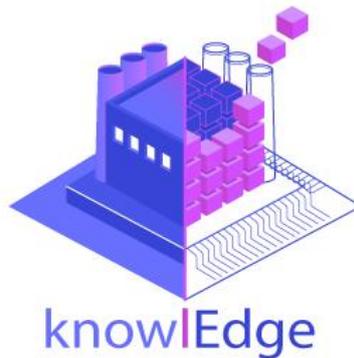# Towards AI powered manufacturing services, processes, and products in an edge-to-cloud-knowlEdge continuum for humans [in-the-loop]

WP9: Dissemination and Exploitation

EU ID: D9.3 Initial Business models and requirements
v1.1

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Date: 2022-03-30

Dissemination: Public

Status: For EU Approval

Abstract

The purpose of this knowlEdge deliverable, D9.3 "Initial Business models and requirements", is to present a first version of the results of the stakeholders' business requirements and models analyses for AI implementation.

Grant Agreement: 957331

Document Status

Deliverable Lead	VTT, Markku Mikkola
Internal Reviewer 1	Cristian Barrue, UPC Miguel Sànchez Marrè, UPC
Type	Deliverable
Work Package	WP9.2
ID	D9.3 Initial Business models and requirements v: 1.1
Due Date (Original)	2022-04
Delivery Date	2022-04
Status	V.1.1: Final reviewed

History

See Annex B.

Status

This deliverable is subject to final acceptance by the European Commission.

Further Information

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Project Partners:

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Executive Summary

AI implementation in the manufacturing context is still in the early phases of development. Companies are exploring the opportunities of AI, as well as its impact on business models. Regarding the manufacturing context, recent studies suggest that AI application typically creates value through making the manufacturing processes more intelligent, quality control and predictive maintenance being the key areas. From value delivery perspective, identification and development of new technology-based capabilities and employee competences, as well as data availablity provide major challenges. Value capture is a challenge due to the typical AI implementation context, which often consists of several stakeholders outside the boundaries of the manufacturing firms and creates costs that needs to be balanced with perceived benefits.

In this deliverable the operation of the knowlEdge network from business perspective is described from three generic stakeholder perspectives. These are: 1) marketplace perspective, 2) AI technology provider perspective, and 3) manufacturer perspective. Business model canvas and platform canvas are used as frameworks to describe the business models for each perspective. Following business models were drafted. Marketplace business model gives the overall view on the business relations of different participants. Marketplace operator and AI technology provider business models focus on these actors specifically, e.g. for AI technology provider 2 separate business models (AI model provisioning and consultation) were created. Two separate business models were also created for manufacturers, the other taking a bit visionary perspective of manufacturer as AI prosumer, i.e. providing trained models to other manufacturers.

A survey was carried out among the project partners to collect their initial views on the different aspects of business models. Limiting to the project partners only, the survey doesn't give e.g. statistically relevant results for broader discussion, but provide some ground to elaborate the knowlEdge business models further during the rest of the project. One interesting finding was that many partners aim to provide AI related consultation services alongside AI technology solutions, which was perhaps not anticipated when business model discussions started. However, this seems to be in line and confirming some earlier studies' findings. Regarding pricing, the partners find software licensing and subscription fee models most preferred. Also, many partners aim to get revenue from implementation services, confirming the intention to provide consultation as well.

This deliverable presents the initial business models developed in the project. The models are to be developed further during the remaining part of the knowlEdge project.

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0 Introduction

0.1 knowlEdge Project Overview

The knowlEdge project is funded by the H2020 Framework Programme of the European Commission under Grant Agreement 957331 and conducted from January 2021 until December 2023. The knowlEdge consortium consists of 12 partners from 7 EU countries, and its solution will be tested and evaluated in 3 manufacturing sectors with a total budget of circa 6M€. Further information can be found at www.knowlEdge-project.eu

AI is one of the biggest mega-trends towards the 4th industrial revolution. While these technologies promise business sustainability and product/process quality, it seems that the ever-changing market demands and the lack of skilled humans, in combination with the complexity of technologies, raise an urgent need for new suggestions. Suggestions that will be agile, reusable, distributed, scalable, accountable, secure, standardized and collaborative.

To break the entry barriers for these technologies and unleash their potential, the knowlEdge project will develop a new generation of AI methods, systems and data management infrastructure. This framework will provide means for the secure management of distributed data and the computational infrastructure to execute the needed analytic algorithms and redistribute the knowledge towards a knowledge exchange society. To do so, knowlEdge proposes 6 major innovations in the areas of data management, data analytics and knowledge management: (i) A set of AI services that allow the usage of edge deployments as computational and live data infrastructure, an edge continuous learning execution pipeline; (ii) A digital twin of the shop-floor to test the AI models; (iii) A data management framework deployed from the edge to the cloud ensuring data quality, privacy and confidentiality, building a data safe fog continuum; (iv) Human-AI Collaboration and Domain Knowledge Fusion tools for domain experts to inject their experience into the system to trigger an automatic discovery of knowledge that allows the system to adapt automatically to system changes; (v) A set of standardization mechanisms for the exchange of trained AI-models from one context to another; (vi) A knowlEdge marketplace platform to distribute and interchange AI trained models.

0.2 Deliverable Purpose and Scope

The purpose of this knowlEdge deliverable, D9.3, is to present a first version of the results of the stakeholders' business requirements and business models analyses for AI implementation. The deliverable is structured as follows. First, the state-of-the-art chapter presents the current understanding of the AI implementation in manufacturing sector and introduces some business models both for different kind of AI technology providers and AI marketplaces based on the recent studies. Second, the business model framework to be utilized in the knowlEdge project business model studies is presented. Third, the preliminary business model concepts for the knowlEdge marketplace and major stakeholder types identified so far are outlined.

0.3 Target Audience

The deliverable aims primarily at providing insights on how to implement AI technologies from business perspective. Target audience is AI based business development experts.

0.4 Deliverable Context

This deliverable reports the preliminary business models developed in WP9 Task 2. The final business models will be reported at the end of the project.

0.5 Document Status

This document is listed in the Description of Action as "Public".

0.6 Document Dependencies

This document has no preceding documents. Final version of the business models are presented in the D9.4 at the end of the project (M36).

0.7 Glossary and Abbreviations

A definition of common terms related to knowlEdge, as well as a list of abbreviations, is available at www.knowlEdge-project.eu/glossary

0.8 External Annexes and Supporting Documents

External Documents:

- Annexes:
  - None
- Supporting Documents:
  - None

0.9 Reading Notes

- None

0.10 Document Updates

None

1   State-of-the-art

The state-of-the-art chapter considers three perspectives essential to the development of knowlEdge AI solutions and marketplace from business model point of view: 1) AI and business models in manufacturing, 2) business models for AI developers, and 3) business models for AI marketplace. The chapter is structured accordingly in three sub-chapters.

AI is fairly new technology that is still in the early phases of implementation in manufacturing context. Thus, also research based knowledge is limited, especially regarding the connection of AI and business-model innovation in industrial ecosystems (Burstom et al, 2021; Bretones Cassoli et al, 2021).

1.1   AI and business models in manufacturing

According to Burstrom et al (2021) and the market studies referred to in the knowlEdge project deliverable D2.3 (2021), firms in the manufacturing industry are in early stage of exploring the opportunities of AI, and there is only some preliminary evidence about development of theory on combining AI, business models, and ecosystems. In their study, Burstrom et al (2021) considered the business model innovation from three perspectives: 1) design or architecture of the value creation, 2) delivery, and 3) capture mechanisms. They came to following conclusions regarding the status of research on AI and its impacts on business models in manufacturing companies.

> *Value creation*: Existing research on AI data-driven manufacturing provides suggestions on how to create new value offerings. One source of new value creation is quality control by using digital technologies, making the manufacturing process more intelligent. AI can also enable new value offerings combining the ability to serve individual customer needs while maintaining the near mass production efficiency. Bretones Cassoli et al (2021) consider different predictive maintenance concepts as being one promising area to get value of AI application in manufacturing.

