for the long-term success and sustainability of the UNDERPIN solution;
- Promoting data-driven innovation by creating value through effective data sharing and collaboration;

Further work towards the delivery of a comprehensive business and sustainability concept with respect to commercialisation initiatives will be carried out in the context of T5.2 “Sustainable business models”, which extends to M15. Relevant activities will be also conducted in the context of T5.3 “Business analysis, KVIs, Societal impact, Sustainability and Operator Model” which extends to M24 of the UNDERPIN project and reported as a part of the deliverable D5.3 “Business, Engagement and Commercialisation Plan”.

1 Introduction

This chapter presents the foundational principles of the UNDERPIN project, outlining its overarching mission, vision, and values. It also highlights the purpose of this document with respect to the project objectives. Finally, the relation to other work packages and deliverables, emphasizing how this document integrates with and contributes to the broader project framework.

1.1 The UNDERPIN mission, vision and values

The emergent European Data Economy relies on the availability and accessibility of large amounts of data as a basis for further innovation and exponential development of technologies, in regard to the European digital (data and technology) sovereignty as well as the development of trustworthy ‘made in Europe’ AI that reflects European values.

The UNDERPIN project aims at providing a sustainable dataspace solution towards carrying out dynamic asset management and predictive/prescriptive maintenance (continuous monitoring and exchanging data on machine status, breakdowns, downtimes, service orders etc.) as an area to unlock deep industrial data for trustworthy and reliable value-added services by parties outside a production site. The UNDERPIN Data Space will thereby provide a cross-organisational data sharing and -exchange solution that is secure and trusted and ensures data sovereignty, with a strong focus on the interplay of SMEs and large industry players to enable both to improve products and services, and operational costs.

Furthermore, one of the UNDERPIN overall objectives is to incorporate the project outcomes within the global European Standardization landscape in the Manufacturing Data Spaces field in the area of Industrial Data Sharing. The solution will comply with EU standards and GAIA-X guidelines [1], providing a secure framework and tools for data sharing among partners. By facilitating data analysis, the project seeks to enhance operations for stakeholders, including machine tool manufacturers, integrators, vendors, maintenance service providers, remanufacturers, refurbishers, reuse, repair, and recycling companies, as well as governmental, public, research, and civil society entities.

1.2 Purpose of this document

The purpose of D5.1 “Existing business models assessment” is to serve as a foundational guide for the UNDERPIN project, which aims to develop a robust data space within the European Union. This document aims to provide a comprehensive overview of the current business models pertinent to Data Spaces, focusing on their structure, orientation, and monetization strategies. By offering a detailed examination of these models, the document lays a foundation for the UNDERPIN project to build upon.

One of the key objectives is to inform the strategic development of the UNDERPIN Data Space. By identifying successful business models and best practices, the document ensures that the data space aligns with industry standards and market demands. It emphasizes the importance of leveraging innovative approaches to data management and monetization, thus guiding the project towards a strategic and sustainable direction.

The document facilitates the collection of diverse insights and exchange solution that is secure and trusted and ensures data sovereignty by carrying out dynamic asset management and predictive/prescriptive maintenance to the demanding and diverse oil refinery, wind energy and manufacturing domain.

Finally, the document establishes a framework for continuous improvement. By setting out a process for ongoing assessment and refinement of business models, it ensures that the UNDERPIN Data Space remains relevant and competitive, allowing for the data space to adapt and improve continually, maintaining its edge in a rapidly evolving landscape.

1.3 Relation to other work packages and deliverables

D5.1 documents the outcomes of task “T5.2 Sustainable business models” which is developed in the context of WP5 “Business plan and sustainability”. To facilitate a clearer understanding of how this deliverable relates to the overall project ecosystem, Table 1 provides an overview of the connections between this deliverable and other project deliverables, highlighting their interdependencies.

Table 1: Interlinks with other project deliverables

Deliverable	Interdependency
D6.1 “Integrated Communication, Exploitation and Dissemination Plan”	The guidelines on performing the communication, exploitation and dissemination activities that are documented in this deliverable provide input to the efforts undertaken in D5.1 with respect to sustainable implementation of project activities.
D5.2 “Trust creation processes design”	D5.2 is conducted in parallel with the present document, offering input for the ongoing assessment and development of the UNDERPIN Data Space's business model. Moreover, the analysis of the legal and ethical challenges relevant to the UNDERPIN Data Space detailed in D5.2 contribute valuable insights to the current document.
D5.3 “Business, engagement and commercialisation plan”	The work undertaken in the present document towards the assessment of existing business models provides input to D5.3 with respect to the delivery of

	a comprehensive and sustainable business model for UNDERPIN.
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1.4 Deliverable structure

The structure of the deliverable is organised as follows:

Section 1- Introduction: This section describes the mission, vision and values of the project, the purpose of this deliverable with respect to the project objectives, as well as the structure and its relationship with the other deliverables of the project.

Section 2– Methodological framework: This section outlines the methodology followed for the identification of a viable, feasible and sustainable business model for the UNDERPIN Data Space.

Section 3– Stakeholders Analysis: In this section the stakeholder analysis is presented where the relevant stakeholders are classified into direct beneficiaries, technology providers, regulatory/advisory and indirect beneficiaries. Within this chapter, relevance, benefits, and expectation of each stakeholder is assessed.

Section 4– Dataspace Business Model Classification: This section presented an investigation of the various business models associated with Data Spaces, based on a comprehensive literature review and focusing on the key elements for delivering the value proposition.

Section 5 – UNDERPIN Business Models: elaborates on designing a sustainable business model for the UNDERPIN Data Space, following a methodology that addresses the requirements for secure and sovereign data sharing for value creation, as well as the specific needs and objectives of the diverse ecosystem's stakeholders.

Section 6– Techno-Economic Analysis for UNDERPIN: Presents the techno-economic analysis of the UNDERPIN Data Space, assessing both technological costs and economic feasibility.

Section 7– Conclusion and Future Work: Concludes the deliverable by summarizing key findings and achievements and sets the scene for the outlook of the second half of the project.

2 Methodological framework

This chapter outlines the methodological framework that was employed for the assessment of existing business models related to Data Spaces. It also highlights the various relevant definitions and classifications, and different types of classification that are proposed in recent literature.

2.1 Overview of methodology

This section describes the approach taken to assess existing business models and frameworks relevant to the UNDERPIN project. It details the methodologies used for research and data collection, as well as the literature review conducted to inform our understanding and evaluation of business models in the context of Data Spaces. The outcomes of this deliverable provide the basis for the definition of a viable, feasible and sustainable business model for the UNDERPIN Data Space. The content and outcomes were fed through the capacity-building actions, desk research and consultations with partners on the best approaches to sustain the impact of the project.

The methodology for assessing business models within the UNDERPIN project involves a comprehensive and structured approach designed to evaluate and classify the business models applicable to Data Spaces. The steps are as follows:

Review of business model literature: A detailed examination of academic and industry literature on business models pertinent to Data Spaces. This provides a theoretical foundation and understanding of the various models in existence and their applicability to the data economy.

Data collection from stakeholders: Gathering qualitative and quantitative data through interviews and surveys with key stakeholders. These stakeholders include industry experts, SMEs, and large corporations within the European data economy. This data helps understand the current business practices, challenges, and opportunities from those directly involved in the field.

Framework development: Constructing a framework for assessing and categorizing business models. This framework incorporates criteria such as scalability, sustainability, compliance with EU standards, and alignment with GAIA-X principles [1]. The framework serves as a tool to systematically evaluate and compare different business models.

Evaluation and analysis: Applying the framework to analyze existing business models to identify the key characteristics and potential of each model. This step involves a detailed examination of how each model performs against the developed criteria.

Validation and feedback: Refining the framework and analysis through feedback loops with stakeholders. Iteratively adjust the framework based on insights and suggestions from stakeholders to ensure its relevance and accuracy.

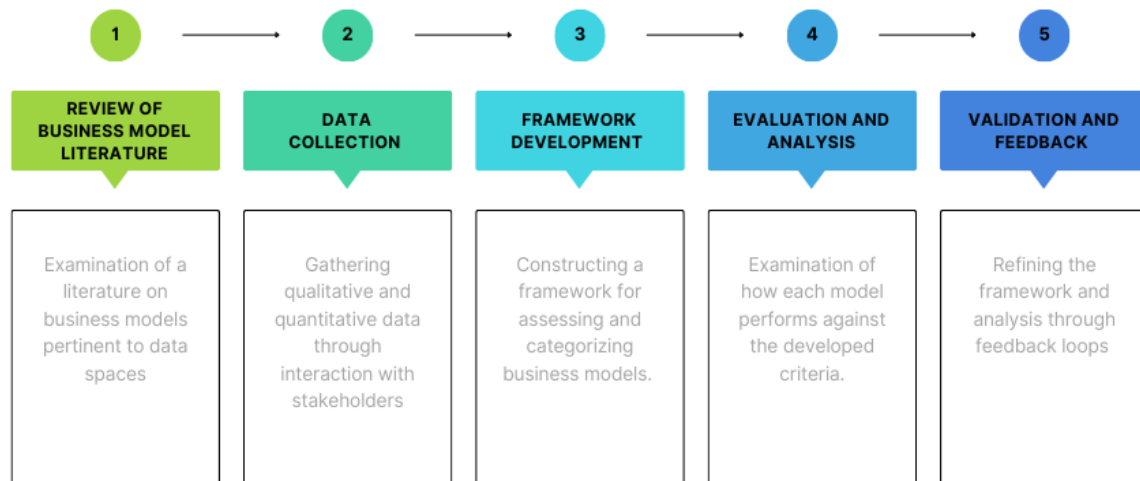


Figure 1: Methodological framework

The landscape of business models in the data economy is diverse and evolving. Various business models are being explored to leverage the potential of Data Spaces, which facilitate secure and trusted data sharing across different organisations. The literature review provides a comprehensive overview of the business model landscape in the data economy.

2.2 Definitions and Classifications

Understanding the various definitions and classifications of business models in Data Spaces is essential to understanding their roles and functionalities. Business models in Data Spaces can be categorized based on various criteria, such as their structural orientation, market focus, and monetization strategies.

- **Structural orientation:** Business models can be centralized or decentralized. Centralized models involve a single entity that controls data exchange, while decentralized models distribute control across multiple entities, enhancing data sovereignty and reducing single points of failure.



- **Market focus:** Models can be market oriented, focusing on creating value through transactions and data services, or hierarchical, where data flows within a structured organization or network.
- **Monetization strategies:** Business models employ various monetization strategies to generate revenue from data assets. These strategies are crucial for the sustainability and scalability of Data Spaces.
- **Industry case studies for the manufacturing sector:** Data Space business models in the manufacturing sector enable predictive maintenance and dynamic asset management. The value of big data is central to promoting and facilitating new services that support not only Data Space activities but also more traditional service and manufacturing processes. Also, companies use data from IoT sensors to monitor machine health, reducing downtime and maintenance costs. By sharing data across the supply chain, manufacturers can optimize operations and improve product quality.
- **Regulatory Context:** European regulations, such as GDPR [2] and initiatives like GAIA-X, play a crucial role in shaping business models within Data Spaces. Compliance with these regulations is essential for ensuring data privacy and sovereignty, which are critical components of any sustainable business model in the data economy. Firstly, adhering to GDPR helps businesses avoid substantial fines and legal repercussions, which can be financially crippling and damage their reputation. Moreover, compliance builds trust with customers and partners, who are increasingly concerned about how their data is being used and protected. This trust is invaluable, as it fosters customer loyalty and encourages data sharing, which is fundamental for innovation and the development of new services and products.



3 UNDERPIN Stakeholders

To ensure that the UNDERPIN Data Space is designed to meet the varied needs of its users, and promote widespread adoption and collaboration, engaging a broad range of stakeholders is key. Project stakeholders may be either internal or external, where the former refers to those participating in the coordination, funding, resourcing, and execution of the project and the latter refers to individuals who may benefit from and/or influence the project, but who do not have a direct organisational role in the project's execution.

For UNDERPIN different types of stakeholders may include European manufacturers, their value chain business ecosystems (such as machine tool manufacturers, integrators, machine vendors, maintenance service providers, remanufacturers, refurbishing, reuse, repairing and recycling companies), governmental and public, research and civil society. The analysis is mostly conducted by the industrial partners of the project during the first year, leveraging their expertise and insights to inform key decisions and strategies.

This section outlines the overall strategy towards the UNDERPIN stakeholder's analysis within the European data ecosystem. The analysis identifies the needs and drivers of stakeholders concerning big data in Europe, while it examines stakeholder relationships across different sectors. The outcomes of this analysis will provide a basis for understanding the role of actors as stakeholders who make consequential decisions about data technologies and the rationale behind the incentives targeted at stakeholder engagement for active participation in a data ecosystem.

3.1 Preliminaries of Stakeholder analysis

This section provides the background necessary to understand and conduct a stakeholder analysis in the context of a manufacturing Data Space. It outlines a strategy that includes structured steps for engaging stakeholders effectively, ensuring that all parties are aligned. Additionally, this section details the essential concepts of stakeholder assessment, focusing on how to identify, categorize, and understand the various stakeholders involved in the manufacturing data space.

3.1.1 Strategy for stakeholder engagement

A comprehensive stakeholder engagement targets to utilize context-specific interactions with entities from relevant stakeholder groups to benefit the UNDERPIN project and its sustained operations beyond the project. Stakeholder identification and analysis in support for business modelling and commercialization efforts can be grouped into three phases.



