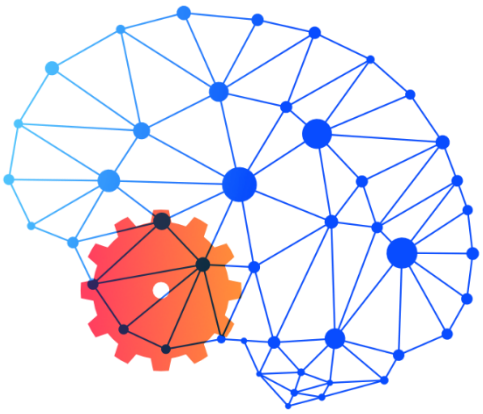

capri

Cognitive Automation Platform for European PRocess Industry digital transformation

Deliverable

D7.2 Initial Report: Business Models Inventory

Deliverable Lead: MONDRAGON SISTEMAS DE INFORMACIÓN (MSI)

Deliverable due date: 31/05/2022 (M26)

Actual submission date: 31/05/2022

Version: 4.0

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Document Control Page	
Title	Initial Report: Business Models Inventory
Lead beneficiary	MSI
Description	The current deliverable is for identifying the key customer segments and analysing the markets they are in. Deliverable 7.2 presents a preliminary draft of the CAPRI Business Models inventory, which will be further refined during the project.
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EXECUTIVE SUMMARY / ABSTRACT SCOPE

Exploitation activities aim at successfully implementing the project results in research and industry, whereas the market uptake measures aim to ensure the market adoption of the products developed in the project.

These tasks are involved in work package 7 of CAPRI project. Training, Replicability and Exploitation (WP7) have been carried out from the end of the first year (M12) of the project and will continue until the end (M42).

The current Report is related to Task 7.1 – Exploitation and business plan development (M12-M42). As the task is going to be executed along the whole project, four reports will be done with the aim of having some first estimation about the exploitation results at the middle of the project. The four reports that make up of Task 7.1 are shown below:

- D7.1 - Initial Report Plan for Dissemination and Exploitation of Results (M24)
- **D7.2 - Initial Report: Business Models inventory (M26) [Current Report]**
- D7.5 - Final Report: Plan and Actions for Exploitation of Results (M42)
- D7.6 - Final Report: Business Models Inventory (M42)

The development of the exploitation plan strategy is led by MSI, with the help and collaboration of all partners. It will be updated to ensure its continued alignment with the evolving CAPRI project.

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1 Summary. Deliverable Description

MONDRAGON SISTEMAS DE INFORMACIÓN (MSI) is leading the WP7 efforts acting as the Exploitation and Market Manager of the project, coordinating and supervising all the related activities.

Moreover, all partners have contributed to the exploitation tasks according to their role and will continue doing so by sharing their knowledge through participation in internal exploitation workshops, and later, when the project ends, working on the exploitation of the products and services identified in the market.

A dissemination and exploitation plan serves the purpose to jointly plan, monitor, assess and report on dissemination and exploitation activities. This current version of the **Business Models inventory** will be updated and completed during the project's lifespan and the final version will be delivered by the end of the project, when partners will have reported with enough factual detail on the actual and expected use to be made of technologies and service offerings they are developing, i.e. setting out the strategies and concrete actions planned to enable a clear route to market alongside supporting market analysis corresponding to those technologies and service offerings.

The current deliverable is for identifying the key customer segments and analysing the markets they are in. Deliverable 7.2 presents a preliminary draft of the CAPRI Business Models inventory, which will be further refined during the project.

Currently 8 Key Exploitable Results have been identified (Deliverable 7.1) and the Osterwalder's canvas methodology has begun for studying potential business models and business environment for the CAPRI different sectors (Asphalt, Steel, Pharma and CAP).

Potential **Business models** will be developed and considered, using the mentioned methodology. Information on customer segments and market, value propositions, revenue streams and needs for resources and activities among other characteristics will be analysed.

This deliverable also presents the scheduled activities for the next year and analyses the upcoming steps.

The outline of the deliverable is as follows:

- **Chapter 1 Summary**, which provides the overall description of the deliverable.
- **Chapter 2 Introduction,** which identifies the framework of CAPRI project upon which the business planning will take place.
- **Chapter 3 Methodology,** describing the Methods and Tools for project exploitation.
- **Chapter 4 Initial market analysis**, providing an overview of the market and initial insights into the market at this stage in the project.
- **Chapter 5 Initial Canvas Business Models**, showing first iteration of canvas business models for results available to date.
- **Chapter 6 Conclusions,** which provides an overview of the scheduled upcoming activities and responsibilities.

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2 Introduction. CAPRI project.

The overall objective of CAPRI is to develop, test and experiment an innovative **Cognitive Automation Platform (CAP)** for achieving Process Industry Digital Transformation enabled by **Cognitive Solutions** that provide existing process industries **flexibility of operation**, **improvement** of **performance** across different Key Performance Indicators (KPIs) and state of the art quality control of its products and intermediate flows.

The CAP encompasses a methodology for governing six **Digital Transformation pathways, 6Ps** in short *(Product, Process, Platform, Performance, People, Partnership*), a Reference Architecture with four levels of cognitive human-machine interaction (industrial IoT connections, smart events processing, knowledge data models and AI-based decision support), a set of reference implementations both commercial and open source for batch, continuous and hybrid process industry plants and a toolbox of cognitive solutions for planning, operation, control and sensing.

CAP prototypes will be modular and scalable, so that advanced applications could be developed and integrated on top of it and its validation will take place addressing manufacturing challenges in industrial operational environments of three relevant process sectors: **asphalt, steelmaking and pharma** industry.