> *Value delivery*: A major challenge in configuring AI-based value delivery systems concerns the identification and development of new technology-based capabilities and employee competences. Incremental development of these capabilities is typical as activities such as support services, technology development, and skills development are interdependent and spread across the organization. Another challenge is to match local organizational capabilities with a global value-delivery system. Alongside competence requirements, Bretones Cassoli et al (2021) point out that data availability is also essential to build AI systems in the first place and thus delivering value from them.

> *Value capture*: The value-capture dimension of the business model relates to elements such as cost structures, potential revenue streams, and revenue model and financial viabilities. Implementation of new technologies typically aims at more cost-efficient processes, which is often performed with stakeholders outside the boundaries of the incumbent firms. Thus, one challenge to be managed when co-creating these technology-based processes is to find a balance between the cost of collaboration and the financial benefits. Nguyen et al (2021) highlight the importance to create incentive mechanisms to engage different stakeholders to collaborative AI-model development and training. According to Björkdahl (2020), manufacturing

incumbents have mainly pursued cost reduction through efficiency improvements, and far less used AI to drive revenue growth.

Recent studies present the following conclusions of the current status of AI impacted business models in manufacturing industry. Manufacturing incumbents are currently developing several AI functionalities such as forecasting, monitoring/controlling, optimizing, and autonomy, but there is a significant difference in the utilization of these business applications (Burstrom et al, 2021). Although AI has been deployed throughout fundamental parts of the business, companies have slightly focused on the core production processes (knowlEdge project deliverable D2.3, 2021). Forecasting and monitoring/control applications such as predictive maintenance applications (Bretones Cassoli et al,2021)) have reached a more mature stage of development, while optimization and autonomy functionalities are still in the exploration stage.

According to Burstrom et al (2021) incumbents are also increasingly trying to develop multiple AI functionalities in parallel, instead of single functionality reported in earlier studies. However, AI applications have not yet disrupted major parts of the manufacturing industry (Burstrom et al, 2021). Small-scale AI innovation in collaboration activities are performed with various ecosystem stakeholders - such as developer communities, research institutes, academia, and customers - in order to identify a competitive edge through AI (Bretones Cassoli et al, 2021; Metelskaia et al,2018). According to Burstrom et al (2021), AI has not yet brought a decisive competitive advantage to incumbents in the manufacturing industry, but it is seen as a competitive requirement.

1.2 Business models for AI developers

Faggella (2021) has conceptualised 5 different business models for AI solutions providers. Four of them are presented below, as one of the models is platform business model, which is considered in the next chapter. Faggella (2021) makes the distinction of product models and services models, the former is based on providing AI technology solutions and software, the latter is based on providing AI consulting services.

AI SaaS Product Vendor

This model's key characteristic is that it focuses on offering solutions that play at the surface of existing systems with minimum tailoring. They often rely on APIs, or do not rely on integrating with a client's existing infrastructure in any way. From customers they require almost no AI competencies and no improvement in AI maturity, SaaS concept means that subscription fee revenue models are often used (Faggella, 2021).

AI Product Vendor

This model offers solutions that integrate with client systems, and use client data. This model often involves a wider range of client applications than AI SaaS offerings. This is partially a result of being able to use the client's own data, and partially a result of a broader tool set in general. It differs from the SaaS model in the integration challenges, which require longer pilots, more hands-on integration, and more hands-on maintenance. Building some AI maturity on customer side is necessary to get the sale, and it might also help them expand their contract and do more work (i.e. win more revenue) with their clients in the long-term (Faggella, 2021).

AI technical and management consulting

This model offers the combination of the widest range of narrow, surface-level AI tools and SaaS integrations, or consulting and strategy work, or longer-term AI maturity at a technical level

(data/IT infrastructure). These firms are important for an enterprise-wide AI roadmap to be developed, as they potentially operate across all functional areas without being locked to any specific vendor allegiance. Smaller firms may need to focus on specific industries, or specific kinds of AI projects (e.g. computer vision, fraud detection, etc). Smart AI technical services firms with management consulting capabilities aim to become a long-term "AI partner" as they can bill almost any kind of project (Faggella, 2021).

Management consulting

Companies applying this business model are capable of advising on strategy, education, and process consulting, but not hands-on technical AI work (e.g. development, integration, data infra). They may need to focus more specifically in order to compete with consulting firms also capable of AI technical work. These firms can potentially find a place in nearly any AI project or initiative, but will be expected to have very specific insights, particularly into what other players in the industry are doing. Strategy or management consulting firms share the incentive of their technical consulting counterparts in benefitting from becoming a trusted "AI advisor" to their clients, but they lack the ability to deliver short-term AI pilots/products (Faggella, 2021).

In their critical take on current status of AI from business perspective, Casado & Bornstein (2020) emphasize that at the moment most AI systems are not quite like software in the traditional sense. They differ from software business by involving ongoing human support and material variable costs and they often do not scale quite as easily as traditional software business. This implies that Casado & Bornstein (2020) seem to consider that typical current AI business model is close to the AI product vendor category of Faggella (2021). In a couple of years earlier study Metelskaia et al (2018) foresee somewhat differently that, comparing to traditional software ventures, AI as SaaS models and their variations become more popular, whereas advertising-based models are used less.

Trying to build bridge between technological solutions and their application Metelskaia et al (2018) have developed a business model canvas for AI solution developers emphasizing the start-up perspective. According to Metelskaia et al (2018) the customer segments for AI are very diverse and difficult to identify, especially for small start-ups. Considering the start-up context, they add one unique potential business model that focuses on technology development and aims for selling the whole company to other larger enterprise. Metelskaia et al (2018) conclude that the role of IP in AI solutions is changing from open source model towards more protected. IP is more often considered as a key resource, including patents and know-how.

1.3 Business models for AI marketplace

Marketplaces are considered as an essential tool to support the diffusion and scalable deployment of AI models (Kumar et al, 2021; Nguyen et al, 2021). Different kind of software and application marketplaces that have existed long time provide a reference model for AI marketplaces, but there are differences that need to be considered. AI solutions typically require data sharing from customer's side, which could be sensitive and require mechanisms to secure confidentiality. AI marketplace should also have some mechanism to determine the quality and trustworthiness of the final delivered AI models (Kumar et al, 2021). As AI models often require maintenance during their life-cycle and the original AI model developers may not be available any more, AI marketplace needs to provide guidelines to developers to support AI model maintenance by other AI developers (Kumar et al, 2021). Nguyen et al (2021) add the valuation methods of the AI models and collaboration incentives

for different stakeholders in model training as factors requiring more attention when developing AI marketplaces.

Several concepts have been developed to overcome the challenges of AI marketplace development. Both Kumar et al (2021) and Nguyen et al (2021) suggest decentralized marketplace structures, based e.g. on Distributed Ledger Technologies (DLT) and Federated Learning (FL) concepts to handle the challenges of privacy and data governance. Focusing on IoT data marketplaces, Nguyen et al (2021) propose a distributed Data Shapley Value based incentive mechanism to stimulate participants to join in the model training in the marketplace, which enables paying participants according to their contributions to training the model.

In their current AI marketplace analysis, Kumar et al (2021) found that most of the marketplaces are still under development and their underlying technical details and planned functionalities are not public. Most of the marketplaces are proprietary and are based on a centralized architecture, though few are decentralized based on DLT. Fixed price per model is the predominant pricing model. Kumar et al (2021) groups the marketplaces into the following categories:

1) AI model Trading marketplace: An AI developer can upload their pre-trained model to a marketplace and customers can purchase access (an API) to use the model. SingularityNET and IBM imaging are examples.

2) Data Trading marketplace: Data owners make their data available to AI developers in a privacy-preserving manner. The marketplace also focuses on ensuring the quality of data including preventing malicious data. OSA Decentralized, Ocean Protocol, and Agorai are examples.

3) Developer-Customer Matching marketplace: Matches the varying AI customers and developers based on the customers' specific requirements and the developers' skills and domain knowledge. Nomidman, AI Global, Genesis AI, Bonseyes, Alphacat, Modzy, SingularityNET, and Orange AI are examples.