Figure 2: Stakeholder analysis Methodology

1. Stakeholders' identification

As a starting point for developing relevant engagement strategies, it is essential to first identify and categorize stakeholder groups. This includes identifying all relevant stakeholders interested in or potentially affected by the reform or intervention objective. In addition, the identification of the stakeholders' categories and grouping is performed, based on their roles, interests, and levels of influence.

2. Stakeholder's assessment

This stage includes the assessment of stakeholders based on their roles, interests, influence, and potential impact on the project. This assessment can be made through key informant interviews, surveys, a workshop or a brainstorming exercise, depending on the communication technique deemed most appropriate for each set of stakeholders identified.

3. Stakeholder's mapping/grouping

In this stage the stakeholders are represented in a map as a means of visualising their relation not only towards the intervention, but also to each other. Mapping can be used to assess institutions, as well as entire governance sectors and political reform proposals. Different structures and graphic effects (size, colour, lines) can be used to represent stakeholder power, interest and relations as determined from the previous steps. This classification enables a more targeted and effective approach in communication and collaboration, ensuring that all key players were appropriately engaged throughout the project's development.

3.1.2 Stakeholder Assessment

In addition to the dimensions introduced above, this section describes the stakeholder characteristics. This stakeholder assessment captures a few additional attributes that are used to profile stakeholders.

This profiling allows for a deeper understanding of how stakeholders might impact or be impacted by the project's outcomes.

- **Knowledge:** Level of information and understanding possessed by the representative about the case study. This information is obtained by asking the representative a set of questions. Knowledge attribute could be expressed as a five-scale value: Very High, High, Average, Low, and Very Low.
- **Position:** Attitude and perspective of the representative towards the exercise, in terms of the degree of opposition or support expressed by the stakeholder representative. This attribute can be represented using a five-scale value: Supporter, Moderate Supporter, Neutral, Moderate Opponent, and Opponent.
- **Interest:** Level of interest shown by the representative in the case study, represented as a five-scale value: Very High, High, Average, Low, and Very Low.



3.2 Identification of UNDERPIN Stakeholders

Stakeholder identification is the first step in the broader stakeholder engagement strategy. By recognizing and categorizing the key stakeholders, UNDERPIN ensures that the engagement process is aligned with the project's core objectives and addresses the needs of all relevant parties. The UNDERPIN stakeholders extend to any group or individual who can affect or is affected by the ecosystem's services. This initial identification facilitates the effective implementation of collaborative strategies and engagement activities.

Firstly, it is essential to underline a classification based on the stakeholders' positions within the value chain and their roles in the business sector. In this regard we define the following range of sectors of stakeholders:

- Wind Energy
- Oil and Gas
- Manufacturing
- Services
- Other

Moreover, the stakeholders for UNDERPIN are broadly grouped based on their roles, interests, and potential impact on the project's success:

1. Data suppliers and providers

Data suppliers are responsible for providing data to the UNDERPIN platform, which powers its analytics. These include manufacturing firms, equipment vendors, and maintenance service providers, which will directly benefit from UNDERPIN's predictive maintenance tools and dynamic asset management services. The project's focus on cross-organizational data sharing ensures these stakeholders are key participants, driving real-time data exchange and enhancing operational efficiencies. Their role as data creators, owners, and providers is critical for UNDERPIN, which requires vast data sources to support its predictive models and decision-making capabilities.

2. Data Consumers and end users

These stakeholders use the data shared in the data space for analysis, decision-making, or improving their operations. Data consumers, including manufacturing firms, logistics and supply chain companies, play an important role in UNDERPIN because their participation ensures the platform is used to optimize supply chain operations, reduce downtime, and improve overall decision-making. As final beneficiaries, these stakeholders benefit from efficiency gains and cost reductions by utilizing the platform's insights to enhance their operations.

3. Technology providers and enablers

Technology providers have an important role in the development and implementation of

the technical infrastructure needed for the project's platform. They design and deliver solutions for data collection, exchange, and management, ensuring that the platform operates efficiently. These stakeholders include ICT solution providers, platform developers, and software firms responsible for enabling seamless interoperability and real-time data processing within the platform.

4. Regulatory and Compliance Bodies

They are essential to ensure that the project adheres to EU data sovereignty policies, such as those defined by GAIA-X. These stakeholders ensure that UNDERPIN complies with legal frameworks, particularly concerning data sharing and privacy across industries.

The following table underlines the categorizes the stakeholders involved in the UNDERPIN project by grouping them according to their roles, and primary function towards the project's objectives.

Table 2: the UNDERPIN stakeholders' classification

Stakeholder	Role	Primary Function in UNDERPIN	Examples
Industrial Participants	Contribute to real-time data exchange and benefit from predictive maintenance tools	Engage in manufacturing, asset management activities and equipment supply	Manufacturing firms, equipment vendors, maintenance service providers
Data Suppliers and Providers	Supply and share operational data	Provide critical data for platform analytics and decision-making, ensuring EU compliance	Oil refineries, wind farm, operators, manufacturing firms
Technology providers	Develop and implement ICT solutions for data management	Provide technical solutions and platforms for data exchange, collection, and analytics	Energy research firms, platform developers, ICT

	Software and application development	Build software for data exchange, enabling interoperability across the platform	Software developers, industrial service technology firms
Regulatory and Compliance Bodies	Ensure regulatory compliance, data governance	Ensure compliance with regulatory frameworks	Electricity transmission system operators (TSOs), gas transmission system operators (TSOs)
	Establish standards	Develop and maintain data space standards	National regulatory bodies, European regulatory bodies
Academic & Research Institutions	Research & Innovation	Develop new models and innovations based on shared data. Contribute to AI, IoT, and predictive technology advancements in the platform	Universities, R&D institutions
End Users and Service Consumers	Final beneficiaries, consumers of data insights	Benefit from efficiency gains and cost reductions by utilizing insights to optimize operations and improve supply chains	Manufacturing firms, logistics companies, SMEs

3.3 Stakeholder Classification

As outlined in the previous section, the UNDERPIN stakeholders were systematically categorised based on their positions in the value chain and their roles in the business sector through a process primarily facilitated by the industrial partners of the consortium in the context of WP4. In this section we present the stakeholder mapping and grouping process which involves categorizing stakeholders into distinct clusters based on shared characteristics, roles, or interests.

Specifically, the stakeholders were grouped based on the specific area of operation for the company and the level of the company within the manufacturing value chain or ecosystem. Additionally, the primary country of operation for each company was recorded.

To provide a clear visualization of the stakeholder analysis findings, the results were graphically represented through charts that illustrate the relationships among different stakeholder groups.

The following sections present the classification for each type of stakeholder sector:

3.3.1 Wind energy sector

Dynamic asset management and predictive maintenance for the renewable energy infrastructure is one of the key value propositions of the UNDERPIN Data Space. Therefore, understanding the needs of the renewable energy sector stakeholders, such as operators, maintenance teams, and investors—along with their specific interests in optimizing operational efficiency, and their interests is essential for the successful deployment of the UNDERPIN solution.

The following table presents some indicative results of the Stakeholder grouping for the wind and energy sector.

Table 3: Stakeholder classification for the wind and energy sector

Company	Sector/Role	Level	Country
Nordex	Wind turbine manufacturer	Asset	Germany
Siemens Gamesa	Wind turbine manufacturer	Asset	Spain
GE Renewable Energy	Wind turbine manufacturer	Asset	France
Vestas	Wind turbine manufacturer	Asset	Denmark
Enercon	Wind turbine manufacturer	Asset	Germany
Leitwind	Wind turbine manufacturer	Asset	Italy
EWT	Wind turbine manufacturer	Asset	Netherlands
Freen	Wind turbine manufacturer	Asset	Estonia
Vortex bladeless	Wind turbine manufacturer	Asset	Spain
Eunice Wind	Wind turbine manufacturer	Asset	Greece
Wind Energy Solutions	Wind turbine manufacturer	Asset	Netherlands

HEXICON	Floating offshore wind design	Asset	Sweden
ZF Wind Power	Wind turbine gearbox manufacturer	Component	Belgium
TERNA Energy	Wind farm developer/operator	System	Greece
Rokas	Wind farm developer/operator	System	Greece
EREN Hellas	Wind farm developer/operator	System	Greece
MYTILINEOS	Wind farm developer/operator	System	Greece
PPC Renewables	Wind farm developer/operator	System	Greece
Cubico Greece	Wind farm developer/operator	System	Greece
Iberdrola	Wind farm developer/operator	System	Spain
EDP Renewables Greece	Wind farm developer/operator	System	Greece
ENEL Green Power	Wind farm developer/operator	System	Italy
Engie	Wind farm developer/operator	System	France
EDF Renewables Greece	Wind farm developer/operator	System	Greece

Next, we present the scatter plot visualising the distribution of wind energy stakeholders, grouping them per Sector, country and level in the value chain. Each point represents a unique stakeholder, color-coded or symbolized according to their sector, with position or grouping markers for country and level of component involvement.

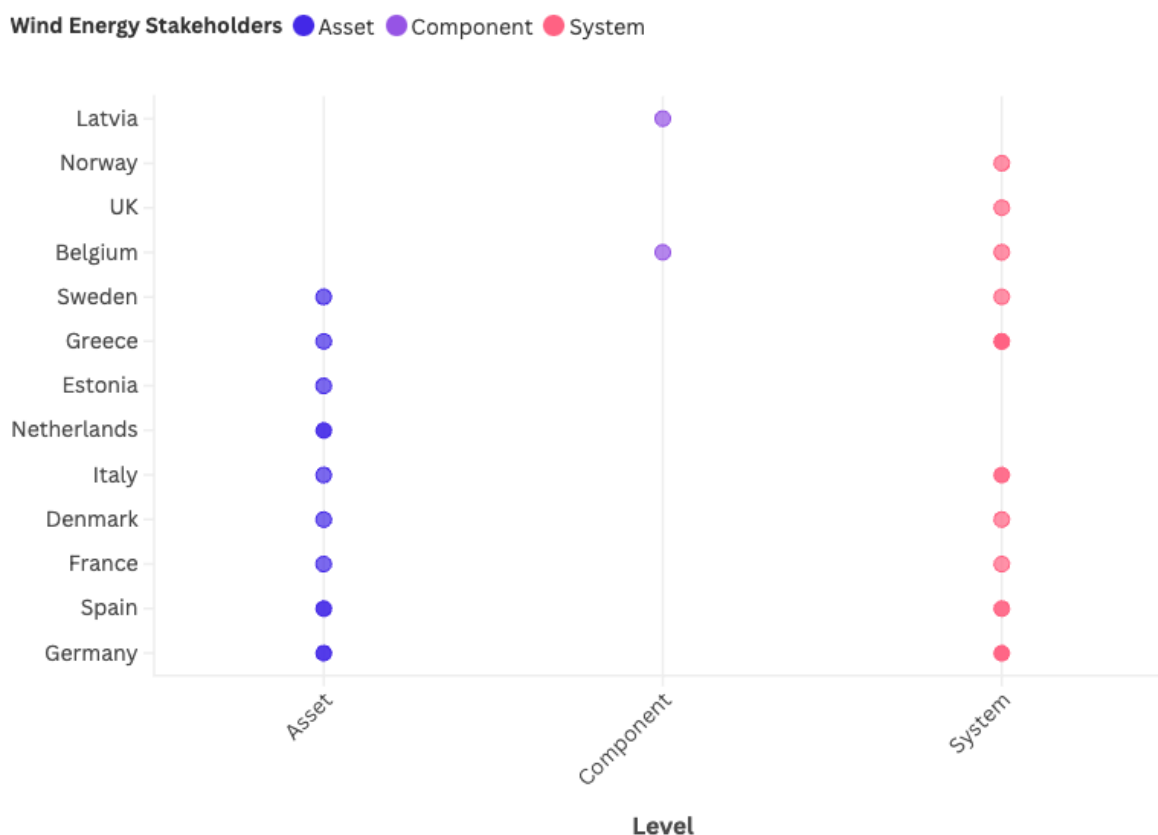


Figure 3: Distribution of Wind Energy Stakeholders by Country and Involvement Level

3.3.2 Oil and gas sector

The UNDERPIN dataspace aspires to reinforce the digital technology supply chain in the oil refinery ecosystem by data sharing, and innovation, ultimately driving operational efficiency and reducing costs across the sector. Therefore, the oil and gas industry supply chain is a key contributor to the UNDERPIN Data Space. Following the methodology presented in the previous section the oil and gas sector relevant stakeholders were identified and grouped in specific categories.

The following table presents a selection of representative results from the stakeholder classification within the oil and gas sector. This table categorizes stakeholders based on their roles, affiliations, and levels across various stages in the oil and gas value chain. The table also highlights the geographic distribution of these stakeholders, providing insights into regional strengths and areas of specialization within the sector.