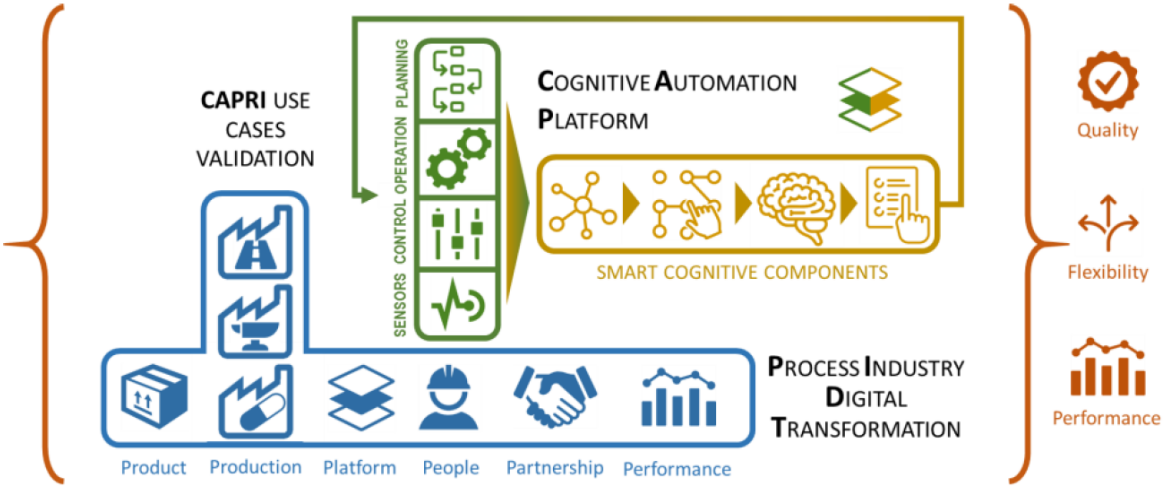

Figure 1: CAPRI main objective concept

This Cognitive Automation Platform will coordinate a set of specific **cognitive solutions** at the various levels of functional organisation of the automation (from planning to sensors). Based on the analysis of the different use cases involved in **CAPRI** project (**asphalt concrete manufacturing, pharma tablets manufacturing and steel billets and bars**), the consortium has identified a list of preferred cognitive solutions that are briefly presented in the following table organised at the different function levels (from planning to control). An analysis of the market will be done with the aim of introducing these cognitive solutions into the market and being exploitable.

Table 1: CAPRI Cognitive Solutions

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Cognitive	[SECTOR] Cognitive solution
planning tools	[MINERALS] Cognitive planning of asphalt plant for production capacities modelling, optimal concatenation of daily orders, reducing downtime and re-planning of emergencies.
	[STEEL] Smart scheduling based on digital twins for monitoring and prediction of steel bar production processes.
operations tools	[MINERALS] Optimal production for plant warm-up and strategies to avoid minimal hot aggregate waste. Influence of recycled asphalt usage in plant operation. [MINERALS] Predictive maintenance of baghouse based on cognitive sensors and expert knowledge.
	[STEEL] Rerouting for deficient steel products based on digital twins.
	[CHEMICAL] Material tracking through the full manufacturing line by linking the real-time data management system with modelling of the residence time distribution.
control approaches	[MINERALS] Advance cognitive control of drum based on Model Predictive Control (MPC) including drying rotation speed and drying and fume temperatures.
	[STEEL] Dynamically adapted control strategies for steel bars represented by digital twins using model predictive and machine learning control.
	[CHEMICAL] MPC for all critical quality attributes (as dissolution), based on self-adapting process models and machine learning.
sensors	[MINERALS] Automated measurement of bitumen content in recycled asphalt. [MINERALS] Humidity and particle size of sand silos.
	[STEEL] Cognitive steel sensors (CSS) for tracking of steel billets and bars (CSS1), initial state of solidified billets after casting (CSS2), temperature evolution in subsequent downstream steps (CSS3), scale formation (CSS4) and prediction of anomalies (CSS5) based on appropriately enabled measurements, first principle and data driven models. [STEEL] Digital twin approach for representing steel products and machines with related quality and process data including cognitive sensor information.
	[CHEMICAL] Soft sensors based on observers for non-measurable signals (such as dryer-internal signals or residual moisture in the different sections) and fault detection.

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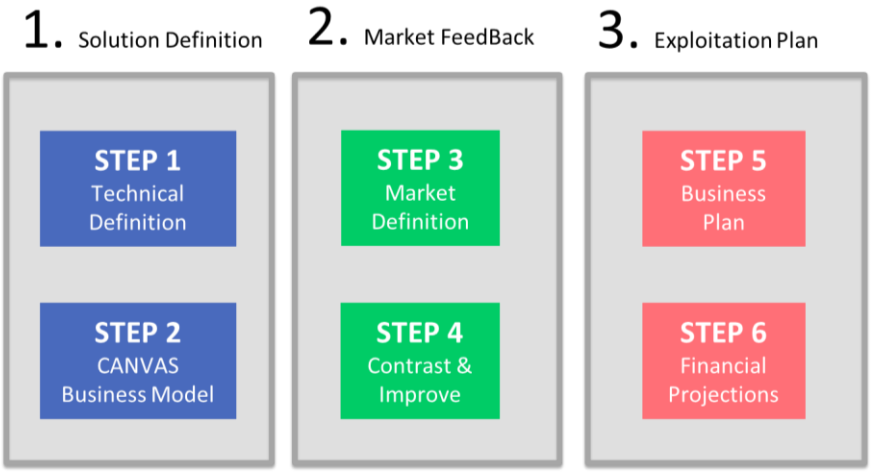
3 Methodology. Methods and Tools for project exploitation

This chapter will explain the important step of designing an exploitation plan. Regarding the methodology used in this Work Package, an exercise for pivoting has been done based on three phases, each composed of 2 steps: Solution definition, Market feedback and Exploitation plan.

Let's begin the study making the following questions:

Solution Definition	• Which project results have high exploitation potential?
Market Feedback	• Is there an accessible market for our exploitable results?
Exploitation Plan	• How are we going to implement the exploitation?

These questions will be answered during the execution of Task 7.1. In this Report, the question related to Market Feedback phase will be worked specifically.



- **Phase I:** Solution definition, focused on identification of available technical solutions in the actual scope of the project and with a first focus on the new market segments. It contains the identification of Key Exploitable Results (KERs). This will be done in a very practical way with a workshop approach with all project partners and applying the available methodologies like Canvas Business Model with special attention to the Value Proposition Definition.