4) Interoperability Standard marketplace: Interoperability standards for AI models allows AI developers the freedom to create their model with their preferred tools and frameworks. This type of AI marketplace focuses on developing such a standard as an SDK. TensorTask, Genesis AI, Akira AI, Bonseyes, SingularityNET, Gravity AI, Kynisys, OVHcloud AI, Neuromation Algorithmia, GraphGrail AI, Agorai, IBM Imaging, and Nuance Communications are examples. Kumar et al (2021) note that none of these marketplaces have publicly released their standards for use.

While the above marketplaces are commercially oriented, there are also other not purely commercial platform activities that aim to advance the development of AI and related ecosystems. European Commission supported AI4EU consortium was established to build the first European Artificial Intelligence On-Demand Platform and Ecosystem with the following support activities (knowlEdge project deliverable D2.3, 2021):

- The creation and support of a large European ecosystem spanning the 27 countries to facilitate collaboration between all Europeans actors in AI (scientists, entrepreneurs, SMEs, Industries, funding organizations, citizens, etc.);

- The design of a European AI on-Demand Platform to support this ecosystem and share AI resources produced in European projects, including high-level services, expertise in AI research and innovation, AI components and datasets, high-powered

computing resources and access to seed funding for innovative projects using the platform;

- The implementation of industry-led pilots through the AI4EU platform, which demonstrates the capabilities of the platform to enable real applications and foster innovation;

Analysing the development stage of current AI marketplaces, Kumar et al (2021) found that, e.g. in two relatively developed marketplaces, SingularityNET and IBM Imaging, there is less than 30 total AI models even two years after the launch of these marketplaces. They contrast this to major recently launched B2B software marketplaces that have thousands of applications. According to Kumar et al (2021) among the marketplaces, SingularityNET seems to be the most developed. Another characteristic they also found, is that current AI marketplaces primarily host models only from large well-known companies like Google DeepMind, IBM Watson, etc. This implies that smaller companies have challenges to enter the AI model marketplace.

In terms of future developments, Kumar et al (2021) found that many of the marketplace companies aim to solve some of the current bottlenecks in model availability. Several marketplaces are developing interoperability standards for AI development. Many are developing comprehensive reputation systems to rate AI developers and companies, helping e.g. with the problem of malicious AI models and providing a signal of developer quality. Also, several marketplaces are developing data sharing frameworks to integrate data from different relevant databases and create unified virtual data stores for use in model training.

Kumar et al (2021) conclude that most of the currently available marketplaces are centralized and company-driven with relatively few models per marketplace, suggesting that the development of AI marketplaces is still in their infancy.

2   Business model frameworks

This chapter presents the main theoretical business model frameworks that are used to describe the KnowlEdge business models in the following chapters. These are the business model canvas by Osterwalder et al (2010) and platform canvas from Allweins et al (2021). Osterwalder et al (2010) business model can be used to describe the business model of a single stakeholder. The platform canvas is used to describe the platform business, i.e. marketplace business model in KnowlEdge context. It can be considered as the central model to describe knowlEdge operation from business perspective.

2.1   Business model canvas

Osterwalder et al (2010) introduced the Business Model Canvas (figure below). The Business Model Canvas consists of nine elements designed to categorize an entrepreneur's assumptions of a business model to compare with other's and expose weaknesses or missing pieces (Ovans, 2015). It is a widely acknowledged and cited framework of a business model, which provides practitioners and academics with a shared language to facilitate description and discussion in order to create innovation and new strategic alternatives (Allweins et al, 2021).

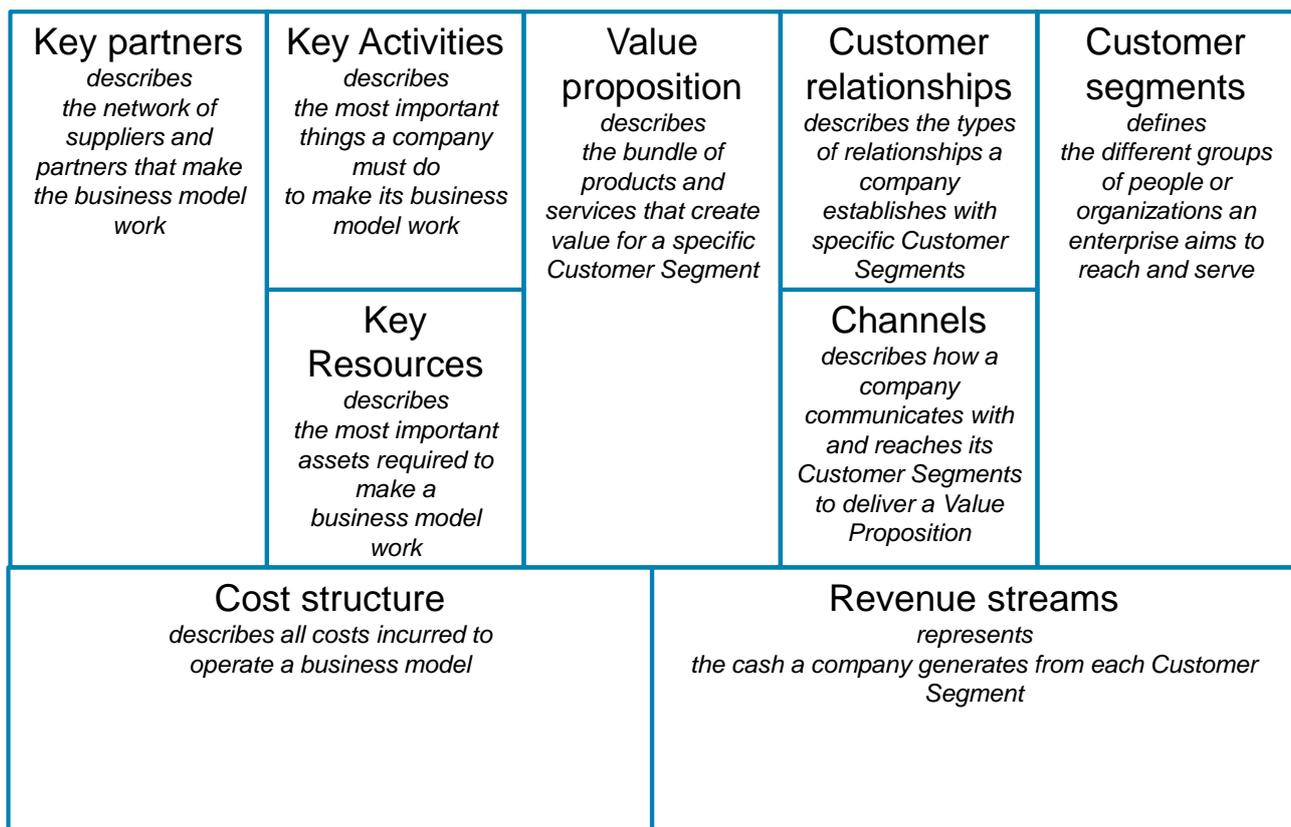| Key partners	Key Activities	Value proposition	Customer relationships	Customer segments
describes the network of suppliers and partners that make the business model work	*describes the most important things a company must do to make its business model work*	*describes the bundle of products and services that create value for a specific Customer Segment*	*describes the types of relationships a company establishes with specific Customer Segments*	*defines the different groups of people or organizations an enterprise aims to reach and serve*
	Key Resources *describes the most important assets required to make a business model work*		**Channels** *describes how a company communicates with and reaches its Customer Segments to deliver a Value Proposition*	
Cost structure *describes all costs incurred to operate a business model*			**Revenue streams** *represents the cash a company generates from each Customer Segment*	

Figure 1. The Business Model Canvas elements (Osterwalder and Pigneur, 2010).

Though being widely used, the Business Model Canvas has also been criticized for its lack of information about the company's external context, including the competition in the market the business aims to operate in (Allweins et al, 2021). Another challenge is that the Business Model Canvas represents the elements of a traditional business that constructs and delivers

its own products or services to customers in a linear, unidirectional flow. Regarding particularly the platform business, which have radically different mechanisms to create and capture value, the need for a distinctive business model diagram has been identified.

2.2 Platform canvas

In order to overcome the shortcomings of the Business Model Canvas in platform business context, Allweins et al (2021) have introduced a platform canvas tool, which tackles the specificities of modelling platform business (Figure 2).

Figure 2. Platform canvas (Allweins et al, 2021).