Table 4: Stakeholder classification for the oil and gas sector

Company	Sector/Role	Level	Country
Helleniq Energy	Oil refining	System	Greece
INA	Oil refining	System	Croatia
MOL Group	Oil refining	System	Hungary
Alma Petroli	Oil refining	System	Italy
ENI	Oil refining	System	Italy
IPLOM	Oil refining	System	Italy
Saras	Oil refining	System	Italy
IP Gruppo	Oil refining	System	Italy
Orlen	Oil refining	System	Poland
Lotos	Oil refining	System	Poland
CEPSA	Oil refining	System	Spain
Repsol	Oil refining	System	Spain
Galp Energia	Oil refining	System	Portugal
TotalEnergies	Oil refining	System	France
SARA	Oil refining	System	France
OMV	Oil refining	System	Austria
H&R	Oil refining	System	Germany
Vitol	Oil refining	System	Netherlands
Tamoil	Oil refining	System	Netherlands
Gastrade	FSRU operator	System	Greece
LNG Croatia	FSRU operator	System	Croatia

Snam	LNG terminal/FSRU operator	System	Italy
Offshore LNG Toscana	FSRU operator	System	Italy
Adriatic LNG	LNG terminal operator	System	Italy
Enagas	LNG terminal/FSRU operator	System	Spain
BBG	FSRU operator	System	Spain
Reganosa	LNG terminal operator	System	Spain
Borealis	Petrochemicals	System	Austria
DOMO Chemicals	Petrochemicals	System	Belgium
Lambiotte	Petrochemicals	System	Belgium
Deza	Petrochemicals	System	Czech Republic
Arkema	Petrochemicals	System	France
Arsol	Petrochemicals	System	Germany
BASF	Petrochemicals	System	Germany

Next, we present the scatter plot of oil and stakeholders, showing the involvement of key players across different countries categorised per Sector and level of component. We can observe that Oil refining occupies the largest number of stakeholders in the oil and gas sector, with multiple points representing companies or organizations from many countries (e.g., Lithuania, Canada, India, Finland, Cyprus, Netherlands, Austria, and more). In addition, the petrochemicals sector also shows a strong presence across countries, with a significant role in the oil and gas value chain, while LNG terminal operators and FSRU operators have a more limited but focused set of countries involved, with specific countries specializing in these sectors.

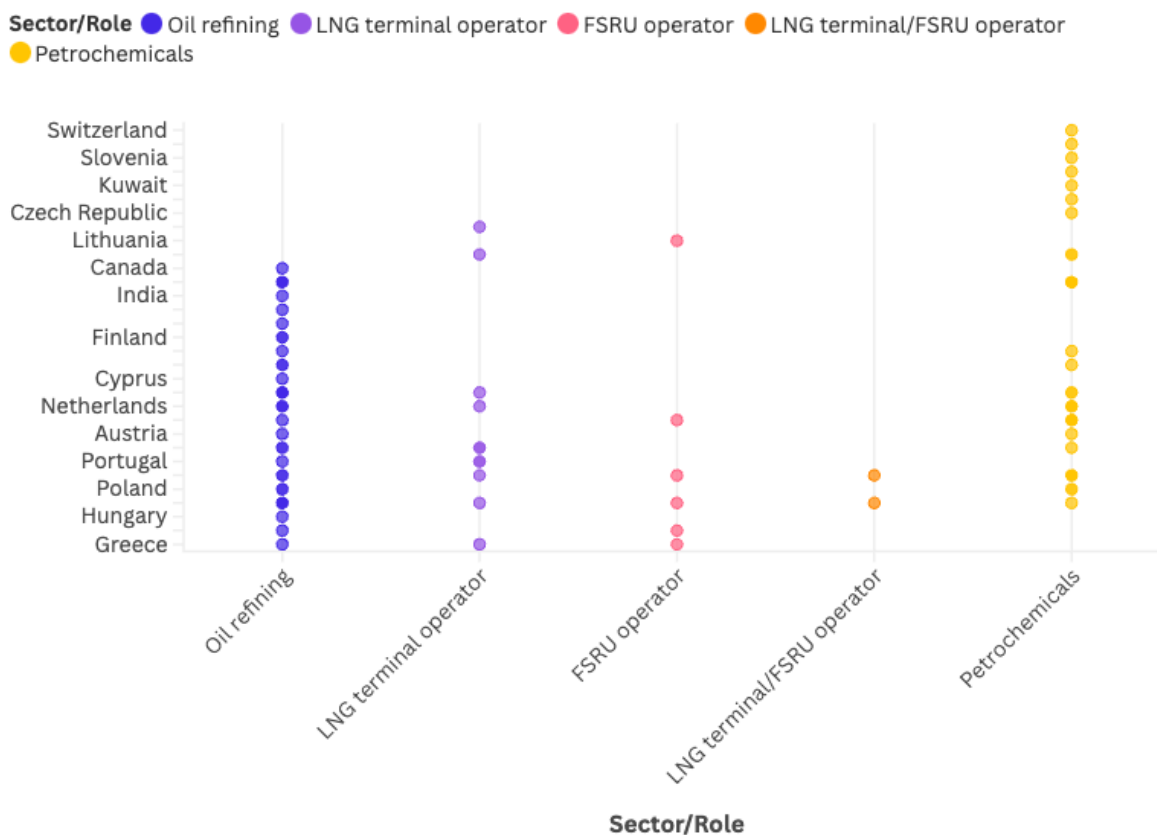


Figure 4: Distribution of Oil and gas Stakeholders by Country and Involvement Level

3.3.3 Manufacturing Sector

One of the core objectives of the UNDERPIN project is to build a strong community and actively engage stakeholders across the European manufacturing industry. By offering a centralized platform for data sharing and analysis, UNDERPIN aims to streamline collaboration and innovation within the industry and attract key manufacturing stakeholders, such as machine users, machine vendors, maintenance service providers, remanufacturers, manufacturers.

In the following table, the relevant stakeholders for the manufacturing sector are depicted and grouped in categories per company, sector, level and country.

Table 5: Stakeholder classification for the manufacturing sector

Company	Sector/Role	Level	Country
Elvalhalcor	Manufacturing	System	Greece

Hellenic Cables	Manufacturing	System	Greece
Sidenor	Manufacturing	System	Greece
Alumil	Manufacturing	System	Greece
Hellenic Halyvourgia	Manufacturing	System	Greece
Sunlight	Manufacturing	System	Greece
TITAN	Manufacturing	System	Greece
Corinth Pipeworks	Manufacturing	System	Greece
FULGOR	Manufacturing	System	Greece
Viohalco	Manufacturing	System	Greece
SIDMA	Manufacturing	System	Greece
Lykomitros Steel	Manufacturing	System	Greece
Kaeser	Manufacturing	Component	Germany
ABB	Manufacturing	Component	Switzerland
Baker Hughes	Manufacturing	Component	USA
Flowserve	Manufacturing	Component/subc omponent	USA
Neuman & Esser	Manufacturing	Component	Germany
Atlas Copco	Manufacturing	Component	Sweden
Burckhardt Compression	Manufacturing	Component	Switzerland
SKF	Manufacturing	Subcomponent	Sweden
Freudenberg Sealing Technologies	Manufacturing	Subcomponent	Germany
Schaeffler	Manufacturing	Subcomponent	Germany

Following the same process as in the previous sections, we present the scatter plot of manufacturing stakeholders, categorised per sector, country and level in the value chain. The diagram showcases the engagement different stakeholders from how various countries at different levels within the manufacturing process.

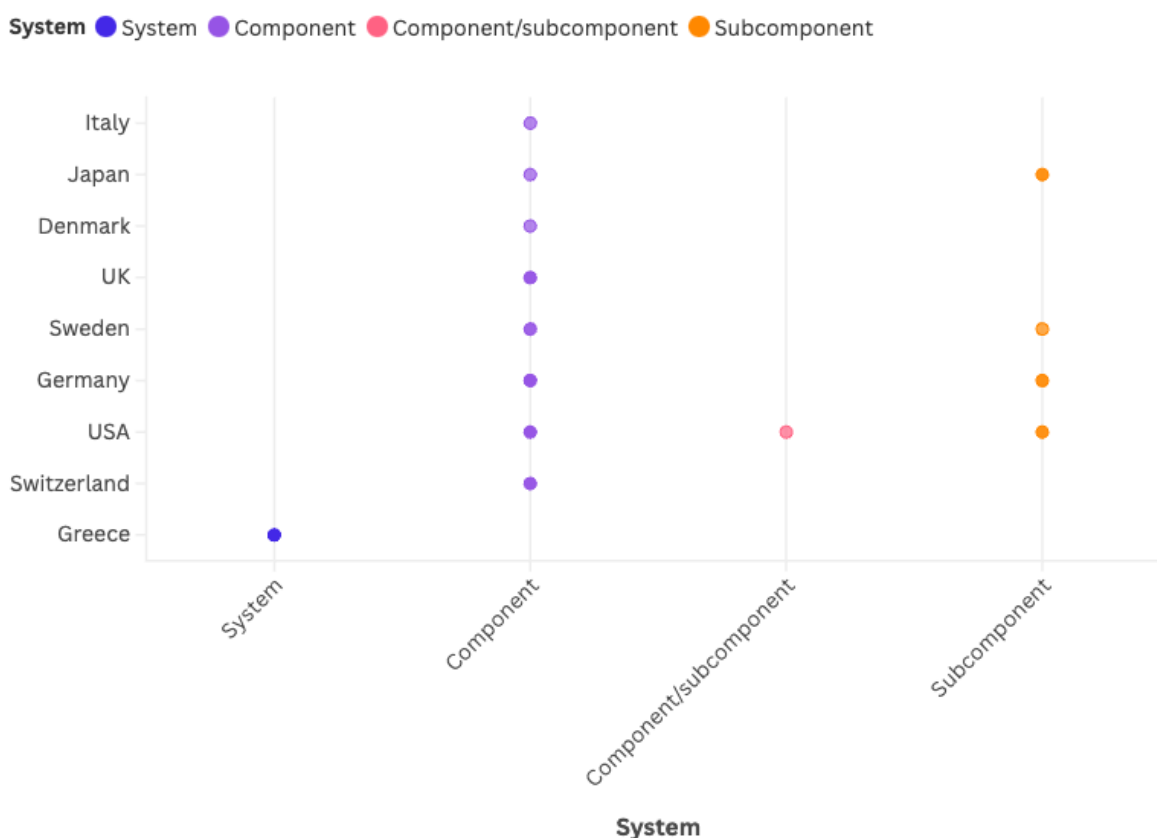


Figure 5: Distribution of Manufacturing Stakeholders by Country and Involvement Level

3.4 Engagement Practices for UNDERPIN

This section presents the UNDERPIN stakeholder engagement strategy based on the project's most important targets and the direct needs of the project. The strategy will identify the most relevant stakeholders and outline in what form those could be engaged in what stage of the project, taking into consideration the project's limitation of resources.

3.4.1 Stakeholder engagement strategy based on UNDERPIN core objectives

Stakeholder engagement is critical to the project as it assists technical and operational development as well as ensuring alignment with broader strategic goals. Additionally, UNDERPIN

has incorporated stakeholder engagement throughout its lifecycle to ensure continuous feedback loops, adaptability and relevance to real-world needs.

- **Role of stakeholders in shaping the project**

The role of stakeholders extends beyond data collection and participation in workshops. Stakeholders from different industries, such as manufacturing and maintenance service providers, as well as research institutions and government agencies, have been instrumental in the continuous improvement of the project. Their input enables the project team to identify challenges, quickly adapt to evolving industry standards, and incorporate innovative solutions that directly address the operational realities of stakeholders.

- **Fostering long-term relationships**

The project has emphasized not just engagement, but the development of long-term relationships with key stakeholders. This has involved establishing trust through transparency, regularly updating stakeholders on progress, and incorporating their feedback into decision-making processes. By creating a platform where stakeholders feel heard and valued, UNDERPIN ensures sustained commitment, resulting in higher adoption rates and a more resilient business model.

- **Collaborative decision-making**

Stakeholder participation in UNDERPIN has facilitated collective decision-making. Whether during business model workshops or regulatory discussions, stakeholders are invited to participate as co-creators rather than passive participants. This has led to more robust business models that respond to market needs and anticipate future requirements and regulatory changes. This collaboration was instrumental in aligning the project with both EU regulatory frameworks and industry needs.

- **Dynamic adaptation based on stakeholder feedback**

Continuous engagement has also enabled UNDERPIN to dynamically adapt to external changes such as technological developments, regulatory updates and market changes.

In brief, stakeholder engagement in the UNDERPIN project is a fundamental element that shapes the direction, adaptability and sustainability of the entire data space initiative. Emphasis on continuous, meaningful interaction with stakeholders ensures that the project remains responsive to industry needs, regulatory landscapes and technology trends. By integrating stakeholders into the decision-making and development process, the project makes data space business models and solutions effective and relevant and sustainable in the long term.

3.4.2 Collaborative Strategies

The UNDERPIN project depends on effective collaboration between a variety of stakeholders, including SMEs, large corporations, government agencies and academic institutions. Collaboration strategies are designed to foster collaborations that ensure the achievement of project goals while leveraging the strengths of all parties involved. A key approach is to form cross-industry partnerships. By encouraging collaboration between manufacturers, technology providers and service operators, UNDERPIN facilitates the creation of interoperable systems that enhance data sharing across sectors. In addition, public-private partnerships are very important, especially with the integration of regulatory authorities to ensure that the data space complies with the EU's industrial and data sovereignty policies. These partnerships ensure that the project meets technical goals and aligns with broader policy goals.

In addition, the collaboration extends to the research and innovation network within the project. Academic and research institutions are engaged to advance cutting-edge technologies such as artificial intelligence and IoT, which are essential to UNDERPIN's predictive maintenance and operational performance goals. Workshops and joint development sessions ensure that all stakeholders, from data providers to consumers, contribute to shaping the platform. This consortium-based decision-making ensures that the project is based on collective expertise, fostering greater innovation and long-term success.

3.4.3 Engagement Through Communication Channels

Communication is a key aspect to ensure that all stakeholders in the UNDERPIN project remain informed, engaged and aligned with the project goals. A multi-channel communication strategy has been implemented to facilitate continuous interaction with all stakeholders.