- **Phase II:** Market feedback, aims at defining a new market segment with the similar pains which can be resolved with the developed solutions. An analysis of the macro-economic landscape must be conducted to evaluate the strategic fit of the suggested KERs to the market. This analysis must be validated with a more detailed market study to ensure if this mental scheme is also recognised by players in the market. The market study should be set up in such a way that as a result the Canvas Business Model can be completed in a detailed manner afterwards.

- **Phase III:** Exploitation plan, involves strategic implementation tools to maximise the impact of the project results, then must be checked whether there is an economic viability by estimating the implantation costs and the expected revenues.

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3.1 Key elements to develop a tailored exploitation strategy and plan

A general overview containing some of the key elements to develop and plan a tailored exploitation strategy, involving the three phases, is present below. It represents all the important aspects as well as the timeline relative to CAPRI project progression.

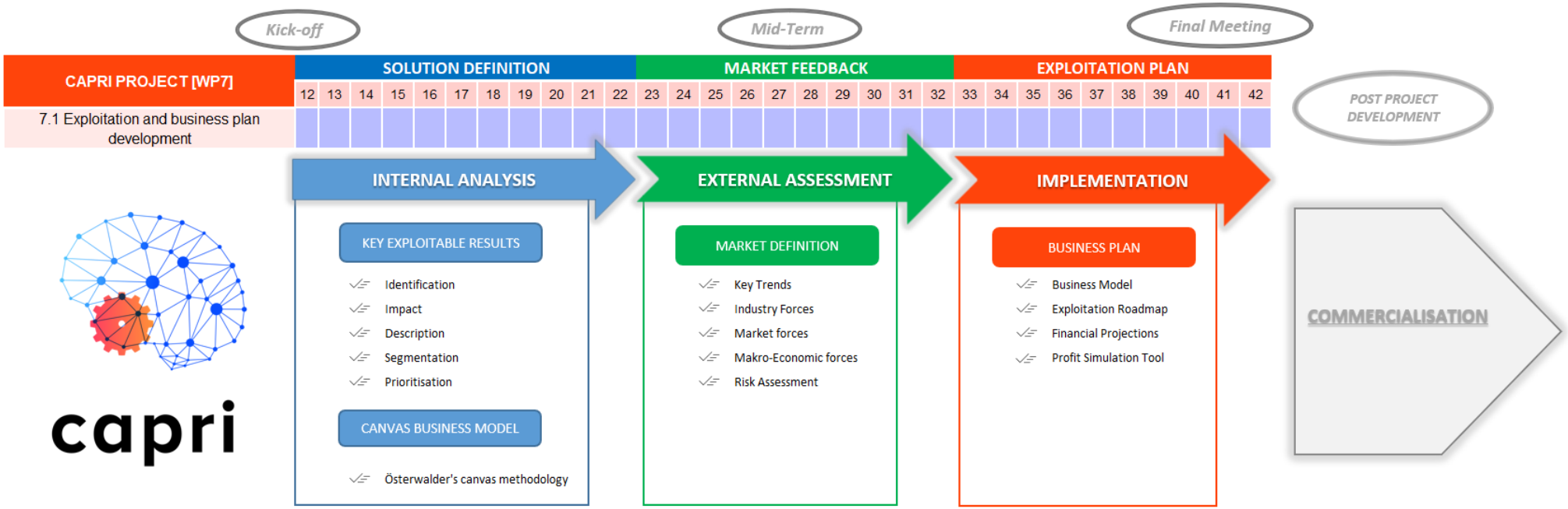

Figure 2: Exploitation Strategy and Plan - Key Elements

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3.2 CANVAS Methodology

The approach for planning and defining the business model key elements in this report is based on following definition by Österwalder (2010): “business model is a translation of a company's strategy into a blueprint of the company's logic of earning money. Which implicates that the company strategy, business models and process models, address similar problems (e.g. those of earning money in a sustainable way) on different business layers”.

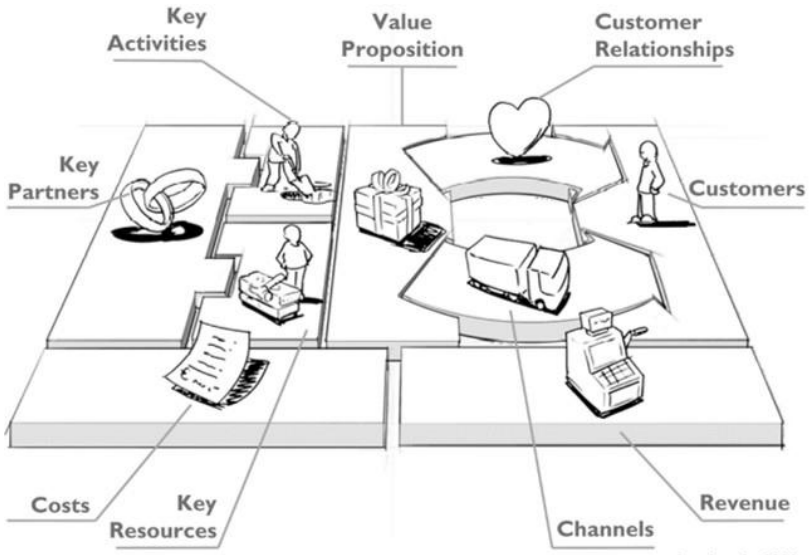

Figure 3: Business Model Canvas as introduced by Österwalder et al. (2010).

3.2.1 Business Environmental analysis methodology

In this deliverable, we try to clarify the trends and the forces related to the four selected CAPRI sectors through Business Environmental analysis (based on the Österwalder et al. 2010).

Österwalder et al. have created the Business Model Environment tool to help in asking specific questions that can uncover new business model ideas. They present the ideas in their Strategyzer blog post (Strategyzer Blog 2015), which we will utilize as the basis of this chapter.

Business models aren’t built in a vacuum. They’re built within a business model environment and are shaped by external forces. For example, business models in healthcare must comply with the EU-level and national regulations. In the entertainment industry, technology has enabled innovative business models to flourish and cater new ways to consume films or music.

Just like an architect who must work with the constraints and advantages of a piece of land, the entrepreneur (or intrapreneur) must pay attention to the business environment to succeed.