The Stimuli element consists of actions the platform takes to make the platform attractive and easy for new participants to join. In general, these actions might include push strategies such as paid promotion and advertising, external networks as bridges, sponsorships or other endorsement activities. From pull strategy perspective the actions may consist of frictionless entry, subsidization and enablement of side switching, i.e. where consumers on the platform are enticed to also become producers.

The Producer Segments element consists of the common attributes of the group that delivers the product, services or information that is consumed by the Consumer Segment. The description of these segments includes geographic, demographic, and psychographic information. It might also include the resources and competencies that each segment contributes to the exchange.

The Consumer Segments element contains the groups of customers, their wants, needs and characteristics that enable the company to pursue effective segmentation and allocate resources accordingly. A platform is comprised of two external segments: the one that consumes a service and the one that produces or hosts it. Value is not created until both sides come together to interact to exchange a product or service.

The Consumer Value Propositions element describes the problems that are solved and the benefits that are gained by participating within the platform. Similarly, the Producer Value Propositions element specifies the perceived values that cater the needs of the Producer Segments and give reason to their desire of participating within the platform.

The Interaction element of the Platform Canvas describes the actions and communications that the consumers and producers provide themselves. The creation of value in a platform business occurs during the Interaction between the involved parties. Through dialog and exchange, producers and consumers co-create value with and for each other.

The Facilitation element defines the internal decisions and actions that the platform company itself takes to drive efficient, fruitful exchanges. The interaction relies on two actions that are mediated by the company building the platform to provide facilitation of the exchange: the platform's technology and governance. The technology consists of the search algorithms, filters, messaging system, location collection, and payment mechanism. Governance in this context refers to the platform's rules and operations that enable, ensure and protect the exchange between the participants.

The Substitutes elements for both the producer and the consumer refer not just to the solution from another platform, but any product or service from any alternative company, regardless of its business model. Substitutes for consumers include solutions that solve some or all of the consumers' foundational problem. Substitutes for producers reflect the alternative ways the producer can monetize its service.

The Metrics element contains the metrics to measure the performance of the platform. These metrics relate to elements in the Platform Canvas that sit above the Metrics element in the diagram. For example, the platform can measure the size, growth, and activity of users in both the producer and consumer segments. Platform operators may track the ratings from consumer and producers that reflect their satisfaction with interactions, giving the platform additional data to improve the experience of the exchange. It can monitor the frequency and transaction size of interactions and collect A/B testing data to discern the impact of different technologies and governance rules to facilitate more and better interactions. The financial metrics relate to elements that sit below the Metrics element in the diagram and includes items like gross revenues, average transaction size, various costs, and therefore profits.

The Cost Model element contains a budget for the activities and investments of the platform business. The platform's fixed costs could include producer and consumer acquisition (stimuli), payroll, technology (facilitation), insurance, and customer support.

The Monetization element comprises the strategies that a platform pursues to generate revenue. This could include commissions, ancillary services, premium accounts with

enhanced user rights, subscription fees, listing fees, advertising, or the sale of data collected on the platform.

2.3 Network of business models

The two business model frameworks presented in previous sections can be combined to depict the network of business models of different stakeholders of knowlEdge (Figure 3). The consideration of the business models from different stakeholders' perspectives is essential to bring up and align, e.g., the different incentives and investment needs of the stakeholders. In this deliverable, the IT systems integrator & service provider perspective seen in the Figure 3 is not included, but may be added later if considered relevant.
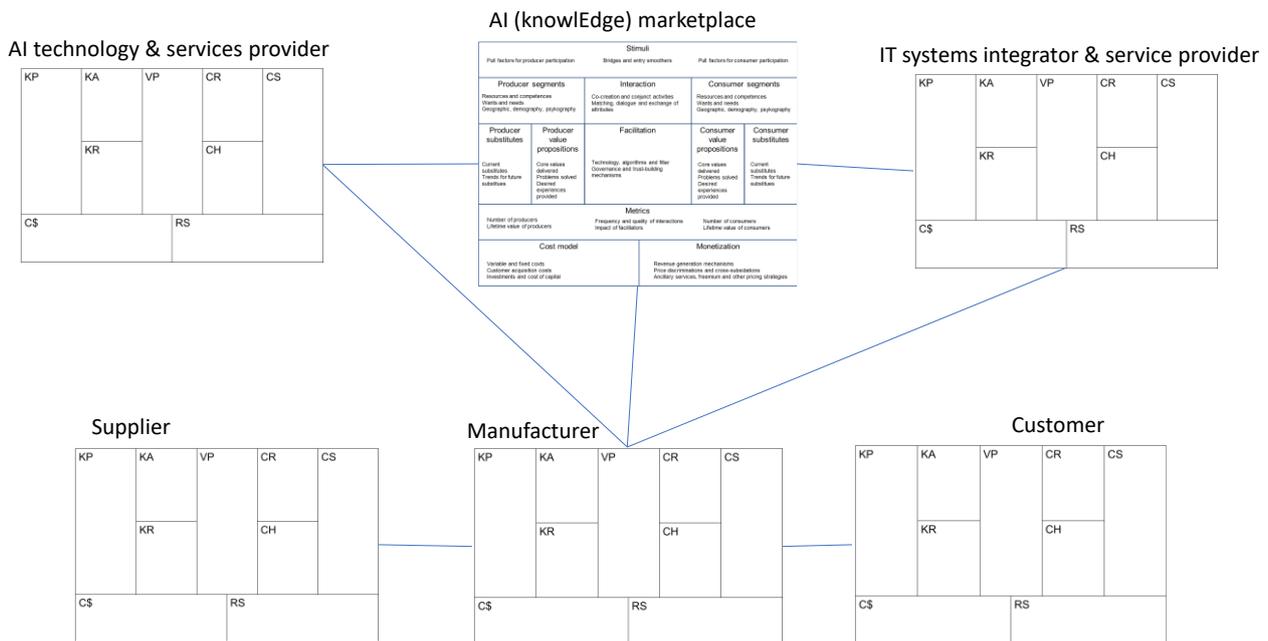

Figure 3. KnowlEdge consists of network of stakeholders and their business models, which are connected via marketplace and its business model.

3 Marketplace business model and canvas

This chapter describes the preliminary ideas for the business model of the marketplace in the mid-stage of the project. The model will be developed further as the project proceeds and understanding e.g. of the different business opportunities and barriers becomes clearer.

Marketplace is the central activity connecting the inputs and outputs of different stakeholders together. The overall marketplace business model is presented in Figure 4. The elements of the model are further described in the following sub-chapters.

Stimuli			
Opportunities to trade your AI models and Solutions	Promoting AI models exchange		Explore and purchase AI Models for your business needs

Producer segments	Interaction	Consumer segments
• Software Developers • Data Scientists • Researchers • Manufacturing companies as prosumers	• consumers provide their business needs and requirements, and domain expertise • producers develop and provide AI solutions for the above needs	• Large Enterprises and SMEs from Industrial Sector • Researchers and Data Analysts

Producer substitutes	Producer value propositions	Facilitation	Consumer value propositions	Consumer substitutes
• Other developers, scientists and companies producing AI models for industries • IT consultancy firms (e.g. Accenture). • in-house expertise.	• Access to an established Marketplace for AI models • Reliable Transaction procedure based on Blockchain • Easy to use interface for uploading your models	• Web Interface • Decentralized Marketplace based on Blockchain • Advanced Search and Recommendation functionalities • Download/upload AI Models • Protection of personal information	• Large variety of AI models • Easy to use interfaces • Secure purchasing mechanisms	• Gravity AI • Nuance Communications • IBM Imaging • EFPF Marketplace • IDSA Appstore • AI algorithms, MILP, FI-S&OP ready-to-use models, etc.

Metrics		
• Number of contributors • Number of AI models and solutions	• Number of total users • Number of interactions/exchanges/purchases	• Number of consumers/customers

Cost model	Monetization
• producer and consumer acquisition costs (stimuli), • salaries for marketplace maintenance and customer and producer support, • technology costs (e.g. cloud services)	• Premium Membership - Free of charge for knowlEdge consortium members • Advertisement Services • Low Platform Commission

Figure 4. Marketplace business model canvas (Allweins et al, 2021).