Effective communication and dissemination of the UNDERPIN project's business models are critical to ensure their widespread adoption and understanding among key stakeholders. The business models developed within the framework of the UNDERPIN project aim to create a sustainable, scalable, and compliant data space ecosystem that addresses the unique needs of the European manufacturing industry.

This section outlines how strategic engagement via different communication channels – such as social media or websites - can be leveraged to communicate these business models to a diverse audience. By utilizing these platforms, the UNDERPIN project aims to foster a deeper understanding of Data Spaces, promote collaboration, and encourage the adoption of innovative data-sharing solutions. The strategy focuses on delivering key messages to each stakeholder category outlined in this document; including SMEs, large enterprises (focusing on oil refineries and wind farms), academic institutions, and policymakers, ensuring that the value of the UNDERPIN Data Space is clearly communicated and widely recognized.

Through consistent, targeted communication efforts, the goal is to not only inform but also engage stakeholders in an ongoing dialogue that supports the growth and evolution of the UNDERPIN business model in line with industry standards and European regulations.

At this moment, UNDERPIN actively uses the following:

- Social media channels (LinkedIn, Facebook, Twitter, YouTube) for communication and dissemination (CD) activities. Over the past few months, we have gained followers and engagement, and we expect to broaden our reach and establish ongoing collaborations that align with planned activities.
- Website for updates on project progress. The news section is used to publish detailed articles, project updates, and information on events attended. It will also be used to provide insights into business models. A dedicated subpage will be created to explain the business models, the role of stakeholders, and to share success stories from early users and testers.
- Newsletter, published approximately once a month, covers interesting topics related to Data Spaces and UNDERPIN. Engaging stakeholders to subscribe to our newsletter via LinkedIn will allow for direct communication with a targeted audience, enabling us to consistently update stakeholders on project milestones and business model developments. If necessary, an additional newsletter provider will be used, and the newsletter may be published more frequently.

Communicating business models can provide valuable feedback from the audience. Remarks and questions cannot only help improve the business model but also enhance how we communicate its benefits. Other communication channels that can be utilized include:

- Webinars and online events - Webinars offer an interactive way to engage with stakeholders and explain complex topics, such as data space business models, in detail. Featuring experts from the consortium, these webinars can foster discussions on the benefits of the business model, including practical applications, scalability, and compliance with EU regulations. Platforms like Zoom, Teams, or even YouTube can be used to reach a broad audience and allow for real-time Q&A. Participation in online events organized by similar initiatives has proven successful, and this type of collaboration will continue.
- Podcast are becoming increasingly popular with professional audiences, providing an opportunity to share in-depth discussions on the project's business models and innovations in a convenient format. While it may not be realistic for the consortium to

launch a podcast on short notice (due to the significant effort involved), participating in podcasts is a more viable option.

- Industry publications and journals - Publishing articles in industry-specific journals and magazines can enhance the project's credibility and reach a professional audience, particularly those focused on manufacturing and data sharing.
- Events and Conferences - Presenting at industry conferences and hosting events provide opportunities for direct interaction with potential stakeholders, partners, and users. These events will also be promoted through the project's social media channels and website.
- Press release can attract attention from traditional (and local) media, expanding the project's visibility and reach. They should be used to announce major project milestones and highlight the project's benefits for the European data economy. To maximize impact, we should target relevant media outlets in the tech, manufacturing, and business sectors.

Different business models often leverage various strategies to build relationships with customers and communities, focusing on interaction, content, and value creation. There are several existing business models that focus on engagement through communication channels, particularly in the digital era where engaging audiences through platforms like social media, websites, and mobile apps is essential.

In the UNDERPIN project, we began attracting followers (potential users) on social media from the outset by creating educational content tailored for manufacturers. Since Data Spaces are still a relatively new concept, educating potential users is essential. This early engagement not only builds awareness but also lays the foundation for long-term relationships. As we move forward, engagement actions will intensify with our Road show activities, which is developed in the context of Task 5.1 "Community Building and Scale Out ". This will allow us to connect directly with target audiences and demonstrate the value of Data Spaces.

Attracting followers and potential users is a long-term process, and any project that relies on end users should initiate awareness activities in the early stages - even before the product is fully launched. Consistent educational content and proactive engagement are key to fostering interest and driving adoption.

General strategy for all channels includes (but is not limited to):

- Cross-Platform Engagement: Promoting content across all platforms by sharing information from LinkedIn, Facebook, and Twitter, driving traffic between platforms, as well as sharing snippets from YouTube videos on other social media. This includes

creating additional communication tools such as flyers, short videos, presentations, info graphics etc...

- **Calls to Action (CTA):** Encouraging stakeholders and followers to actively participate by asking questions, leaving comments, or signing up for newsletters or upcoming events. Ensuring that all content highlights how the UNDERPIN business model aligns with their needs.
- **Visual Consistency:** By using consistent branding and visual identity across all platforms, we will ensure that every channel reflects the professionalism and innovation of the UNDERPIN project. The visual materials created will align with the planned campaign, clearly explaining the benefits of the UNDERPIN Data Space. This approach will effectively communicate the unique selling proposition (USP) and the value of participating in the UNDERPIN Data Space.

3.5 Monitoring and Evaluation of Engagement Practices

UNDERPIN regularly monitors and evaluates its stakeholder engagement activities to ensure alignment with project goals and stakeholder needs. The evaluation process is structured around key metrics that assess the effectiveness of engagement, feedback mechanisms that enable continuous improvement, and adaptive strategies that adjust based on the outcomes of stakeholder interactions. This ensures that engagement remains dynamic, responsive, and contributes to the overall success of the project.

3.5.1 Metrics for Assessing Stakeholder Engagement

UNDERPIN applies a set of metrics to evaluate the effectiveness of our stakeholder engagement practices. These include:

- **Participation Rates:** The project tracks attendance and participation in workshops, webinars, and collaborative activities. The number of stakeholders actively participating reflects the effectiveness of strategic engagement.
- **Diversity and Inclusion:** UNDERPIN assesses whether its engagement practices successfully engage a broad range of stakeholders, including SMEs, major industries, academic institutions and regulatory bodies. Ensuring diverse representation helps align the project with the needs of all stakeholders.
- **Quality of engagement:** Qualitative measures such as feedback from workshops and collective discussions are analyzed to determine the depth of stakeholder engagement. This includes evaluating contributions to project decisions, suggestions made during sessions, and overall participant satisfaction.

- **Stakeholder Engagement:** The project monitors the sustainability of stakeholder engagement, focusing in particular on ongoing engagement, repeat engagement, and the extent to which stakeholders incorporate the results of UNDERPIN into their own operations or decision-making processes.

3.5.2 Feedback Mechanisms and Continuous Improvement

UNDERPIN ensures continuous improvement of its engagement practices by implementing a range of structured feedback mechanisms. After key events and workshops, the project gathers feedback through surveys, interviews, and focus group discussions. This methodical approach enables UNDERPIN to collect actionable insights directly from stakeholders, which are then factored into future decision-making processes. This is because effective stakeholder engagement is not a one-time effort but requires iterative processes that continuously adapt to the evolving needs of the stakeholders.

Additionally, feedback is collected alongside regular updates, where stakeholders learn how their input has influenced project changes. These updates promote transparency, which is key to the engagement strategy. This transparency helps build trust and encourages ongoing participation. Trust is especially important for UNDERPIN, as long-term collaboration is very important for the success of the project.

To improve how feedback is used, UNDERPIN makes sure that stakeholder input is part of its overall strategy. When stakeholders raise concerns or offer suggestions about the engagement process, the project adjusts better match their needs and expectations. This keeps UNDERPIN flexible and able to respond to new challenges or opportunities without losing progress. By regularly adapting its engagement practices, the project ensures they stay up to date, in line with stakeholder expectations, and support its main goals.

Additionally, by incorporating feedback into adaptive strategies, UNDERPIN ensures that its engagement practices are continually optimized, not only improving stakeholder relationships but also enhancing project outcomes. As stakeholders experience the positive impact of their contributions, they are more likely to remain engaged, creating a good collaboration and innovation.

3.5.3 Adjusting Engagement Strategies Based on Outcomes

UNDERPIN continuously refines its engagement strategies based on the outcomes of its monitoring and feedback processes. When specific engagement activities reveal gaps or opportunities, strategies are adjusted to enhance effectiveness. For instance, if feedback indicates that certain stakeholder groups are not as actively engaged, the project tailors its approach to better meet their needs. This is because maintaining diverse and inclusive participation ensures that UNDERPIN can gather a wide range of insights and expertise, which is essential for the project's adaptability and success.

Additionally, if specific communication channels (e.g., online forums or focus groups) are found to be more effective for certain stakeholder groups, UNDERPIN increases the use of these channels to facilitate deeper collaboration. The flexibility in adjusting communication methods based on real-time feedback ensures that the project remains responsive to stakeholders' preferences, thereby strengthening relationships and ensuring alignment with their expectations.

Adjustments are also made to collaborative activities when outcomes show that stakeholders require more hands-on involvement or clearer guidance on how to contribute. For example, if stakeholders' express uncertainty about their role in workshops or decision-making processes, UNDERPIN can enhance onboarding materials or increase advisory support. This ensures that stakeholders remain actively involved and that engagement is both meaningful and productive.

3.6 Validation through Key Value Indicators (KVI)

Validating business models for dataspace, like the UNDERPIN project, requires evaluating how effectively the business model meets its objectives, especially in fostering collaboration, innovation, and data exchange. Key Value Indicators (KVI) provide measurable criteria that track progress and success, ensuring alignment with strategic goals.

KVIs will be used twofold:

- 1) to validate the specific uses cases implemented in UNDERPIN and,
- 2) to validate the business models developed in the context of the project and relate to the UNDERPIN Data Space value proposition.

The following KVIs have been identified so far:

Table 6: UNDERPIN Use Case KVIs

UNDERPIN Use Case KVIs	
UC	KVI
1.1: Refinery PdM	KV1: Accuracy of PdM predictions
	KV2: Cost reduction in maintenance
	KV3: Equipment performance increase due to PdM

	KV4: Lifetime extension of equipment
	KV5: Energy consumption reduction
2.1: Wind farm PdM	KV1: Accuracy of PdM predictions
	KV2: Cost reduction in maintenance
	KV3: Lifetime extension of equipment
	KV4: Unplanned downtime prevented by PdM
	KV5: Loss of revenue reduction due to streamlining maintenance scheduling
2.2: Blade damage prediction	KV1: Accuracy of predictions
	KV2: Number of visual inspections prompted
	KV3: Prevention of blade failures

By applying **KVIs** to specific use cases, i.e. for the **refinery** and **wind farms** — we can directly assess how well the implemented solutions achieve their objectives. KVIs like **accuracy of predictions**, **cost reductions**, and **equipment performance improvements** provide measurable insights into the value generated by these use cases. High accuracy in predictive maintenance, along with notable savings in maintenance costs and reduced equipment downtime, not only validate the technical success of these solutions but also prove their commercial viability. The demonstrated value, including equipment lifespan extension and energy savings, enhances their appeal to potential users, showing that these innovations contribute real, measurable benefits.

Table 7: UNDERPIN Data Space KVIs

UNDERPIN Data Space KVIs	
KVI	Description
KV1: Retention rate of users	Tracks the retention rate of users participating in the DataSpace
KV2: Number of data transactions per user	Tracks how many instances of data exchange a user participates in on average
KV3: Volume of data exchanged per user	Tracks the data volumes for the exchanges per user and between specific users

KV4: Number of unique interactions between users	Tracks how many different users a user interacts with (in terms of data exchange/services) on average
KV5: Number of repeated interactions between users	Tracks how many times two users sign subsequent contracts between them (after first successful interaction)

The KVs focused on the Data Space are essential for validating the platform's business model by ensuring it delivers on its value propositions. Metrics such as user retention rate, number of data transactions per user, and frequency of repeated interactions are vital for assessing how well the platform fosters data exchange, collaboration, and innovation. These KVs demonstrate that the platform maintains a vibrant, engaged user base—crucial for ensuring the financial sustainability of the project. High engagement and repeated user interactions signal that the platform is delivering significant value to users, strengthening its business case.

4 Dataspaces Business Model Classification

4.1 Overview of Business Models for Data Spaces

As Data Spaces gain prominence in facilitating effective data sharing, understanding their business models becomes crucial. This chapter explores the various business models associated with Data Spaces, incorporating Alex Osterwalder's definition [3], which states that a business model describes the rationale of how an organization creates, delivers, and captures value.

A data space consists of multiple roles that are essential for its operation. As depicted in Figure 6, at least two primary participants are necessary: data providers and data consumers. Additionally, other critical roles include identity providers, data catalogues, vocabulary providers, app stores, and transaction logs. These roles collaborate within a soft infrastructure designed to support data sharing.

Data providers can define usage policies for their data, ensuring mutual agreement with potential consumers before any sharing occurs, thus fostering trust.