However, untapped opportunities are often identified in an ad-hoc and unstructured way. Someone with good intuitions will identify an opportunity that others can't see (e.g. a new technology, an unmet need, a new regulation) and will transform it into a growth engine. But companies cannot rely on someone else's great foresight capabilities for long-term growth. They need a tool to map a clear picture of their environment and identify opportunities, constraints and threats.

A tool called the Business Model Environment (Österwalder 2010) is created to help people map their environment’s forces in a structured and tangible way. This tool is often used during strategic conversations to raise awareness on environmental forces and create a shared understanding across teams. We use the Business Model Environment in the exercise below to uncover insights, associations and patterns that ultimately lead to new business model ideas.

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The Business Model Environment is organized into four areas: Market Forces, Key Trends, Industry Forces and Macro-Economic Forces. These areas surround the Business Model Canvas as they influence the design of the model in the following sense: Unlike the Business Model Canvas blocks, on which the business usually has full control, external forces represent design constraints that one has to work with and adapt to.

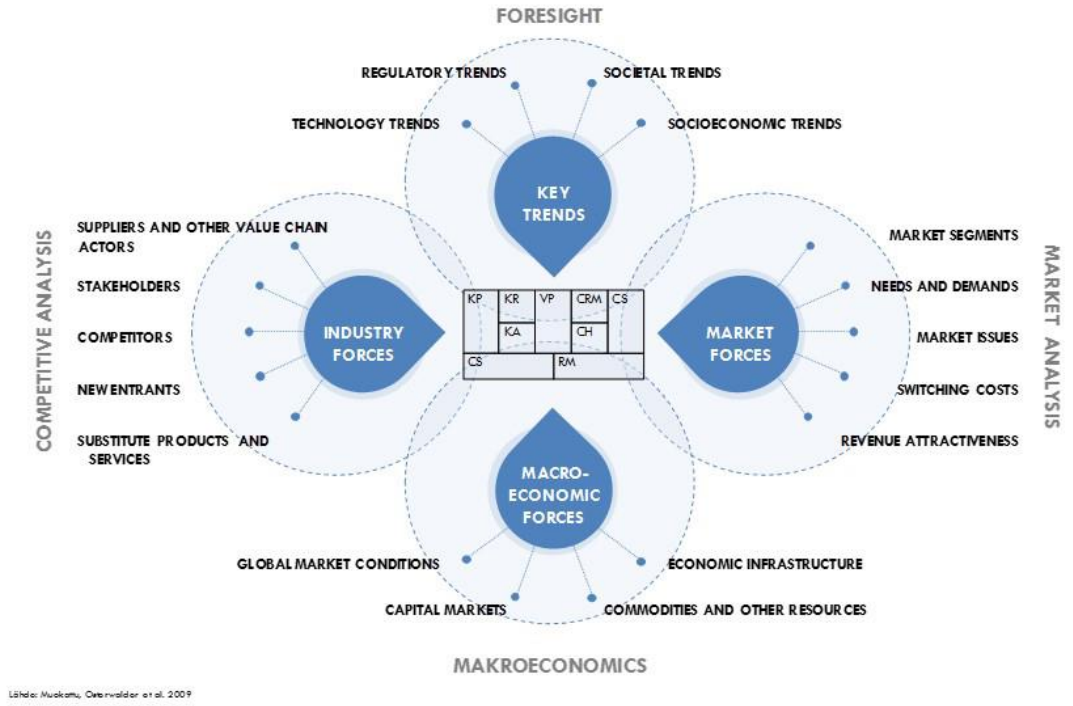

Figure 4: Business Environmental Map introduced by Österwalder et al. (2010).

More detailed definition for the Environmental Map areas are as follows:

Key Trends

Key trends are shaping the business arena, such as technology innovations, regulatory constraints, social trends etc.

- Which emerging technologies are customers adopting?
- How would you characterize income and wealth distribution in your market?
- Describe key societal trends. Which shifts in cultural or societal values affect your business model?

Market Forces

Market Forces are defining the key customer issues in your arena, such as growing or shrinking segments, customer switching costs, changing jobs, pains and gains etc.

- What are the crucial issues affecting the customer landscape?
- Which peripheral segments deserve attention?
- Where are the biggest unsatisfied customer needs?

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Macroeconomic Forces

Macroeconomic Forces include macro trends such as global market conditions, access to resources, high or low commodities prices etc.

- How easy is it to obtain the resources needed to execute your business model (e.g. attract prime talent)?
- How costly are these resources?

Industry Forces

Industry Forces are Key actors in your space such as rising value chain actors, new or fading technology providers etc.

- Who are the dominant players in your particular sector? What are their competitive advantages or disadvantages?
- What business model traditions do substitute products stem from (e.g. high-speed trains versus airplanes, mobile phones versus cameras, Skype versus long-distance telephone companies)?

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4 Initial market analysis

This step is the first stage of the market analysis of the CAPRI project. A market analysis is a quantitative and qualitative assessment of a market. It looks into the size of the market both in volume and in value, the various customer segments and buying patterns, the competition, and the economic environment in terms of barriers to entry and regulation.

4.1.1 Asphalt

As a first stage, an initial characterization of the actual market that the main exploitation partners are attempting is Asphalt.

In Europe there are over 4.000 asphalt production sites and more than 10.000 companies involved in production and/or laying of asphalt (from which 90% of the companies can be classified as Small and Medium sized Enterprises)[1]. Although the Asphalt's market data from 2021 has not been fully disclosed yet, the available data from the European Asphalt Pavement Association (EAPA) shows that the demand for asphalt during the pandemic stayed comparatively steady. For 2020, the total production of hot and warm mix asphalt decreased by 3.7% to 208,3 million tons for EU-27. Nevertheless, when data from Great Britain, Norway, Switzerland and Turkey was added to the equation, the total production was reduced by only 1% to 276,9 million tons. This decline was most likely driven by the Covid-19 crisis, but the complete figures of 2021 will be key to assess the actual impact of the pandemic in the sector[2].

- **Cognitive sensor of bitumen content in recycled asphalt (CAS1)**

  Asphalt pavements are built by using natural recourses including aggregates and binders. These resources are limited and therefore recycling of Reclaimed Asphalt Pavement (RAP) is important for sustainable development. According to the Brundtland definition, sustainability entails "*Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs*"[1]. Given that asphalt pavement is 100% re-usable/recyclable, sustainable development on this matter is at our reach. Also, this indicates that RAP is an important tool within the construction sector, to meet the challenging objectives of circular economy, which the European Commission included in "The European Green Deal".