3.1 Stimuli and interaction

Regarding stimuli, the push strategy actions (e.g. advertising) are not yet defined at this point of the project. For pull strategies one action to be promoted is ability for both the producers and consumers to share knowledge and generate value by e.g. trading data, models and algorithms. The easy-to-use functions of the marketplace will enable decentralized interaction among parties without the need of intermediaries.

Regarding interaction, the consumers (i.e. manufacturing companies) bring to the marketplace their business needs and requirements, which they can solve by collaborating with the producers (AI technology developers), who have the capabilities to develop and provide AI solutions. Another value co-creation opportunity is for consumers to provide their use-case trained AI models to other AI developers as well as other consumers (manufacturers).

A survey was made for project partners to gather information about how they currently see the various elements of business models from their perspective. Figure 5 shows the target operations that the partners see the knowlEdge marketplace solutions supporting. Process planning, resource allocation, and quality control form the top group.

Figure 5. Target operations that the knowlEdge marketplace solutions support.

In the business model survey, we also tried to compose an overview on how the partners see the interaction between producers and consumers most likely happening. For that, 5 different interaction scenarios were created and partners asked to put them in the order of preference (3 most preferred). The scenarios were:

Scenario 1: A company has a description of a target problem and a data model and wants to rent computing time in knowlEdge for using a model (automatically recommended by the platform) without having to share their data.

Scenario 2: A company has a description of a target problem and a data model and wants to run, in their edge platform, a model provided by knowlEdge (automatically recommended by the platform) without having to share their data.

Scenario 3: A company has a description of a target problem, a data model and actual data and wants to rent computing time in knowlEdge for using a model trained using this data.

Scenario 4: A company wants to rent (in a secure way) the usage of their own data, so that knowlEdge can use it to train and improve models.

Scenario 5: A software development company wants to develop a new method to become available in the knowlEdge marketplace.

The results of the survey on the most preferred interaction scenarios are presented in the Figure 6. Scenarios 2 and 1 were the top selections, suggesting that partners prefer models, which don't require sharing of data.
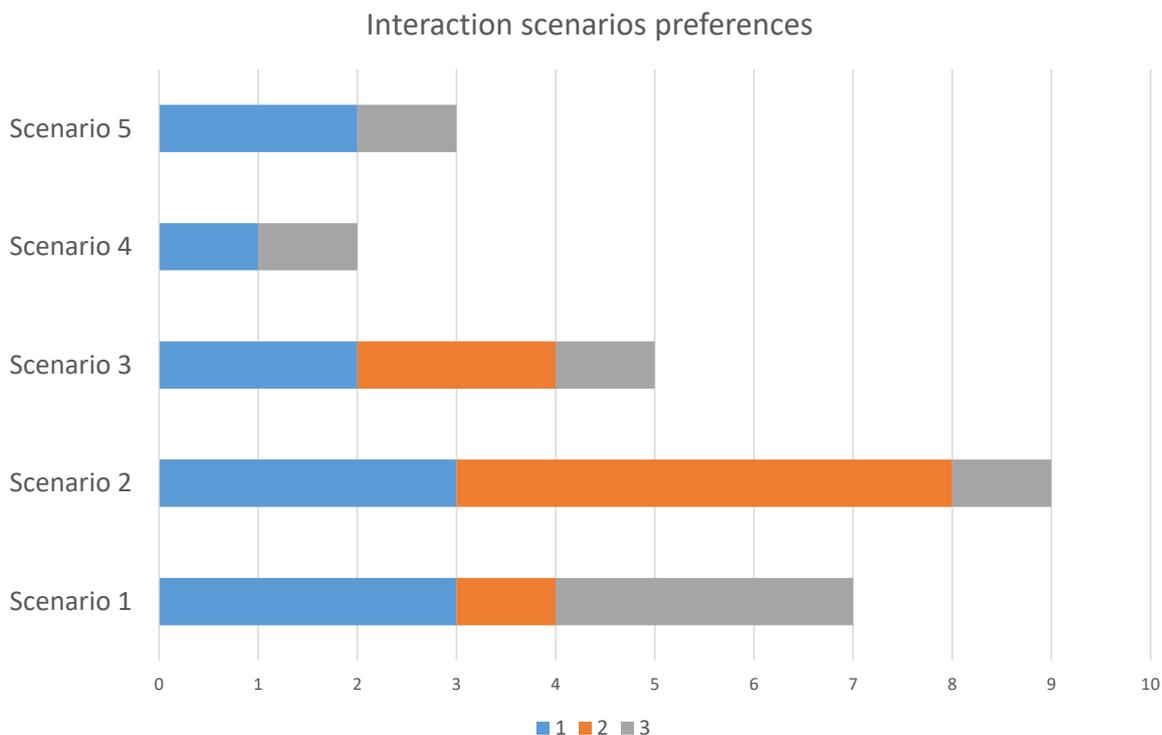

Figure 6. Most likely interaction scenarios for the marketplace producers and consumers according to knowlEdge business model survey (Legend: 1 = selected as no 1, 2 = selected as no 2, 3 = selected as no 3).

3.2 Consumer and producer elements

The consumer element includes end-user companies for AI solutions, typically manufacturing companies in various industrial sectors, such as equipment manufacturers, engineering companies, food companies, etc. The producer element includes different kind of AI solutions providers, e.g. software developers, IT service providers, and academic technology developers. Particularly interesting producer group are the manufacturing companies, which can e.g. provide the AI models or data sets that have been trained in their business context. At this stage of the project this role for the manufacturers is only an idea, no concrete plans exist yet.

Figure 7 shows the results of the survey on the potential target consumer groups for knowlEdge marketplace. As expected, manufacturing companies are the main target. Some manufacturers indicated during the business model development meetings that they often buy IT services from dedicated service providers and that knowlEdge solutions could also

be purchased via that channel. Perhaps interestingly, this option did not receive much support in the survey. However, this may be important point to consider in the further business model studies of the project.
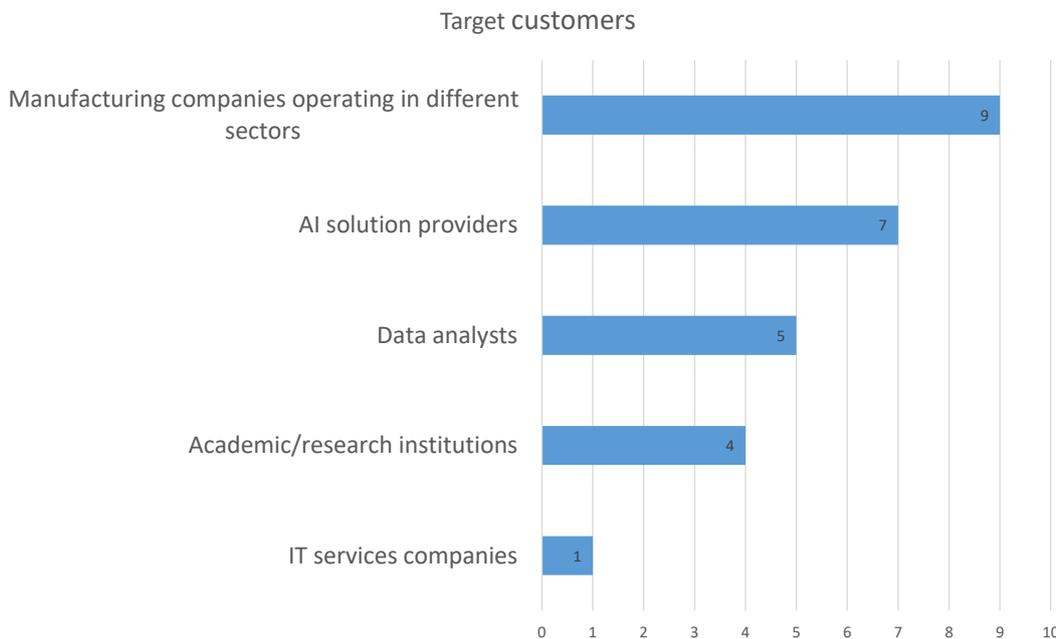

Figure 7. Survey results on the potential target customers for knowlEdge marketplace.