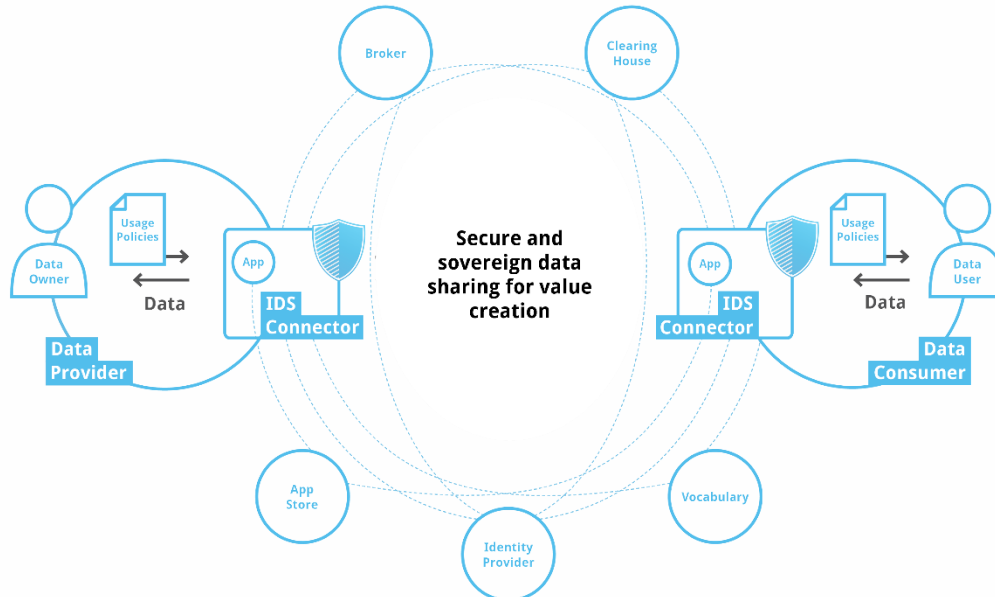


Figure 6: The different roles in a data space

The core value proposition of a Data Space lies in enabling sovereign data sharing for value creation. This value is realized through various use cases supported by the data space, with participants offering data products—datasets, data services, or combinations thereof—that are utilized in final products or services.

The collaborative nature of data space business models is crucial for fostering a functional ecosystem. The perceived value correlates with the number of participants; the more there are, the greater the value. This environment fosters two-sided network effects, like platform business models, yet distinguishes itself by promoting data sovereignty among participants.

4.2 Framework for Assessment and evaluation criteria

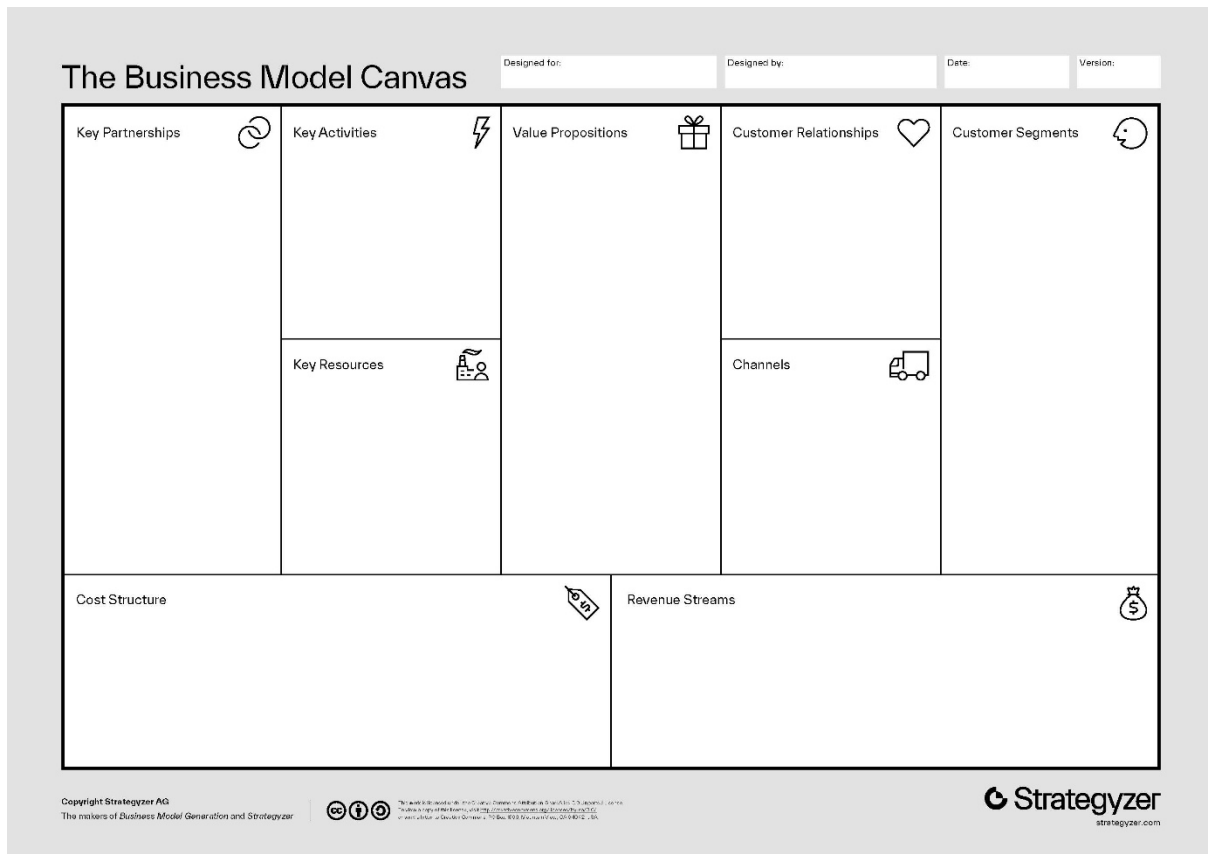


Figure 7: The Osterwalder Business Model Canvas

The most widely used business model definition today is that of Alex Osterwalder, stating that a business model “describes the rationale of how an organization creates, delivers and captures value”. This definition is operationalized in the Osterwalder Business Model canvas, as shown in Figure 7.

A business model sits between business strategy and processes, helping organizations realize their strategic vision through implementation and workflow translation. In today's complex value networks, understanding the perspective from which a business model is developed is critical. Each actor—whether a commercial enterprise, non-profit, or governmental body—shapes the value proposition, making it essential to analyse multiple business models as they impact one another.

Key elements for describing a business model, as illustrated in Figure 8 include:

1. **WHAT:** The value proposition—the promise of value delivered to meet customer needs.
2. **WHO:** The actor offering the value proposition; making this explicit is vital for understanding the business model in a complex network.
3. **HOW:** The mechanisms for delivering the value proposition, including key resources, activities, and partners, along with associated costs.
4. **TO WHOM:** The target customers, often segmented, involving channels and relationships that influence revenue.
5. **BALANCE:** A sustainable business model requires balancing costs and revenues, considering both economic and societal impacts.

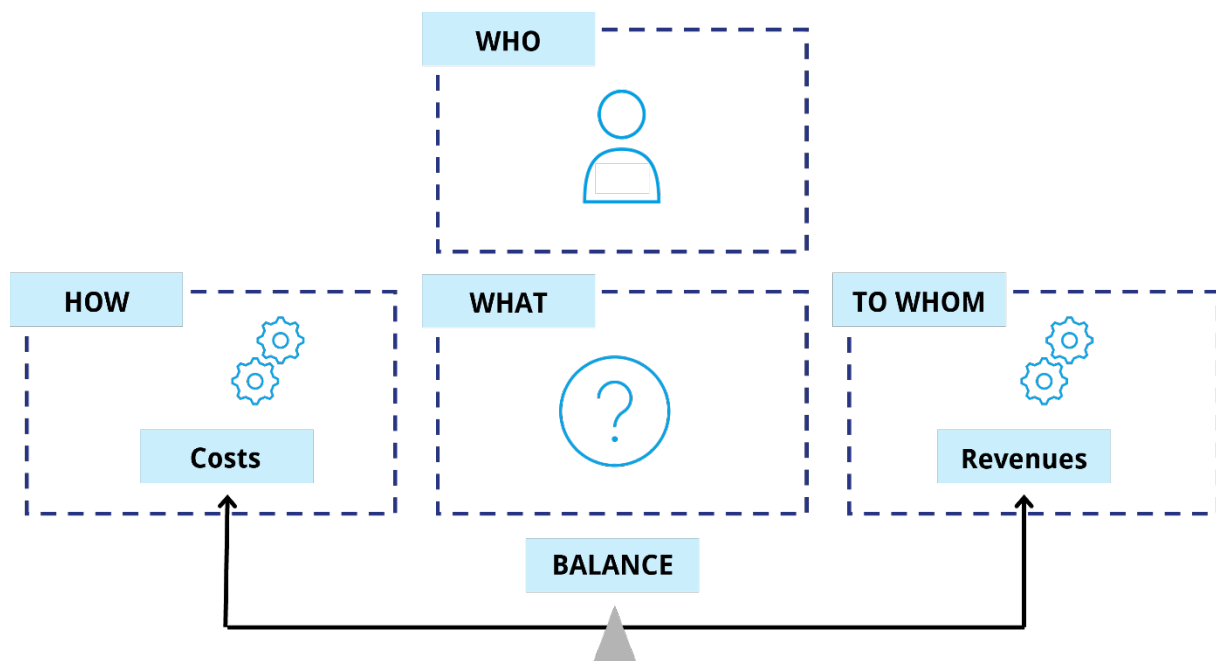


Figure 8: Roles to be considered for a business model

More information on the general topic of Data Spaces and business models from the perspective of the IDSA community can be found in the latest publication on this topic which was also used as input for the former sections [4].

4.3 Position of UNDERPIN Business Case

Focusing on organizational entities within a data space, such as UNDERPIN, reveals that public involvement is often significant. Revenues for such entities may rely partially on public funding—either project-based or through ongoing subsidies. As the Data Space generates value through use cases, value recuperation from these use cases may increase over time, potentially utilizing various pricing schemes that can be uniform or tailored to specific use cases.

As synergies between use cases grow, so does the value generated. On the cost side, organizational entities incur development and operational expenses. Economies of scale emerge as data products are reused across multiple use cases. In the long term, the balance between costs and revenues can be improved by capturing added value from various use cases, indicating that the business model is not static but rather evolving.

4.4 Recommendations

To stimulate value creation and address participant acquisition challenges, several strategies can be employed:

1. **Strengthening one side first:** Focus on attracting users to one side of the ecosystem through funding or leveraging existing networks.
2. **Simultaneous engagement:** Attract participants that can engage on both sides, possibly offering a broader range of services or employing a big bang adoption approach.
3. **Redistribution of value:** If one user side shows a higher willingness to pay, value redistribution strategies may be employed, where the financially robust side subsidizes the other.

4.5 Business Model Recommendations for UNDERPIN

To enhance the effectiveness and impact of the UNDERPIN research project, the following recommendations are proposed:

1. **Engage stakeholders early:** Foster collaboration with key stakeholders, including data providers, consumers, and policymakers, from the project's inception. This will ensure that diverse perspectives are considered and that the resulting business models are relevant and practical.
2. **Iterative development of use cases:** Employ an iterative approach to developing and refining use cases. Regular feedback loops with stakeholders can help adapt the project to meet evolving needs and challenges, ensuring that the solutions developed are both effective and user centric.

3. **Ensure exploitation of project results:** The technological readiness gap after the funding of UNDERPIN ends will have to be closed to establish a profitable business. Therefore, further funding opportunities have to be invested, including additional public funding (to investigate in open questions on an early technological readiness level), private investments, and collaborative grants, to ensure financial sustainability. Establishing a clear strategy for revenue generation will support long-term viability.
4. **Promote data sovereignty:** Emphasize the importance of data sovereignty in all aspects of the project. Providing clear guidelines and tools for data providers will foster trust and encourage participation in the data space.
5. **Leverage synergies across use cases:** Identify opportunities to create synergies between different use cases. This can enhance value generation and improve cost efficiency, ultimately leading to a more robust business model.
6. **Monitor and adapt business models:** Regularly assess the evolving business models within the data space. Adapt strategies based on feedback and changing market conditions to ensure ongoing relevance and effectiveness.
7. **Facilitate knowledge sharing:** Create environments for knowledge sharing among participants. This can include workshops, webinars, and online forums to disseminate best practices and foster a collaborative community.
8. **Evaluate impact and success metrics:** Establish clear metrics for evaluating the impact and success of the project. This will help in measuring progress, understanding the effectiveness of different business models, and informing future strategies.

By implementing these recommendations, the UNDERPIN project can maximize its potential to create value through effective data sharing and collaboration, ultimately driving innovation and improving outcomes for all participants involved.

5 UNDERPIN Business Models

This chapter provides a thorough analysis of the definition and systematic development of business models tailored for UNDERPIN, highlighting the key elements essential for their design. It introduces a collection of business-case patterns for Data Spaces that represent key use cases, designed to address the diverse needs of data-related services. Additionally, the chapter explores various monetization models uniquely suited to Data Spaces, showcasing the diverse strategies organizations can adopt to generate revenue from shared data assets. To support the development process, comprehensive research was undertaken to compile an extensive database of empirical cases related to data marketplaces. This research involved systematically collecting and analyzing publicly available information from a wide array of data marketplaces. The aim was to extract insights into their defining characteristics, operational business models, and strategic market approaches. By doing so, the chapter provides a robust framework for developing effective and sustainable business models for UNDERPIN.

5.1 Business model Development

Nowadays, advancements in the global economy have altered the traditional balance between customer and supplier relationships. The proliferation of new communications and computing technology, coupled with the establishment of reasonably open global trading regimes, have opened the way for new opportunities in the business landscape. Businesses can now leverage digital platforms and software tools, data analytics, and global supply chains to create new products, streamline processes, and enhance customer experiences, ultimately reshaping industries and fostering greater competition on a global scale. In such a context, current businesses are required to explore more customer-centric modes of operation, especially since technology has evolved to allow the lower cost provision of information and customer solutions. In addition, these developments have amplified the need to consider not only how to address customer needs more accurately, but also how to capture value from providing new products and services [5].