  According to the asphalt figures of 2020, RAP was used in 17 of the European countries providing data: Austria, Belgium, Croatia, Czech Republic, Denmark, Finland, France, Germany, Great Britain, Hungary, Ireland, Norway, Romania, Slovakia, Slovenia, Spain and Turkey. The total amount used in these countries was 46,4 million tons, being that the leading countries were Germany at 11,6 million tons (25% of the total), France at 6 million tons (13%) and Great Britain at 5 million tons (11%). Moreover, in 14 of these European countries (Czech Republic, Denmark, Finland, France, Germany, Great Britain, Hungary, Ireland, Norway, Romania, Slovakia, Slovenia, Spain and Turkey) data showed that reclaimed asphalt was used for a variety road building tasks. A total of 27,4 million tons of reclaimed asphalt was available, out of which 64% was re-used, 33% was recycled and only 3% was used on unknown applications or sent to landfill[2]. Thus, the overall usage of RAP in asphalt production has been increasing over the years, which boosts the need for proper technology to measure RAP's characteristics.

  According to EAPA[3] the promotion of increased re-use/recycling of asphalt mixes and constructive evaluations of the suitability must be combined with technical innovation and enhanced quality management systems in order to generate a product that retains the

[1] https://eapa.org/eapa/
[2] https://www.worldhighways.com/wh6/news/europes-steady-demand-asphalt
[3] *Industry Statement on the recycling of asphalt mixes and use of waste of asphalt pavements*, EAPA, May 2004.

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potential for 100% re-usability of RAP. Nevertheless, for the particular case of *ex-situ* asphalt recycling processes (RAP excavated from the road is transported to processing units/plants in order to be used as an ingredient in fresh asphalt mixtures), careful assessment of RAP feedstock is necessary in order to ensure it is added in the right proportions to the new materials as to deliver the necessary performance[4]. This includes careful consideration of the amount of bitumen already present in RAP. In this context, CAS1 presents itself as an innovative solution, not commercially available, that allows non-destructive and real-time measurement of the content of bitumen in RAP, allowing for immediate savings in virgins materials, which will ultimately lead to the increase in the usage of RAP.

To evaluate the size of CAS1 potential market, the figures on the asphalt production sites evolution on the usage of RAP are presented in Table 2. As it can be seen, at European level there has been a general increase in plants fit for re-use of RAP in asphalt production, especially in Spain. The expectation is that more and more plants will be made fit for such purpose, since accordingly to EAPA 'the goal should be to achieve 100%' RAP usage[5].

Table 2: Number of asphalt production sites that re-use/recycle RAP per country[6].

Country	Plants fit for hot and warm RAP re-use		
	2018	2019	2020
Austria	no data	85	90
Czech Republic	76	77	78
France	>350	>370	>370
Germany	580	549	538
Great Britain	>165	>165	170*
Italy	380	no data	no data
Netherlands	36*	no data	no data
Spain	25	25	114
Switzerland	no data	80	80*
Turkey	15*	15*	no data

(*Numbers estimated based on historic data)

Due to the nature of CAS1 and that it is a novelty on the field, there are no competitors in the market (therefore no information on section 4.1.1.2). Nevertheless, there are three different segments of stakeholders to be considered (see section 4.1.1.1 and 4.1.1.4): asphalt manufacturing companies, asphalt associated engineering companies and sensor manufacturing companies. Due to the huge number of plants that potentially can profit from CAS1 innovation (at least 1700 in 2020[6], even more estimated by 2022), the stakeholder's analysis is focused on the countries that have more plants fit for RAP re-use according to Table 2 (France, Germany, Great Britain and Spain). Moreover, since in each of such countries there are a lot of companies working in the area, the stakeholder's considered are asphalt associations of such countries, since this type of associations are connected to all major players in the area and, therefore, will be able to disseminate the information through the possibly interested companies in their country in an effective way.

[4] *Asphalt the 100% recyclable construction product*, EAPA, June 2014.
[5] *Arguments to stimulate asphalt reuse and recycling*, EAPA, May_2008.
[6] https://eapa.org/asphalt-in-figures/

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- **Cognitive sensor for particle size measurement or Cognitive sensor of filler amount (CAS2)**

One important role in asphalt mixture performances is represented by the filler content and characteristics. The efficiency of the asphalt plants collectors is determined by the design of the collector, the operating conditions, and the characteristics of the particulates to be collected. Thus, a cognitive sensor to determine filler (dust) amount which is removed from the cold feeder is very important to define the variability related to the efficiency of the filler collection system and the nature of the cold feed aggregate. Also, this sensor will aim to synchronize the operation of the dryer and the baghouse with the feed to the hot bin or the hot elevator.

To evaluate the size of CAS2 potential market, not only the figures on the asphalt production sites have to be taken into account, but also other industrial sectors will be considered. Application examples of measured products may be:

- Materials: All dust, powders, granulates, panels, threads etc. Also, sticking, or abrasive materials.
- Industries: Building materials industry, cement or lime industry, production of ceramics, etc.

We will focus the market analysis on construction materials industry, i.e., cement and lime industries, which are very important to the EU's economy. Cement products are essential for construction and civil engineering, while lime is irreplaceable for the steel industry, as well as construction materials, paints, plastics, and rubber.

Cement manufacturers market in Europe (CEMBUREAU, European Cement Association):

The European Cement Association based in Brussels is the representative organisation of the cement industry in Europe. Currently, its Full Members are the national cement industry associations and cement companies of the European Union (except for Malta and Slovakia) plus Norway, Switzerland, Turkey and the United Kingdom. Croatia and Serbia are Associate Members of CEMBUREAU. Cooperation agreements have been concluded with Vassiliko Cement in Cyprus and UKRCEMENT in Ukraine.

The major players in the industry are Holcim Ltd., HeidelbergCement AG, CRH plc, Vicat Group, Buzzi Unicem SpA., CEMEX, S.A.B. de C.V, Cementir Holding N.V., and Titan Cement International S.A., among others.