3.3 Consumer and producer value propositions

For the consumers (i.e. manufacturers) participating to the marketplace provides an opportunity to improve and optimize the efficiency of their production processes, as well as enhancing their quality control and management. Applying the AI models and algorithms render their operations more reliable and economically profitable.

The producers (i.e. AI technology providers) are able to sell their easy-to-use, trustworthy and tailorable algorithms and models in order to help customers' business to improve and grow. Basically, their value proposition is to help solve the process improvement needs of the manufacturers.

3.4 Facilitation

The marketplace provides the following services that facilitate the exchange between the participants: easy-to-use interface with upload and download functions for AI models and datasets, search algorithms and filters for consumers to browse the marketplace offering, recommendation system for consumers to rate the products and services, and payment mechanism to purchase products and services. The marketplace is decentralized based on blockchain technology. The marketplace governance is yet to be decided, one idea is to form a joint venture for that. Another option is that one of the knowlEdge partners take the role of marketplace operator.

3.5 Consumer and producer substitutes

For producers, substitutes can be other AI marketplaces where they can offer their products and services. Also, substitutes can be any IT firms offering their services to manufacturing

companies that are searching solutions to refine and reshape their processes by applying AI algorithms and models, or other disruptive technologies. Additionally, if the customer has adequate competences, the producer can provide the services directly to the customer.

Consumer substitutes are all those products and services that may cater to consumers' needs outside the KnowlEdge marketplace. Competing marketplaces and technology providers are e.g. Gravity AI, Nuance communications, IBM Imaging, EFPF marketplace, IDSA appstore.

3.6 Metrics

The Metrics element contains the metrics to measure the performance of the platform. These metrics relate to elements in the Platform Canvas that sit above the Metrics element in the diagram. For example, the platform can measure the size, growth, and activity of users in both the producer and consumer segments. Platform operators may track the ratings from consumer and producers that reflect their satisfaction with interactions, giving the platform additional data to improve the experience of the exchange. It can monitor the frequency and transaction size of interactions and collect A/B testing data to discern the impact of different technologies and governance rules to facilitate more and better interactions. The financial metrics relate to elements that sit below the Metrics element in the diagram and includes items like gross revenues, average transaction size, various costs, and therefore profits.

Following metrics related to different elements of the knowlEdge marketplace canvas have been identified:

Performance metrics related to the marketplace:
- Number of total users (producers and customers)
- Number of interactions/ratings/exchanges/purchases

Performance metrics related to the consumers:
- Number of consumers

Performance metrics related to the producers:
- Number of contributors
- Number of AI models and solutions
- Recommendation rating from consumers

Financial metrics related to the consumers:
- Amount of purchases (€)

Financial metrics related to the producers:
- Amount of sales (€)

- Costs of sales
- Profit (€), profitability

Financial metrics related to the marketplace:

- Amount of sales and the amount of transaction fees they incur (€)
- Costs of maintaining the marketplace (€)

3.7 Cost model

The fixed costs for the marketplace include:

- producer and consumer acquisition (stimuli),
- salaries for marketplace maintenance and customer and producer support,
- technology costs (e.g. cloud services)

At this stage of the project these costs have not yet been considered.

3.8 Monetization

The Monetization element comprises the strategies that a platform pursues to generate revenue. This could include commissions, ancillary services, premium accounts with enhanced user rights, subscription fees, listing fees, advertising, or the sale of data collected on the platform.

In the business model survey, the partners were asked to prioritize different pricing models from their perspective. The results are shown in the Figure 8. Software licensing and subscription fee models were most preferred. Also, many partners aim to get revenue from implementation services. This is something to be considered when designing the marketplace and how different offerings are presented there. It may also have impact on the revenue sharing models between the marketplace and producers, i.e. share of software sales may be calculated differently than share of implementation services (consultation).
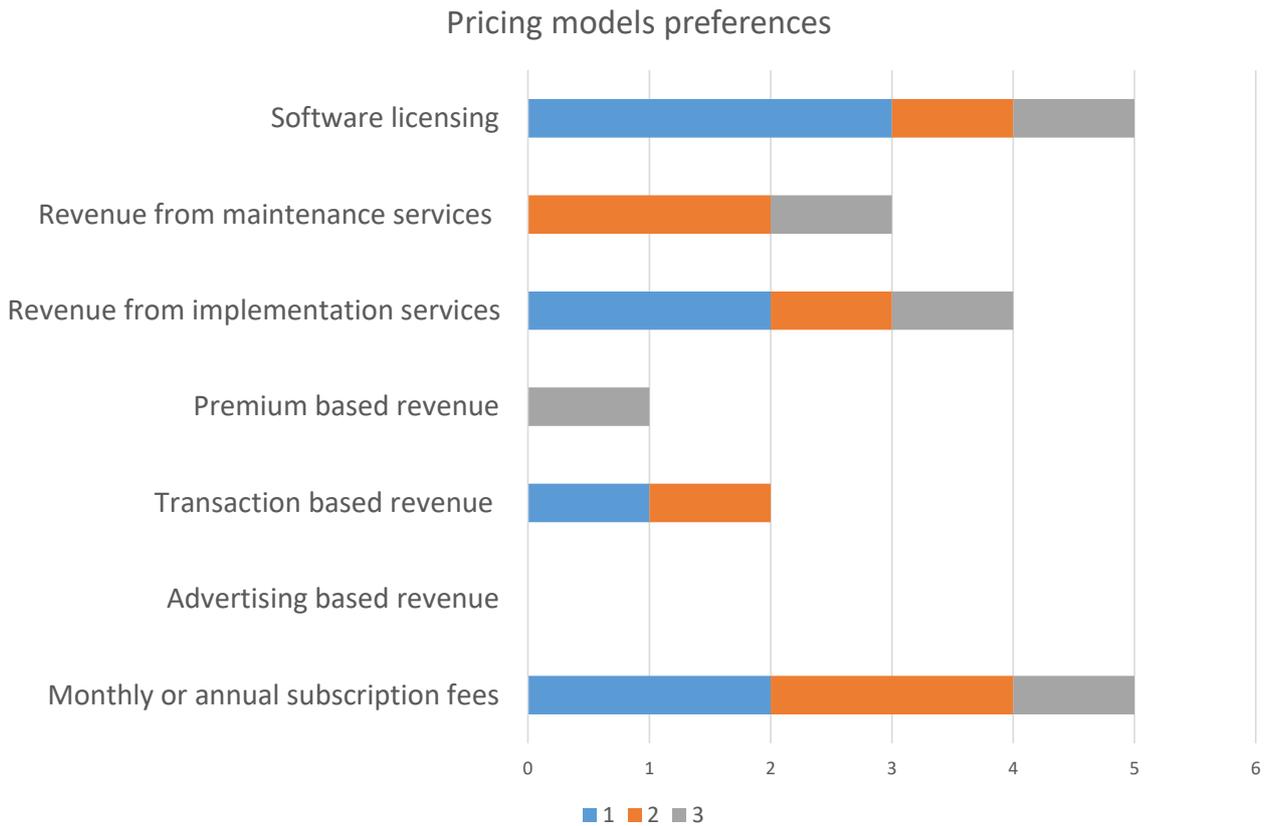
Pricing models preferences

Figure 8. Partners' preferences regarding the pricing models (Legend: 1 = selected as no 1, 2 = selected as no 2, 3 = selected as no 3).

4 Marketplace operator's business model

Though the marketplace is based on decentralized structure, from business perspective there needs to be some entity to manage it, to take the role of the marketplace operator. At this point of the project this marketplace operator has not been decided. Potential alternatives are a joint venture of knowlEdge partners or one partner taking the role. In this chapter, the business model concept for the operator is outlined. Business model canvas is used as a framework. Some elements of the business model canvas are already considered in the marketplace canvas chapter, e.g. value proposition, customer segments, and channels.