This evolving environment has leveraged the necessity to address customer needs in a less fragmented manner providing more transparent alternative solutions. Consequently, without a well-developed business model, innovators will fail to either deliver – or to capture – value from their innovations. Originally, the term Business Model (BM) stands for a conceptual tool that contains a set of elements and their relationships and allows to express the business logic of a specific firm. A business model reflects the strategic framework used to create and deliver the value that a company creates through its products, along with its operations and customer engagements. It articulates the logic and provides data and other evidence that demonstrates how a business creates and delivers value to customers. It also outlines the architecture of revenues, costs, and profits associated with the business enterprise delivering that value. In that sense, a viable business model leverages on balancing profitability with customer satisfaction, ensuring that the price charged reflects the perceived value of the product or service while

meeting quality expectations of the customer. Thus, by effectively aligning their offerings with market demands, businesses can sustain operations and foster long-term growth.

The various elements essential for determining a business model design are outlined in the figure below (Figure 9).

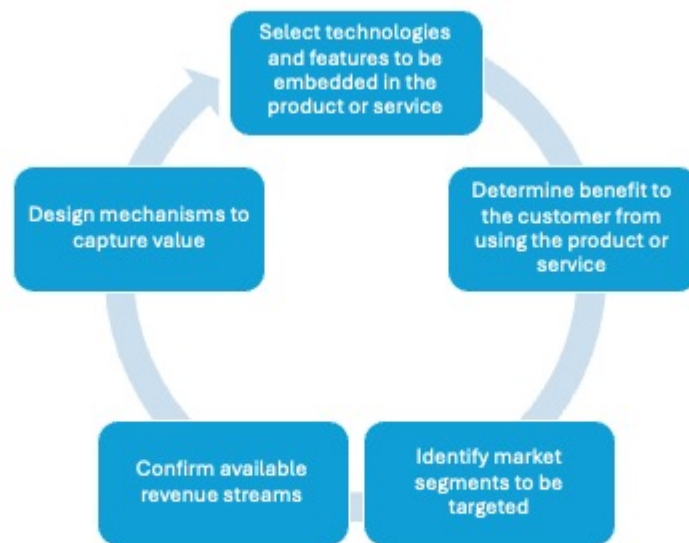


Figure 9: Elements of business model design

5.2 Business models for Data Spaces

The definition and development of business models for dataspace is a challenging task, primarily due to the involvement of multiple parties and stakeholders, each one with different objectives, requirements, and revenue models. For instance, data providers may offer their data in exchange for monetary compensation or access to other datasets. Data consumers may seek to maximise the value they derive from data usage by how effectively they can access, analyse, and utilize data to meet their specific needs. Service providers may seek to add value by combining and refining data from multiple sources and monetizing it through subscriptions or licensing.

Designing a sustainable business model for Data Spaces requires careful consideration of the ecosystem's needs, participant roles, and governance frameworks. Data Spaces can be created through different pathways, each influencing the business model's structure ¹:

- **Commercially Driven:** Organisations might operate the data space like a business, ensuring a high standard of service. They might charge participants to use the data space, but they also make sure it's well-maintained and offers valuable services.
- **Cooperative Initiatives:** In this model, data space participants collaborate on decision-making. This is especially effective when all parties have an equal stake and share in the benefits of the data space.
- **(Non)Governmental or NGO-Driven:** Data Spaces initiated by public bodies or NGOs are often subvention-funded and may evolve into more cooperative structures over time. These spaces prioritise social impact or public interest over direct commercial returns yet must still develop sustainable business models to ensure long-term viability.

A plethora of business modelling approaches has been proposed in recent literature addressing the specific needs of secure and sovereign data sharing for value creation. Among these models, Osterwalder's process of business model innovation is based on participation of a range of stakeholders, and his business model canvas has become immensely popular in the business world [3].

Using Osterwalder's business model canvas in the workshops for defining UNDERPIN initial business models provides a structured framework that helps identify key components such as value propositions, customer segments, revenue streams, and cost structures. This approach encourages collaborative brainstorming and ensures a comprehensive understanding of how various elements interact, thereby facilitating the development of a robust and viable business model tailored to meet market needs.

Apart from the key objectives of secure and sovereign data sharing for value creation, Data Spaces should also cater to the diverse needs of data-related services by enabling various collaborative business models through different patterns of business cases. The following table presents a collection of business-case patterns for Data Spaces that represent key use cases.

Table 8: Business-case patterns for Data Spaces

Business-case pattern	Description
Cost Sharing	Participants in a data space collaborate by sharing their data to fulfil common objectives, such as ensuring regulatory compliance, increasing process efficiency, and enhancing

¹ <https://trustbok.ishare.eu/enable-ishare/business-models-for-data-spaces>

	transparency. All participants to achieve their goals more efficiently and cost-effectively.
Joint Innovation	All ecosystem members work together to achieve customer innovation. No single ecosystem member has all the necessary data.
Combined Forces	Ecosystem members collaborate to prevent a limited number of dominant market players from emerging. No single ecosystem member has the necessary resources and commitment to achieve this on their own.
Shared Marketplace	Ecosystem members collaborate to provide quality-assured, easy access to data of a domain of common interest (open data, business partner data, etc.). Transaction costs go down for all ecosystem members.
Greater Common Good	Public and private sector share data for a greater common, societal goal (e.g., climate protection).

5.2.1 Data Monetisation in Data Spaces

Data Spaces are designed to support fair, flexible, and sustainable monetization of shared data assets, balancing the interests of both data providers and consumers. Data monetization in Data Spaces refers to the process of transforming data into financial value, allowing organizations to leverage their data assets for revenue generation. As such, the monetisation strategies for Data Spaces must focus on leveraging data as a strategic asset that drives value across various touch points within the ecosystem.

By adopting such approaches, organizations can ensure that data is not only seen as a commodity but also recognized as a pivotal resource that underpins their competitive advantage and operational efficiency, ultimately leading to sustainable growth and long-term success in an increasingly data-driven landscape.

The following table outlines various monetization models uniquely identified for Data Spaces, highlighting the different strategies organizations can employ to generate revenue from shared data assets.

Table 9: Monetisation strategies for Data Spaces

Data monetization model	Description
Pay-per-Use Model	Participants pay based on the volume or type of data they consume. This model is highly scalable and flexible, allowing for granular control over who can access specific datasets. It is particularly useful for organisations that wish to share only certain segments of their data and retain control over its broader use.
Subscription-Based Model	Participants pay a regular fee to access the data space or certain premium features. This approach provides a predictable revenue stream, which can be used to fund the ongoing operation of the data space, including the maintenance of technology and certified roles like the Authorisation Registry and Identity Providers. Subscription models encourage long-term engagement and can foster stable relationships between data providers and consumers
Data-as-a-Service	This model allows data providers to package their data into services that participants can access on-demand. Instead of simply selling raw data, organisations provide curated datasets or insights that can be integrated into other platforms or applications. DaaS facilitates the monetization of data by integrating it into real-time decision-making processes, thereby enhancing its actionability and overall value.
Freemium Model	This model offers basic data access for free while charging for premium services or advanced features, encouraging wider user engagement while generating revenue from premium tiers. This approach can attract a diverse range of participants by lowering the initial barriers to entry. As users begin to recognize the value of the data space and find themselves in need of more advanced services or additional data, they are more inclined to transition into paying customers.
Revenue Sharing Models	This model focuses on revenue-sharing agreements are commonly established among data providers, intermediaries, and consumers, allowing earnings to be shared among participants based on usage or

	predefined agreements. Revenue-sharing models are suitable in ecosystems where multiple parties contribute data.
Tiered pricing	This model allows users to select from different service levels or data quality tiers, catering to diverse user needs and budgets. By offering tailored options, it allows individuals and organizations to select the level of service that best aligns with their specific needs.

5.3 Desk Research on Existing Data Marketplaces

Comprehensive research was conducted to compile a database of empirical cases of data marketplaces. This research involved systematically gathering and analyzing publicly available information on various data marketplaces to understand their key characteristics, business models, and market approaches. As part of the research, the data discovery platform Datarade.ai² was consulted. This platform provides extensive information of more than 200 data platforms. As a result, the business models of existing data marketplaces were documented, describing key aspects such as their value proposition, industry domain, revenue model, pricing model, and price discovery approach. The following table lists the findings from this research.

Name	Value proposition	Industry Domain	Revenue Model	Pricing Model	Price discovery
DAWEX	Secure data sharing	Any	Subscriptions	Freemium	Set by external sellers
Otonomo	Secure data sharing	Sensor & Mobility data	Commissions	Multiple	Set by external sellers
Caruso	Easy data access and/or tooling	Sensor & Mobility data	Commissions	Multiple	Set by external sellers
IOTA	Secure data sharing	Sensor & Mobility data	Commissions	Multiple	Set by external sellers
SimilarWeb	High quality and unique data	Audience data	Subscriptions	Freemium	Set by marketplace provider
Streamr	Easy data access and/or tooling	Sensor & Mobility data	Subscriptions	Freemium	Set by external sellers

² <https://datarade.ai/>



HERE Platform	Easy data access and/or tooling	Geo data	Subscriptions	Freemium	Set by external sellers
CARTO	All services in single platform	Geo data	Subscriptions	Freemium	N/A
Red Lion Data	High quality and unique data	Geo data	Asset sales	Package based pricing	Set by marketplace provider
Veracity	Easy data access and/or tooling	Any data	Commissions	Multiple	Set by external sellers
oneTRANSPORT	Easy data access and/or tooling	Sensor & Mobility data	Subscriptions	Freemium	Set by external sellers
Snowflake Data Marketplace	Secure data sharing	Any data	Usage fees	Pay-per-use	Set by external sellers
Opendatasoft	Easy data access and/or tooling	Any data	Usage fees	Freemium	Set by external sellers
Data Republic	Easy data access and/or tooling	Audience data	Subscriptions	Multiple	Set by external sellers
RollWorks	All services in single platform	Audience data	Subscriptions	Pay-per-use	Set by marketplace provider
Datum Data Marketplace	Secure data sharing	Health & Personal data	Usage fees	Pay-per-use	Negotiation
BattleFin Ensemble	Easy data access and/or tooling	Financial & Alternative data	Subscriptions	Flat fee tariff	Set by external sellers
Intrinio	Easy data access and/or tooling	Financial & Alternative data	Subscriptions	Freemium	Set by marketplace provider
Open:Factset Marketplace	Easy data access and/or tooling	Financial & Alternative data	Subscriptions	Pay-per-use	Set by external sellers
QuantConnect	Easy data access and/or tooling	Financial & Alternative data	Subscriptions	Freemium	Set by external sellers
Knoema	Easy data access and/or tooling	Any data	Subscriptions	Freemium	N/A

5.4 UNDERPIN Business Model Recommendations

This section outlines the key aspects and strategy that was followed for the successful implementation of the recommendations for UNDERPIN, enabling the project to maximize its potential for value creation through effective data sharing and collaboration.

5.4.1 UNDERPIN Business Roles

For every individual role and the whole data space, it is crucial to observe the value creation and capture by individual participants, and the overall value created. The overall value created is a governed secure data exchange for a more resilient supply chain. Such a data-driven application is one of the many similar applications in the manufacturing domain that could use an underlying data space. Table 10 presents the seven (7) different business roles of contributors in the UNDERPIN ecosystem.

Table 10 Mapping of Business roles for UNDERPIN

Data provider	Provides data and makes it available to be shared within the data space.
Data consumer	Consumes and processed data to solve a specific industry problem und create business value
Provider of core services	Responsible for deploying, operating, and maintaining all core services of the UNDERPIN Data Space
Provider of enabling services	Responsible for deploying, operating, and maintaining enablement services (e.g., EDC connector) according to UNDERPIN standards
Provider of on-boarding services	Responsible for deploying, operating, and maintaining onboarding services according to Catena-X standards. The onboarding services enable and support data space participants to register and onboard and offboard to UNDERPIN Data Space
Provider of business applications	Responsible for deploying, operating, and maintaining business applications to Catena-X standards. Business applications enable data providers and consumers to leverage different use cases and data-driven processes to solve a specific industry problem

Compliance Assessment Bodies	Ensure compliance of services with platform standards and regulatory requirements and play a crucial in the certification process
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5.4.2 Business Model Development Workshop

In the context of the UNDERPIN project, a business model development workshop was conducted among the members of the consortium online in July 2024. This session fostered engaging discussions and strategic brainstorming among partners, while it laid the groundwork for the creation of a comprehensive Business Model Canvas to outline the main business concepts of the project.

This workshop was essential in shaping the strategic direction and operational framework of the project. The primary purpose was to collaboratively develop a Business Model Canvas that would serve as a strategic blueprint for the UNDERPIN project. The objectives included identifying key partners, defining key activities, outlining value propositions, and establishing the necessary resources and channels for successful implementation.

At first, a conceptual model of a Business model Canvas was presented to the consortium, followed by a brief description of its elements that outlined the purpose and structure of each section. This aimed to familiarize participants with the canvas as a strategic tool and to establish a common understanding of how it could be applied to the UNDERPIN project.