In below figure we can see world cement production figures in 2019:

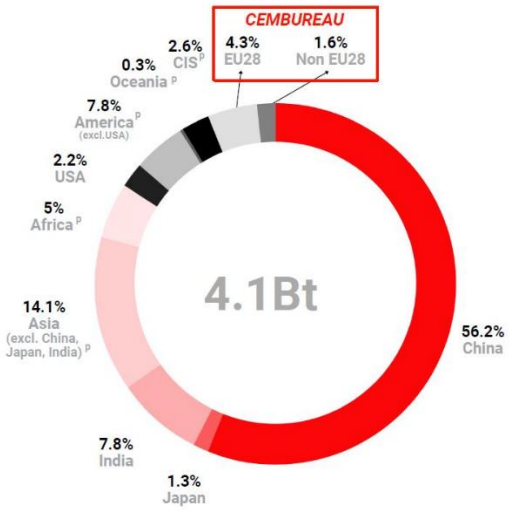

Figure 5: World cement production 2019, by region and main countries, % Estimations

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Lime manufacturers market in Europe (Eula, European Lime Association):

EuLA, the European Lime Association, was set up in 1990 to provide sector-based representation for the European lime industry before the European institutions. EuLA supports realising the vision of the lime sector.

Membership to EuLA is open to EU national associations representing the lime industry

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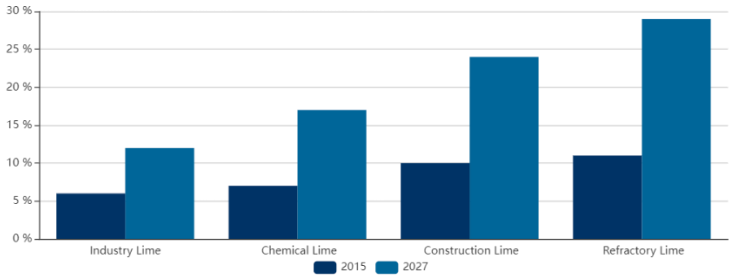
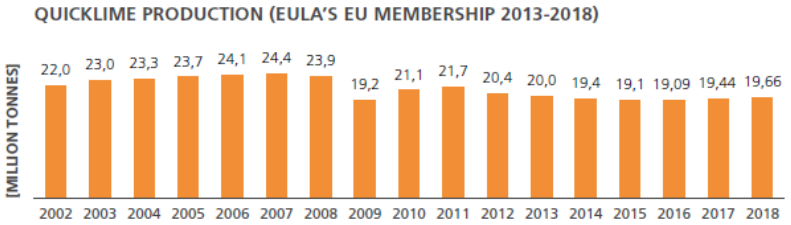
Austria	Fachverband der Stein- und Keramischen Industrie
Belgium	Fediex
Bulgaria	Plena Bulgaria
Croatia	Intercal d.o.o.
Czech Republic	Czech Lime Association
Denmark	Faxe Kalk
Estonia	Nordkalk
Finland	Finnish Lime Association
France	Union des Producteurs de Chaux (UP' Chaux)
Germany	Bundesverband der Deutschen Kalkindustrie
Greece	Yioi Th Tsarouha OE
Hungary	Carmeuse Hungaria Kft
Ireland	Clogrennane Lime Ltd
Italy	Unicalce SPA and Fassa SRL
Norway	Franzefoss Minerals A/S
Poland	The Polish Lime Association
Portugal	Lhoist Iberica, Lusical, Calcidrata
Slovakia	Carmeuse Slovakia s.r.o
Slovenia	IGM d.o.o.
Spain	Ancade
Sweden	Svenska Kalkföreningen
Switzerland	Kalkfabrik Netsal AG
United Kingdom	British Lime Association





Note: this graph shows quicklime production, which is reported by EuLA members for membership purposes.

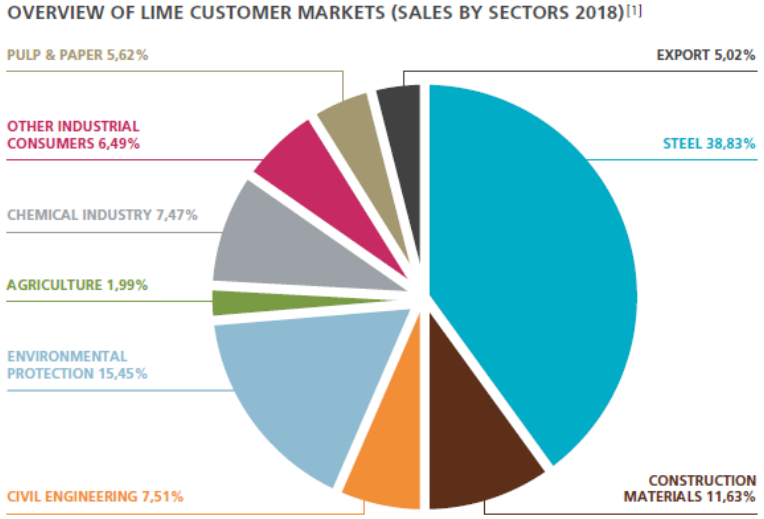


Figure 6: Lime manufacturers market in Europe

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4.1.1.1 Stakeholders' analysis

Table 3: Asphalt Stakeholders' analysis

Stakeholder Name	Impact How much does the project impact them? (Low, Medium, High)	Influence How much do they have over the project? (Low, Medium, High)	What is important to the stakeholder?	How could the stakeholder contribute to the project?	How could the stakeholder block the project?	Strategy for engaging the stakeholder
EIFFAGE *(Spain) [CAS1]*	*High*	*Medium*	*New solution for the measurement of bitumen content in RAP*	*Host institution and partner in the development*	*By leaving the project, not providing RAP samples and laboratory analysis, or by blocking the access to the plant*	*Continuous development with the stakeholder involved*
EIFFAGE *(Spain) [CAS2]*	*Medium*	*Medium*	*New solution for the measurement of filler extracted in the drying drum in real time*	*Host institution and partner in the development*	*Blocking the access to the data from the plant*	*New solution with good results, continuous support to enhance the product.*
EAPA *(Europe) [CAS1]*	*High*	*Low*	*New solution for the measurement of bitumen content in RAP*	*Dissemination of the new solutions amongst European Stakeholders in general*	-	*Dissemination of the project's work and invitation for a workshop*
EAPA *(Europe) [CAS2]*	*Medium*	*Low*	*New solution for the measurement of filler extracted in the drying drum in real time*	*Dissemination of the new solutions amongst European Stakeholders in general*	-	*Dissemination of the project's work and invitation for a workshop*