Key partners	Key Activities	Value proposition	Customer relationships	Customer segments
Marketplace technology developers (e.g. blockchain?) *AI model providers*	*Marketplace:* • *development* • *maintenance* • *marketing* *Support for AI model providers and customers*	*Easy to use marketplace interface* *AI Models Purchasing* *Search capabilities* *AI Models download/upload* *Notifications about new models* *Recommendations* *Protection of personal information*	*Transactional (projects)* *Long-term (subscription)*	*Manufacturing companies:* *Quality management processes* *Operations (production) planning processes* *AI model developers* *Data analysts* *Researchers*
	Key Resources *IT experts* *AI application domain experts* *Computing hardware* *Software* *Decentralized marketplace based on Blockchain*		**Channels** *knowlEdge marketplace* *(IT services providers)*	

Cost structure	Revenue streams
IT experts *Computing hardware* *Software*	*Share of AI model providers' revenue streams:* *Project fees (transaction based)* *Subscription fees* *Licencing fees*

Figure 9. Business model canvas for the marketplace operator.

5 AI technology provider's business models

AI technology providers business model is divided in two separate concepts, one considering the technology products' business model and the other considering the consultation services business model. This is due to the different characteristics of these activities. Preliminary business model canvases for both concepts are presented in Figure 10 and Figure 11 respectively.

Key partners	Key Activities	Value proposition	Customer relationships	Customer segments
Complementary technology & services providers	*AI technology and product development* *AI implementation support for customer*	*Technology products* • *Industrial data collection and integration toolkit* • *Site-wide data storage and management suit* • *(Semi-) automatic knowledge discovery service* • *Secure provisioning and deployment and monitoring framework* • *Trustworthy AI models* • *Digital Twin based simulation toolkit* • *DSF & Advanced visualisation toolsets* • *knowlEdge integrated solution.*	*Transactional (AI projects)* *Long-term (maintenance service subscription)*	*Manufacturing companies:* *Quality management processes* *Operations (production) planning processes* *knowlEdge marketplace*
	Key Resources *AI technology experts* *AI software* *AI application domain experts* *Computing hardware*		**Channels** *knowlEdge marketplace* *Other marketplaces* *IT services providers*	

Cost structure	Revenue streams
AI technology experts *AI software* *Computing hardware*	*Project fees (transaction based)* *Subscription fees (e.g. solution maintenance services)* *Licencing fees*

Figure 10. AI technology provider's business model considering the product business.

Key partners	Key Activities	Value proposition	Customer relationships	Customer segments
Complementary technology & services providers	*AI technology consultation* *AI implementation support for customer*	*Service offerings* • *Site-wide AI learning orchestration and monitoring service* • *Recommendations for Digital Twin for factories* • *Recommendations for knowledge/ model exchange* • *knowlEdge integrated solution.*	*Transactional (AI projects)* *Long-term (maintenance service subscription)*	*Manufacturing companies:* *Quality management processes* *Operations (production) planning processes*
	Key Resources *AI technology experts* *AI application domain experts* *Computing hardware*		**Channels** *knowlEdge marketplace* *Direct customer contacts*	

Cost structure	Revenue streams
AI technology experts' salaries *AI application domain experts' salaries*	*Consultation fees (transaction based)*

Figure 11. AI technology provider's business model considering the consultation business.

The value propositions of these canvases are still very much based on the ideas presented in the project plan. These will be refined and revised in the latter half of the project. The distribution of work and thus resources between the marketplace and the producers is one key issue, which has a great impact on the organization of the knowlEdge operation and costs allocation.

The business model survey included a question on what generic business models the partners see as the most suitable for their business case. The generic business model options were based on the 5 categories of Faggella (2021), which are presented in the state-of-the-art chapter. The survey result for this question is presented in the Figure 12. The result shows that while the AI software provisioning either with SaaS model or software product model are naturally most preferred, there are also many partners that aim for delivering AI related technical consulting (e.g. related to implementation of AI, as shown by the pricing question).
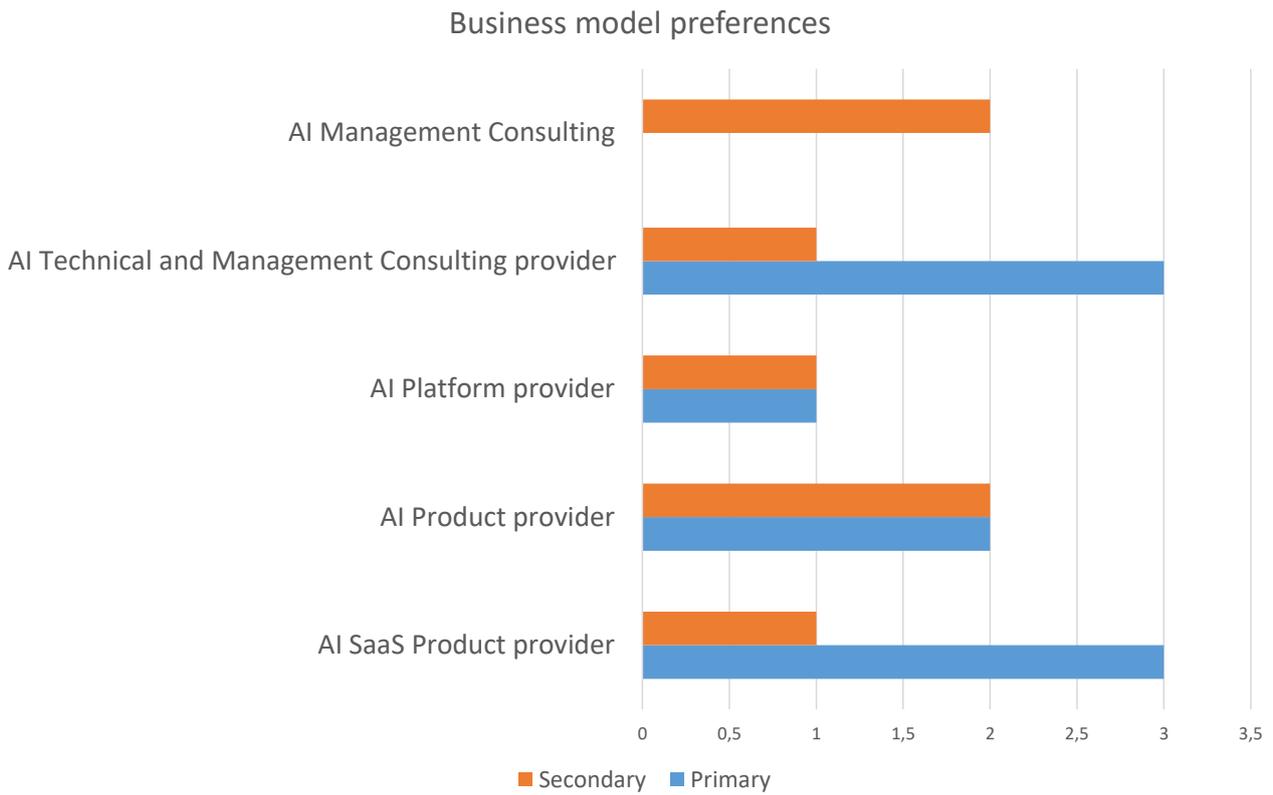
Figure 12. Preferred business model categories (Legend: Primary = primary BM choice, Secondary = secondary BM choice).

6 Manufacturer as AI user business model

The base case for manufacturers business model is that it produces benefits by improving efficiency of the manufacturing processes and thus enabling cost reductions. At least at this point of the project there is no ideas under development regarding AI supported new offerings to manufacturers' own customers. That is, manufacturers do not get new revenue streams. However, one conceptual idea for manufacturers is to provide trustworthy trained AI models to other manufacturers or data analysts and become a kind of prosumer (combined producer and consumer). This idea is considered in the next chapter.

Key partners *Complementary technology & services providers* *IT services providers* *AI developers*	Key Activities *Manufacturing activities:* *Quality management* *Operations (production) planning* Key Resources *Domain experts* *Operations technologies* *IT experts* *AI technology experts* *AI software* *Computing hardware*	Value proposition *Agile and efficient manufacturing processes* *Optimization of planning and production, e.g., demand planning, predictive maintenance, logistics optimization, generative design, inventory management,*	Customer relationships *Transactional (projects)* *Long-term (subscription)* Channels *knowlEdge marketplace* *IT services providers*	Customer segments *Manufacturing companies:* *Quality management processes* *Operations (production) planning processes*
Cost structure *Domain experts* *AI technology experts (/fees)* *AI model fees (marketplace/licencing/IT services provider's fees)* *Computing services fees*			Revenue streams *Cost savings by improved manufacturing efficiency* *Cost savings from buying AI models as a service vs. investing in own capabilities*	

Figure 13. Business model canvas for the manufacturer as AI user.