To facilitate collaboration, we used the Miro app, enabling all partners to have real-time access and share their ideas and proposals for each component of the Business Model Canvas. This collaborative platform allowed for efficient communication and the seamless integration of diverse perspectives, ensuring a comprehensive and cohesive business model. By leveraging Miro, we ensured that every participant could contribute to the development process, fostering a sense of ownership and alignment among all stakeholders. The result was a well-rounded Business model Canvas that reflects the collective expertise and strategic vision of the UNDERPIN project team.

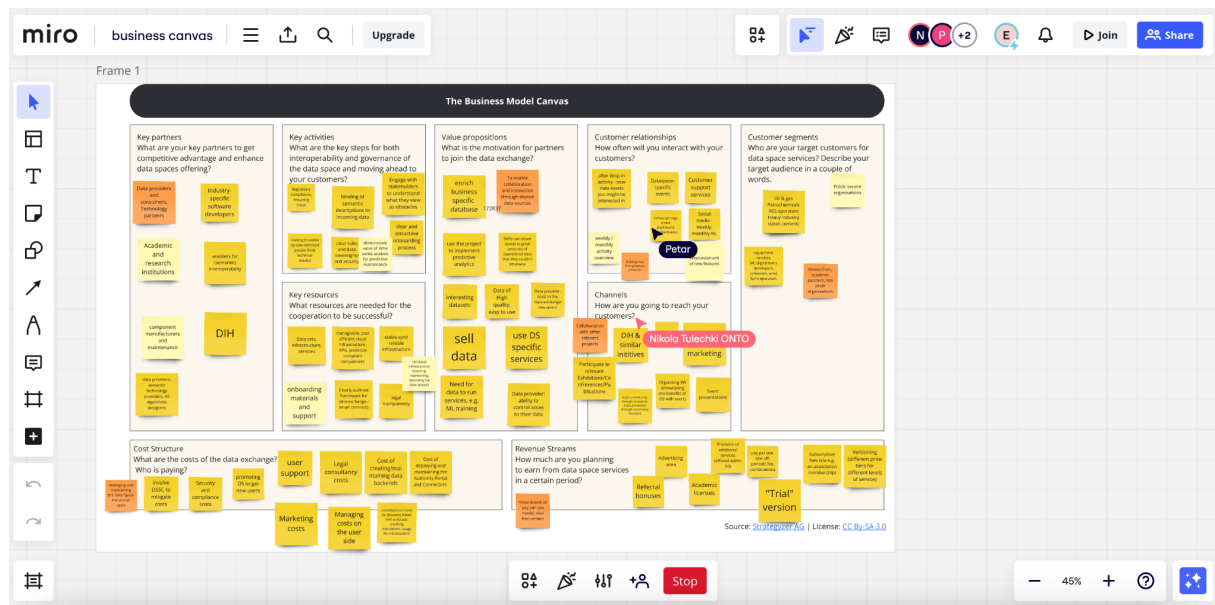


Figure 10: Validated output on business model

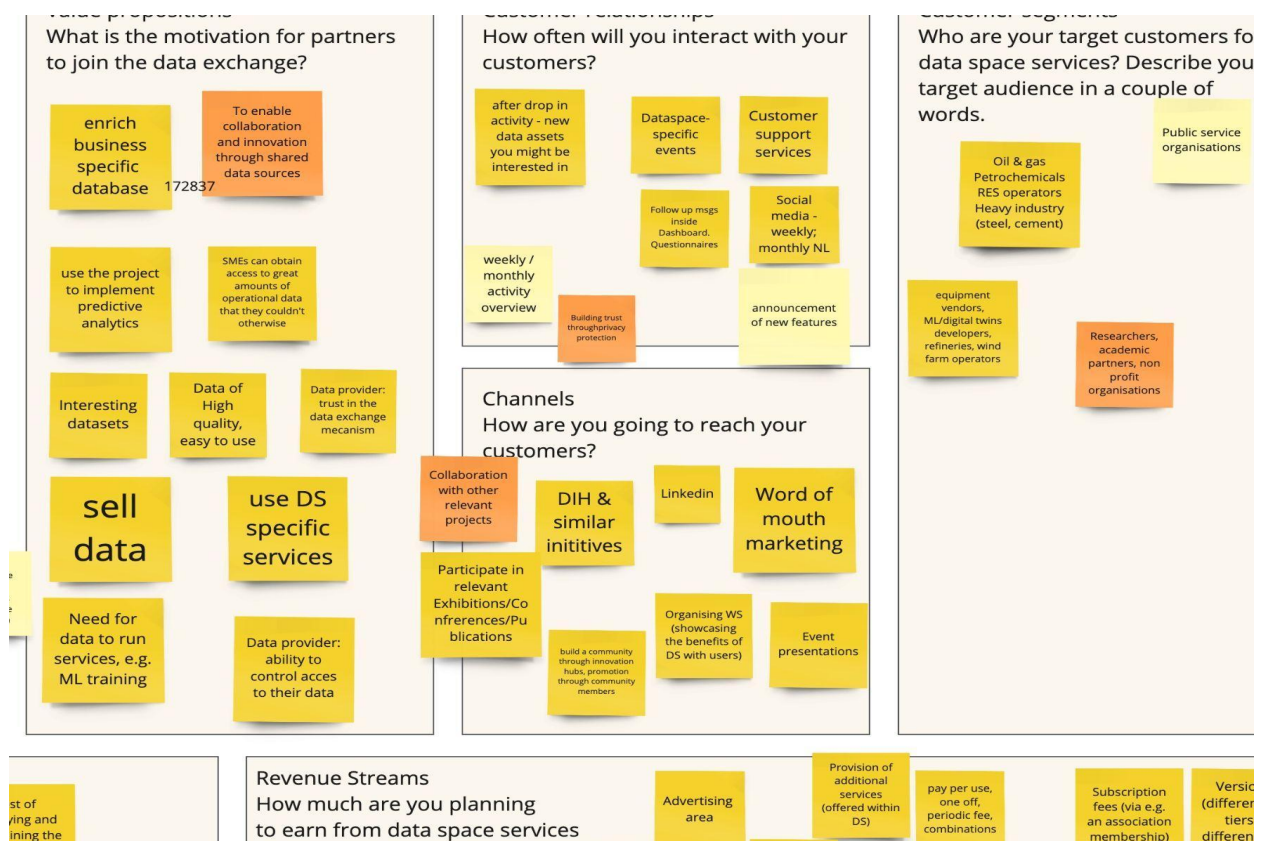


Figure 11: Validated output on business model II

5.4.3 Key Components and Discussions:

The outcomes of the workshop laid a solid foundation for the UNDERPIN project's business strategy. Each element of the Business Model Canvas is described in detail in the following sections.

1. **Key Partners:** In the Business Model Canvas for the UNDERPIN project, the identified key partners are essential for supporting the data exchange ecosystem. Data providers and consumers, along with technology partners, play a critical role in supplying and utilizing data. Industry-specific software developers are involved in creating and maintaining the specialized software needed for different industries. Academic and research institutions contribute through research, innovation, and technical expertise. Component manufacturers and maintenance providers ensure that the hardware components are reliable and up-to-date. Enablers for semantic interoperability facilitate seamless data exchange by ensuring compatibility and understanding across systems. Lastly, Digital Innovation Hubs (DIHs) support the project by assisting in technology transfer and fostering innovation.
2. **Key Activities:** The primary activities necessary for the UNDERPIN project's success include ensuring regulatory compliance and building trust among stakeholders. This involves binding semantic descriptions to incoming data, making it understandable and usable. Engaging with stakeholders to understand their perspectives and address obstacles is crucial for aligning project goals with stakeholder needs. Additionally, creating a clear and attractive onboarding process makes it easier for new users to join the platform. The project also aims to make the platform usable for non-technical people, thereby broadening its user base. Establishing clear rules and ensuring data sovereignty and security are vital for protecting data and respecting ownership. Demonstrating the value of time series analysis for predictive maintenance helps showcase practical benefits, encouraging adoption.
3. **Key Resources:** The key resources identified for the UNDERPIN project include data sets, infrastructure, and services that form the core elements for data operations. A manageable and cost-efficient cloud infrastructure, along with APIs and protocols, ensures that the system is scalable and economically viable. Stable and reliable infrastructure is critical for maintaining continuous operations. Onboarding materials and support are provided to help new users get started quickly. A clearly outlined framework for data exchange, including smart contracts, provides clear guidelines for data handling. Legal transparency is maintained to ensure compliance and build trust among users.
4. **Value Propositions:** The value propositions of the UNDERPIN project focus on offering unique benefits to its users. The project aims to enrich business-specific databases,

providing valuable data for businesses. It enables collaboration and innovation through shared data sources, fostering partnerships and the development of new solutions. By implementing predictive analytics, the project helps businesses gain insights and improve operations. Small and medium-sized enterprises (SMEs) can access valuable operational data that would otherwise be unavailable to them. The platform offers interesting and high-quality datasets that are easy to use, attracting a wide range of users. For data providers, the project ensures trust in the data exchange mechanism, making it a reliable platform for data sharing.

5. **Customer Relationships:** Maintaining strong and continuous engagement with customers is a priority for the UNDERPIN project. After a drop-in activity, the project suggests new data assets that might interest users, keeping them engaged. Regular activity overviews, provided weekly or monthly, keep customers informed about their usage and activity on the platform. Customer support services are available to assist users, ensuring their satisfaction. The project uses social media and newsletters to maintain regular contact with customers. Announcements of new features keep users informed about improvements and new offerings. Building trust and prospective engagement are essential for ensuring ongoing customer interest and confidence in the platform.
6. **Customer Segments:** The target customer segments for the UNDERPIN project include public service organizations, which can use data for public benefit and service improvement. Industries such as oil & gas, petrochemicals, RES operators, and heavy industry (steel, cement) are also targeted as they can significantly benefit from data-driven insights. Additionally, equipment vendors, researchers, academic partners, and non-profit organizations are identified as potential users who can leverage the data for various purposes. These segments are chosen due to their potential to benefit from data-driven decision-making and innovation, making them ideal users of the project.
7. **Channels:** To reach its customers, the UNDERPIN project utilizes a variety of channels. Collaboration with other relevant projects leverages synergies and enhances the project's reach. Participation in relevant exhibitions, conferences, and publications increases visibility and credibility. Digital Innovation Hubs (DIH) and similar initiatives are partners that promote digital innovation and support the project. Professional networks like LinkedIn and word-of-mouth marketing are used to spread awareness and attract new users. Event presentations and organizing workshops engage potential users through direct interaction and education, demonstrating the benefits of the project.
8. **Cost Structure:** The cost structure of the UNDERPIN project focuses on necessary expenses to maintain, secure, and promote the platform while supporting users effectively. Costs include managing and maintaining the data space, personnel costs, and involving Data Spaces Support Centre DSSC to mitigate expenses. Security and compliance costs ensure data protection and legal adherence. Marketing costs are

incurred to promote the data space and attract new users. User support and legal consultancy costs are essential for providing assistance and managing legal issues. Additionally, the costs of creating and maintaining data backends, as well as deploying and maintaining the Authority Portal and Connectors, are included in the budget.

9. **Revenue Streams:** The UNDERPIN project identifies several revenue streams to ensure financial sustainability while offering value to different types of users. Advertising areas generate revenue through ads. Academic licenses are offered to specialized academic users. Referral bonuses incentivize current users to bring in new users. Provision of additional services, such as premium features, generates income. Flexible pricing models, including pay per use, one-off, and periodic fees, cater to different user needs. Subscription fees, such as association memberships, ensure steady revenue. Lastly, versioning with different price tiers for various levels of service allows users to pay based on their needs and usage levels.

5.5 Business models selected for UNDERPIN services

In developing the UNDERPIN Data Space, careful consideration was given to selecting business models that align with the project's goals, target audience, and sustainable growth strategies. This section explores the chosen business model outcomes that will drive the delivery, scalability, and long-term viability of UNDERPIN services.

The **UNDERPIN Business Model Canvas** provides a structured overview of the strategic components needed to deliver and sustain the project data-driven services effectively. It comprises of the following key elements:

- Key partners, including data providers, technology providers, and research institutions, enable the platform to source, manage, and secure high-quality data.
- With high-quality, secure data exchange as the core value proposition, the platform appeals to a diverse customer base, from heavy industry and energy sector players to academic and nonprofit organizations.
- Key Activities focus on ensuring data integrity and regulatory compliance. Key processes include binding semantic descriptions to incoming data, implementing a secure and user-friendly onboarding process, and maintaining data sovereignty. Additionally, activities such as engaging with stakeholders and demonstrating value help build trust and drive adoption.
- Key resources of UNDERPIN include high-quality datasets, robust cloud infrastructure, and onboarding materials. Other critical resources include smart contracts for secure data transactions and support services that facilitate smooth customer interactions and onboarding.
- Customer relationships are maintained through dedicated support services, feature updates, and regular activity overviews, with outreach occurring through industry events, collaborations, and social media.
- Revenue is generated through a combination of value-based pricing, pay-per-use models, and academic licenses, covering essential costs like infrastructure maintenance, security, and compliance.