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Asefma *(Spain) [CAS1] https://www.asefma.es*	*High*	*Low*	*New solution for the measurement of bitumen content in RAP*	*Dissemination of the new solutions amongst Spanish Asphalt mix manufacturers*	-	*Dissemination of the project's work and invitation for a workshop*
Asefma *(Spain) [CAS2] https://www.asefma.es*	*Medium*	*Low*	*New solution for the measurement of filler extracted in the drying drum in real time*	*Dissemination of the new solutions amongst Spanish Asphalt mix manufacturers*	-	*Dissemination of the project's work and invitation for a workshop*
DAV *(Germany) [CAS1] https://www.asphalt.de*	*High*	*Low*	*New solution for the measurement of bitumen content in RAP*	*Dissemination of the new solutions amongst German Asphalt mix manufacturers*	-	*Dissemination of the project's work and invitation for a workshop*
DAV *(Germany) [CAS2] https://www.asphalt.de*	*Medium*	*Low*	*New solution for the measurement of filler extracted in the drying drum in real time*	*Dissemination of the new solutions amongst German Asphalt mix manufacturers*	-	*Dissemination of the project's work and invitation for a workshop*
MPA *(UK) [CAS1] https://www.mineralproducts.org*	*High*	*Low*	*New solution for the measurement of bitumen content in RAP*	*Dissemination of the new solutions amongst Britain Asphalt mix manufacturers*	-	*Dissemination of the project's work and invitation for a workshop*
MPA *(UK) [CAS2] https://www.mineralproducts.org*	*Medium*	*Low*	*New solution for the measurement of filler extracted in the drying drum in real time*	*Dissemination of the new solutions amongst Britain*	-	*Dissemination of the project's work and invitation for a workshop*

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				Asphalt mix manufacturers		
Routes de France *(France) [CAS1] https://www.routesdefrance.com*	*High*	*Low*	*New solution for the measurement of bitumen content in RAP*	*Dissemination of the new solution amongst French Asphalt mix manufacturers*	-	*Dissemination of the project's work and invitation for a workshop*
Routes de France *(France) [CAS2] https://www.routesdefrance.com*	*Medium*	*Low*	*New solution for the measurement of filler extracted in the drying drum in real time*	*Dissemination of the new solutions amongst French Asphalt mix manufacturers*	-	*Dissemination of the project's work and invitation for a workshop*
INTRAME *(España) [CAS1] https://www.intrame.com/*	*High*	*Low*	*New solution for the measurement of bitumen content in RAP*	*Dissemination of the solution to their clients*	-	*Dissemination of the project's work and invitation for a workshop*
INTRAME *(España) [CAS2] https://www.intrame.com/*	*Medium*	*Low*	*New solution for the measurement of filler extracted in the drying drum in real time*	*Dissemination of the solution to their clients. Offer this sensor in the new plants*	-	*Dissemination of the project's work and invitation for a workshop*
Ammann *(Switzerland) [CAS1] https://www.ammann.com/en/plants/asphalt-plants*	*High*	*Low*	*New solution for the measurement of bitumen content in RAP*	*Dissemination of the solution to their clients*	-	*Dissemination of the project's work and invitation for a workshop*
Ammann *(Switzerland) [CAS2] https://www.ammann.com/en/plants/asphalt-plants*	*Medium*	*Low*	*New solution for the measurement of filler extracted in the drying drum in real time*	*Dissemination of the solution to their clients. Offer this*	-	*Dissemination of the project's work and invitation for a workshop*

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				sensor in the new plants		
Benninghoven *(Germany) [CAS1] https://www.wirtgen-group.com/ocs/en-de/benninghoven/asphalt-mixing-plants-187-c/*	*High*	*Low*	*New solution for the measurement of bitumen content in RAP*	*Dissemination of the solution to their clients*	-	*Dissemination of the project's work and invitation for a workshop*
Benninghoven *(Germany) [CAS2] https://www.wirtgen-group.com/ocs/en-de/benninghoven/asphalt-mixing-plants-187-c/*	*Medium*	*Low*	*New solution for the measurement of filler extracted in the drying drum in real time*	*Dissemination of the solution to their clients. Offer this sensor in the new plants*	-	*Dissemination of the project's work and invitation for a workshop*
Parker *(UK) [CAS1] https://www.parkerplant.com/asphalt*	*High*	*Low*	*New solution for the measurement of bitumen content in RAP*	*Dissemination of the solution to their clients*	-	*Dissemination of the project's work and invitation for a workshop*
Parker *(UK) [CAS2] https://www.parkerplant.com/asphalt*	*Medium*	*Low*	*New solution for the measurement of filler extracted in the drying drum in real time*	*Dissemination of the solution to their clients. Offer this sensor in the new plants*	-	*Dissemination of the project's work and invitation for a workshop*
Raytek *(USA)[CAS1] https://www.raytek-direct.com/content/our-stores*	*High*	*Low*	*New solution for the measurement of bitumen content in RAP*	*Show interest in the technology*	-	*Dissemination of the project's work and invitation for a workshop*
Raytek *(USA)[CAS2] https://www.raytek-direct.com/content/our-stores*	*Medium*	*Low*	*New solution for the measurement of filler extracted in the drying drum in real time*	*Show interest in the technology*	-	*Dissemination of the project's work and invitation for a workshop*

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***Baumer** (Germany) [CAS1] https://www.baumer.com/de/en/*	*High*	*Low*	*New solution for the measurement of bitumen content in RAP*	*Show interest in the technology*	-	*Dissemination of the project's work and invitation for a workshop*
***Baumer** (Germany) [CAS2] https://www.baumer.com/de/en/*	*Medium*	*Low*	*New solution for the measurement of filler extracted in the drying drum in real time*	*Show interest in the technology*	-	*Dissemination of the project's work and invitation for a workshop*
***Polytec** (Germany) [CAS1] https://www.polytec.com/int*	*High*	*Low*	*New solution for the measurement of bitumen content in RAP*	*Show interest in the technology*	-	*Dissemination of the project's work and invitation for a workshop*
***Polytec** (Germany) [CAS2] https://www.polytec.com/int*	*Medium*	*Low*	*New solution for the measurement of filler extracted in the drying drum in real time*	*Show interest in the technology*	-	*Dissemination of the project's work and invitation for a workshop*
***OXYCOMB** [CAS2]*	*Medium*	*Low*	*New solution for the measurement of filler extracted in the drying drum in real time*	*Show interest in the technology*	-	*Dissemination of the project's work and invitation for a workshop*

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4.1.1.2 Competitors analysis

CAS1 is an innovative sensor for which there are not competitors in the market, as there is no sensor commercially available to accomplish the same task. Due to this situation, only CAS2 competitors are detailed in the next table.