7 Manufacturer as AI prosumer business model

The rapid change of customers' needs and the amount of data which needs to be processed every day lead many companies to devise a system able to cope with all the difficulties and serious problems this inflicts to manufacturing operations management. If large enterprises were not to amass and exploit the data at their disposal, they would not make their businesses competitive and therefore it is imperative to make the most of all the available information. The knowlEdge project provides evidence that it is possible to create a network of enterprises that share their knowledge and information at their disposal in order to become more competitive in the global economic system.

If a company acts both as a producer and as consumer (prosumer) benefiting from a certain product/service (e.g. AI optimization algorithm, digital twin, etc.), it could lay ground to a network of large enterprises competing with one another to join forces and collaborate on sharing their knowledge on the industry and on disruptive technologies to reap the benefits. During this experience, economic players can extract value by sharing information as to whether it is possible to deploy disruptive technologies and magnify their profits and how their expertise can be helpful for others (Hackney et al, 2005). Those economic players not willing to join at such business players will be automatically ruled out and inherently act as consumers with whom the network might establish a mere transactional relationship.

Conceptually, and of course depending on the technological architecture of the AI models and solutions, the manufacturers could share the AI models they have trained in their own location and context to other manufacturers to utilize and develop further. From business perspective this could provide following benefits. On the one hand, the manufacturer could get direct revenue from sharing the trained model in the marketplace. On the other hand, through sharing of trained models the manufacturer could gain indirect benefit, as this sharing enables other manufacturers to develop the model with their own data and return the improved model to the marketplace again to be utilized by others, including the first model provider. A prerequisite is that the companies agree to this kind of joint model development. Unfortunately, potential "free-riding" can exist and must be restrained. That is, a serious reluctance of one participant to share valuable data or to deliberately benefit from the network without being compliant with the "give-and-take" mechanism. Therefore, some costs are incurred: trust deeds can be issued within the marketplace in order to prevent one stakeholder taking the lead, which can have detrimental consequences for all participants. Utilizing Federated Learning model, where participants share only locally trained models and not local data, could support the trust building and lower the cost of collaboration between the participants. Figure 14 presents the conceptual business model for this kind of manufacturer as AI producer business case.
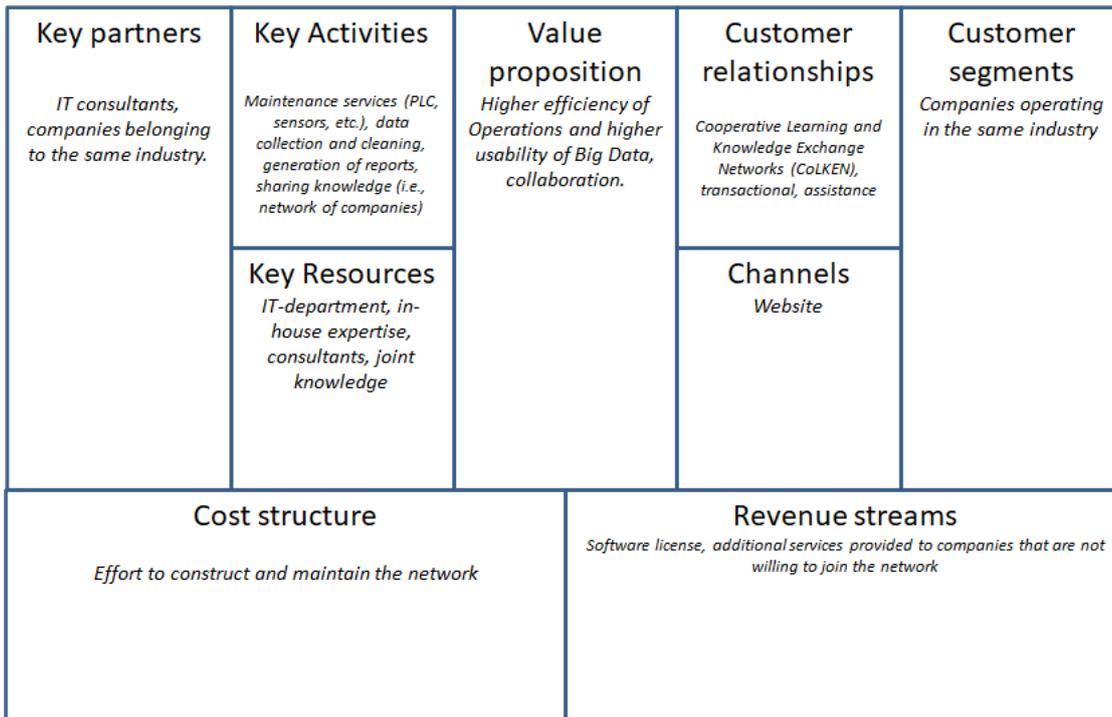
Key partners	Key Activities	Value proposition	Customer relationships	Customer segments
IT consultants, companies belonging to the same industry.	Maintenance services (PLC, sensors, etc.), data collection and cleaning, generation of reports, sharing knowledge (i.e., network of companies)	Higher efficiency of Operations and higher usability of Big Data, collaboration.	Cooperative Learning and Knowledge Exchange Networks (CoLKEN), transactional, assistance	Companies operating in the same industry
	Key Resources IT-department, in-house expertise, consultants, joint knowledge		**Channels** Website	

Cost structure	Revenue streams
Effort to construct and maintain the network	Software license, additional services provided to companies that are not willing to join the network

Figure 14. A conceptual business model for manufacturer as prosumer business case.

8 Conclusions

AI utilization in manufacturing is still in its early stages. Companies see AI providing big opportunities for process improvement and business development, and are currently making the first AI experimentations and implementations to find out how to best take advantage of it. From business development perspective there is currently more expressions of expectations rather than actual results.

Introduction of AI technologies changes the business environment. Each stakeholder in various business networks, value chains and ecosystems need to reconsider and revise their strategies to include the potential impact of AI. In manufacturing context we have identified following key stakeholders or actors: Manufacturers as AI users, AI technology developers as AI solution providers, AI marketplace as connector of manufacturers and AI developers. For each actor type we have identified a couple of alternative roles depending on their potential interests and business ideas regarding AI use or offering. For each of the different actor types and their roles we have developed preliminary business models using the Business model canvas and Platform canvas as base frameworks. These preliminary business models will be refined in the latter part of the project.

The different actor types and their various alternative AI offerings and AI uses may form a network where most likely each actor has to consider several different business models for different business situations. One major consideration is the relationship of the marketplace both with the AI users and providers, e.g., on the division of responsibilities. The technological concept of the knowlEdge project aims at decentralized structure, but from business perspective there may be a need to have one actor in central role (e.g. as a marketplace operator) in the network. This issue is still open and will be considered in the latter part of the project.

Annex A: History

Document History	
Versions	5.1.2022 first draft 0.1 19.1.2022 updated structure and first models 0.2 - continuous update of v0.2 jan-mar 30.3.2022 v1.0, first full version 21.4.2022 review comments 3.5.2022 final version 1.1.
Contributions	- Ideas, concepts and feedback for business models from task group partners - Business model survey responses (8 out of 11 partners) - reviewer comments

Annex B: References

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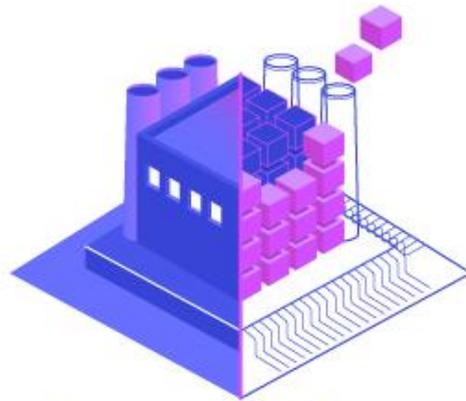
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