Table 11: UNDERPIN Business Model Canvas

Data Space Business Model Canvas				
Key Partners	Key Activities	Value Proposition	Customer Relationships	Customer Segments
Data providers and consumers Technology providers Components manufacturers Industry specific software developers Academic and Research institutions	Binding of semantic descriptions to incoming data Regulatory compliance Clear and attractive onboarding process Data sovereignty and security Engage with stakeholders	Enable collaboration and innovation through shared data sources Implement predictive maintenance Data of high quality Ease of use and deployment Enrich business specific use cases Ability of the data providers to control access to their data Trust in data exchange mechanism	Customer support services Announcement of new features Social media, weekly or monthly activity overview	Oil and gas industry Petrochemicals industry RES operators, Heavy industry Equipment vendors Researchers and academic partners nonprofit organisations Public bodies
	Key Resources		Channels	
	Data sets, Infrastructure (cloud), Services Onboarding materials and support Smart contracts		Participation in relevant exhibitions Collaboration with relevant projects Event presentations, conferences Social media DIH and similar initiatives	
Cost Structure			Revenue Streams	
Authority Portal and Connectors deployment and maintenance Data infrastructure maintenance Security and compliance Marketing and legal consultancy costs User support			Value-based or pay per use model Academic licences Different price tiers for different levels of service Academic licences Pay per use and periodic fee	

5.6 Legal considerations

The regulatory landscape for Data Spaces is undergoing rapid development, complex and evolving legal environment in which Data Spaces operate. This reflects the crucial need for understanding the legal requirements that apply to data use for the different types of involved stakeholders.

A robust legal and organizational framework is critical for fostering trust in the UNDERPIN data space. This framework governs the roles, responsibilities, and legal agreements between participants, ensuring that data is shared securely and transparently. Ensuring transparency, sovereignty and trust through the entire lifecycle of data sharing ecosystems is invaluable, as it fosters customer loyalty and encourages data sharing, which is fundamental for innovation and the development of new services and products. These activities range from embedding various design considerations of the Data Space within regulatory parameters, to identifying participants' roles and responsibilities, and formulating internal policies to ensure compliance. Compliance with these regulations is essential for ensuring data privacy and sovereignty, which are critical components of any sustainable Data Space. A more comprehensive analysis of the regulatory landscape as well as the creation of trust processes for UNDERPIN can be found in document “D5.2 Trust Creation processes.”

6 Techno-Economic Analysis for Data Spaces in UNDERPIN

For the techno-economic analysis of Data Spaces within the UNDERPIN project, we'll focus on evaluating both **technological costs** and **economic feasibility** to understand the viability of proposed business models and monetization strategies [6,7]. This analysis involves estimating the associated costs of infrastructure, services, compliance, and the value generation potential of the data space. However, it should be noted that this analysis is based on estimates and should be treated as a preliminary assessment, as actual costs and value generation may vary depending on evolving market conditions and implementation specifics of the Data Space.

Below, we will structure the analysis as follows:

1. **Cost Structure Analysis:** Identify and break down the primary costs associated with implementing and operating the data space.
2. **Monetization Strategies Review:** Outline potential revenue models with examples from industry practices.
3. **Economic Feasibility and ROI:** Analyze the economic impact and return on investment (ROI) based on different scenarios.

6.1 Cost Structure Analysis

The primary costs associated with developing and maintaining a data space like UNDERPIN can be categorized into **capital expenditures (CapEx)** and **operational expenditures (OpEx)** [8]:

A) Capital Expenditures (CapEx)

Infrastructure Setup Costs:

- Cloud infrastructure deployment, including server and storage resources.
- Deployment of core and enabling services (e.g., EDC connector, onboarding services).
- Security and compliance tools, including smart contracts and data sovereignty protocols.
- Platform development costs for initial setup, integration with legacy systems, and API provisioning.

Initial Legal and Compliance Costs:

- Legal consultancy fees for drafting data-sharing agreements.

- Certification costs for compliance with regulations (e.g., GDPR, DGA).

Technical Development Costs:

- Development of the Authority Portal, connectors, and semantic binding services.
- Costs associated with integrating predictive analytics and machine learning components for time series analysis.

Tables 11 and 12 provide a detailed breakdown of the financial requirements for setting up and running the UNDERPIN Data Space describing each cost category, including explanations for each item.

Table 12: Capital Expenditures (CapEx) Breakdown

Cost Category	Description	Estimated Cost (€)	Notes
Infrastructure Setup	Cloud infrastructure, servers, storage	10,000-30,000	One-time cost for initial setup
Core Service Development	Development of core services (API, EDC)	5,000-10,000	Includes software development
Security and Compliance Tools	Encryption, access control, smart contracts	2,000-3,000	Initial cost for security setup
Legal and Regulatory Costs	Legal consultancy and certifications	2,000-3,000	GDPR compliance and legal fees
Onboarding and User Interface	Development of onboarding tools and UI	3,000-6,000	Includes user training materials
Predictive Analytics Module	Integration of analytics for predictive use	2,000-4,000	Initial integration cost
Total CapEx		25,000-56,000	

B) Operational Expenditures (OpEx)

Data Management and Processing Costs:

- Ongoing cloud service costs (compute, storage, and bandwidth).
- Data cleaning, curation, and enrichment services.
- Maintenance of APIs, smart contracts, and other platform components.

Compliance and Security Costs:

- Ongoing costs for regulatory compliance and data privacy (e.g., audits, updates to legal frameworks).
- Data security measures, including encryption, access control, and continuous monitoring.

Customer Support and Engagement Costs:

- Personnel costs for user support and onboarding assistance.
- Marketing and outreach expenses (e.g., industry events, digital campaigns).

Operational Overheads:

- Costs of continuous platform updates, bug fixes, and feature enhancements.
- Infrastructure scaling costs to accommodate increased user demand.

Table 13: Operational Expenditures (OpEx) Breakdown

Cost Category	Description	Monthly Cost (€)	Annual Cost (€)	Notes
Cloud Services	Connectors, storage, and bandwidth costs	5,000-10,000	60,000-120,000	Varies based on user activity
Data Curation and Enrichment	Ongoing data quality management	2,000-5,000	24,000-60,000	Includes data cleaning and updates

Security Maintenance	Continuous monitoring and updates	3,000-6,000	36,000-72,000	Regular updates and threat monitoring
Customer Support	Personnel for user support and onboarding	4,000-7,000	48,000-84,000	Includes onboarding assistance
Marketing and Outreach	Promotion through industry events and media	1,000-2,000	12,000-24,000	Digital campaigns and event fees
Legal and Compliance	Ongoing legal support and audits	500-1000	6,000-12,000	Regular compliance checks
Platform Updates	Feature enhancements and bug fixes	2,000-4,000	24,000-48,000	Continuous improvement costs
Total OpEx		10,500	126,000	

6.2 Monetization Strategies Review

A comprehensive review of business models in the context of industrial Data Spaces, data marketplaces, and data-as-a-service (DaaS) solutions highlights several potential revenue streams [10]:

A. Pay-Per-Use Model

Users are charged based on the volume or type of data accessed.

- Benefits:
 - Scalable and flexible, catering to diverse user needs.
 - Encourages granular data usage, appealing to organizations with specific data requirements.

- Challenges:
 - Requires robust tracking and billing mechanisms.
 - May deter smaller users due to variable costs.

B. Subscription-Based Model

Participants pay a regular fee for access to the data space or premium services.

- Benefits:
 - Provides a predictable revenue stream.
 - Encourages long-term engagement and stable relationships with users.
- Challenges:
 - Requires a strong value proposition to justify recurring payments.
 - May limit accessibility for smaller organizations or SMEs.

C. Data-as-a-Service (DaaS)

Data providers offer curated datasets or insights on demand.

- Benefits:
 - Adds value by packaging data with actionable insights, increasing its utility.
 - Enhances real-time decision-making capabilities for end users.
- Challenges:
 - High initial development costs for data curation and processing.
 - Requires continuous updates and maintenance to ensure data relevance.

D. Freemium Model

Basic access is free, with premium features or advanced data services available at a cost.

- Benefits:
 - Lowers the barrier to entry, attracting a larger user base.

- Converts a portion of free users into paying customers as they recognize the value of advanced services.
- Challenges:
 - Requires a clear distinction between free and premium offerings.
 - May result in limited revenue if a significant number of users remain on the free tier.

E. Revenue Sharing Models

Earnings are distributed among data providers, intermediaries, and consumers based on usage or predefined agreements.

- Benefits:
 - Encourages collaboration and data sharing among multiple stakeholders.
 - Provides incentives for data providers to contribute high-quality data.
- Challenges:
 - Complex to implement, requiring clear agreements and transparent revenue-sharing mechanisms.
 - Potential conflicts of interest among participants.

F. Tiered Pricing Model

Offers different service levels or data quality tiers to cater to various user needs.

- Benefits:
 - Provides flexibility for users to choose a plan that aligns with their budget and requirements.
 - Maximizes revenue by catering to both budget-conscious users and those seeking premium services.
- Challenges:
 - Requires careful design to differentiate between tiers effectively.
 - Potential risk of cannibalizing higher-priced tiers if lower-tier options offer sufficient value.

6.3 Economic Feasibility and ROI Analysis

To evaluate the economic feasibility of the data space, we can consider three scenarios:

Scenario 1: Conservative Growth (Focus on SMEs and niche users)

- Initial revenue generation from subscription and freemium models.
- Gradual expansion to larger industry players, increasing pay-per-use income.
- ROI achieved within 3-5 years, assuming moderate user growth and retention rates.

Scenario 2: Moderate Growth (Balanced Approach)

The target audience here is a mix of SMEs and large industry players, including early adopters and mid-sized enterprises.

- The respective revenue model combines multiple strategies, including pay-per-use, subscription-based models, and a tiered pricing structure for different user segments.
- Initial focus on building a solid user base with flexible pricing models.
- Gradual introduction of Data-as-a-Service (DaaS) offerings as user engagement increases.
- Aims to strike a balance between acquiring new users and maximizing revenue from existing participants through premium features.
- ROI achieved within 2-3 years, reflecting moderate but consistent growth in both user base and revenue.

Scenario 3: Aggressive Growth (Focus on large industry players and rapid scaling)

- Emphasis on DaaS and tiered pricing models, targeting enterprises with high data consumption needs.
- Faster break-even point due to higher initial investment but increased revenue from premium services.
- ROI achieved within 1-2 years, with significant expansion in user base and data transactions.

By presenting different growth scenarios (Table 15) the analysis accounts for variations in user adoption and scaling, helping stakeholders make informed decisions.

Table 14: Scenario-Based Cost Analysis (Annual Costs)

Scenario	Total CapEx (€)	Total OpEx (€)	Total Annual Cost (€)	Notes
Conservative Growth	600,000	210,000	810,000	Assumes limited initial user adoption
Moderate Growth	750,000	315,000	1,065,000	Baseline scenario with expected adoption
Aggressive Growth	900,000	420,000	1,320,000	Assumes rapid user scaling and demand

The ROI table (Table 14) offers a quick overview of the financial feasibility and potential profitability of the project, assisting in evaluating investment decisions.

Table 15: Return on Investment (ROI) Analysis

Metric	Conservative Growth	Moderate Growth	Aggressive Growth
Initial Investment (€)	€600,000	€750,000	€900,000
Annual Revenue (€)	€270,000	€450,000	€800,000
Payback Period (Years)	3-5 years	2-3 years	1-2 years
Net Present Value (NPV) (€)	150,000	350,000	600,000
ROI (%)	25%	45%	75%



Given the uncertainties in user adoption and market response, the **moderate growth scenario** could serve as the baseline plan. It offers a balanced approach, allowing for adjustments based on real market feedback while still aiming for profitability within a reasonable timeframe.



7 Conclusion and Future Work

The UNDERPIN project aims to enhance value creation through effective data sharing and collaboration, in line with the European values for data and technology sovereignty, by developing a sustainable dataspace solution for dynamic asset management and predictive maintenance.

In this frame, the deliverable D5.1 “Existing business Models assessment” provided a thorough examination of existing business models relevant to Data Spaces, focusing on their structure, orientation, and monetization strategies and highlighting the strategic components essential for delivering and sustaining data-driven services for Data Spaces effectively. By identifying successful business models and best practices, the document ensures that the UNDERPIN Data Space aligns with industry standards and market demands, while it emphasizes the importance of leveraging innovative approaches to data management and monetization, thus guiding the project towards a strategic and sustainable direction.

In addition, this document elaborated on the design and development of a sustainable business model tailored for the UNDERPIN Data Space, employing a methodology that emphasizes secure and sovereign data sharing to enhance value creation. This involved defining the roles that open business model opportunities for the UNDERPIN solution. To facilitating a deeper understanding of the landscape in which data-driven services operate, comprehensive desk research was conducted by collecting and analysing publicly available information on a diverse range of data marketplaces, aiming to derive valuable insights that can inform the development of effective strategies and best practices for the UNDERPIN project.

The main outcomes of this document encompass the creation of the a UNDERPIN Business Model Canvas which offers a structured overview of the essential strategic components required for the effective delivery and sustainability of data-driven services associated with the project. Additionally, this deliverable includes a comprehensive techno-economic analysis of the UNDERPIN Data Space, concentrating on the evaluation of both technological costs and economic feasibility to assess the viability of the proposed business models and monetization strategies.

Outlook on the Second Half of the Project

In the second half of the project, Task *T5.2 Sustainable Business Models* will intensify its efforts to explore and refine feasible and sustainable business models for the UNDERPIN Data Space. This will involve engaging with stakeholders to gather insights and iterating on proposed models to ensure alignment with user needs and regulatory frameworks. Concrete actions for commercializing the dataspace service will be prioritized, such as developing partnerships, creating tailored marketing strategies, and identifying potential revenue streams. By establishing a clear roadmap and measurable objectives, UNDERPIN aims to enhance the viability and scalability of the Data Space, ultimately driving its adoption and impact within the European Union.

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