Table 4: Asphalt Competitors analysis

Direct Competitors		**Company 1**	**Company 2**	**Company 3**
Company Profile	**Company Highlights**	Mütec Instruments	Dr. Födisch	Oxycomb
Key Competitive Advantage		Predictive Maintenance. Quality Control. Operational Efficiency. Workforce Safety	Predictive Maintenance. Quality Control. Operational Efficiency. Workforce Safety	Predictive Maintenance. Quality Control. Operational Efficiency. Workforce Safety
Target Market	**Market Information**	Asphalt plants, cement, and lime factories, etc.	Asphalt plants, cement, and lime factories, etc.	Asphalt plants, cement, and lime factories, etc.
Products & Services	**Product Information**	Sensor for measure the amount of dust through a pipe	Sensor for measure the amount of dust through a pipe	Sensor for measure the amount of dust through a pipe
Pricing		Custom quotation	Custom quotation	Custom quotation
Strengths	**SWOT Information**	Warranty at high particles flow. The installation is simple and cost effective.	Warranty at high particles flow. The installation is simple and cost effective	Warranty at high particles flow. The installation is simple and cost effective
Weaknesses		Data transmission (connectivity, etc.)	Data transmission (connectivity, etc.)	Data transmission (connectivity, etc.)
Opportunities		Open-source hardware, open to customization	Open-source hardware, open to customization	Open-source hardware, open to customization
Threats		Vibrations, internet security, weather conditions	Vibrations, internet security, weather conditions	Vibrations, internet security, weather conditions
Trends				

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4.1.1.3 Key Trends analysis

Table 5: Asphalt Key Trends analysis

KER	Trends in consumer Needs and Behaviour	Shifts in consumer perception of value	Trends in Industry cost drivers	Change and evolution of the industry
CAS1	Need for less time-consuming measurement of bitumen in RAP. Need for less human resources involved in the measurement of bitumen in RAP. Need for less usage of solvents in the measurement of bitumen in RAP.	CAS1 will allow for real-time optical measurement of bitumen in RAP, with no need for solvents and almost no need for human resources (only for maintenance). As so, it will allow for real-time compensation of virgin material. This will entail savings in human resources, equipment, solvents, energy consumption and raw materials. All this savings will compensate for CAS1 price in the short run.	Although the cost of the materials that constitute CAS1 will vary in accordance with the optics market, their overall costs are low and their maintenance very low. Additionally, there are constant developments on the field, lowering even more the costs. These material's low maintenance and longevity are advantages for the asphalt industry.	CAS1 will allow for savings in virgin materials in real-time, will allow for the recycling of bigger amounts of RAP, will allow for savings in human resources, equipment, and energy consumption, and will allow for a safer environment for human resources working in asphalt plants by eliminating the need for the use of dangerous solvents.
CAS 2	A cognitive sensor to determine filler (dust) amount which is removed from the cold feeder is very important to define the variability related to the efficiency of the filler collection system and the nature of the cold feed aggregate	this sensor will aim to synchronize the operation of the dryer and the baghouse with the feed to the hot bin or the hot elevator	The trend of optimization the energy efficiency and raw materials savings, lead to the development of new sensors to measure parameters of the process that before have never been measured.	Predictive Maintenance. Quality Control. Operational Efficiency. Workforce Safety

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4.1.1.4 Market Segments

Table 6: Asphalt Market Segments

Market Segment	***Size*** *How large is this target market? Worth pursuing?*	***Expected Growth*** *Even if the market is small, it may be profitable if there are indications that it will grow.*	***Competitive Position*** *(Low, Medium, High)* *Low competition equals attractive market.*	***Cost to Reach*** *Is this market accessible with our tactics?*	***Compatibility*** *How aligned is this market to our goals?*
Asphalt Associations *(and associated asphalt industries) [CAS1]*	Data provided by EAPA from 2020 shows that at least 1703 asphalt plants in Europe are recycling RAP, although industry trends indicate that in the current year the expect number of plants doing so should be higher.	The indication provided by EAPA is that the asphalt market in Europe is expected to reach the goal of recycling 100% of the RAP produced, as so the market is expected to grow a lot in the next years.	Low	The market is expected to be very accessible since there are no competitors in the field.	Very aligned.
Asphalt Associations (and associated asphalt industries) [CAS2]	Data provided by EAPA from 2020 shows show that there are more than 3000 stationary production sites	According to EAPA, asphalt market in Europe is a stable market with more than 200 million tons of asphalt per year, since more than 10 years ago	Medium	The market is expected to be accessible since competitors in the field cannot warranty measurement in asphalt plants conditions.	Aligned
Asphalt associated engineering companies *[CAS1]*	Four from the five major asphalt plants manufacturers are in Europe. These engineering manufacturers serve most of the asphalt plants in Europe.	The market is big, and it is expected to grow.	Medium	The market is expected to be very accessible since there are no competitors in the field.	Very aligned.

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Asphalt associated engineering companies *[CAS2]*	Four from the five major asphalt plants manufacturers are in Europe. These engineering manufacturers serve most of the asphalt plants in Europe.	The market is big, and it is expected to grow.	Medium	The market is expected to be accessible since competitors in the field cannot warranty measurement in asphalt plants conditions.	Aligned.
Sensors Manufacturers *[CAS1]*	The sensor market is very large. Nevertheless, CAS1 is a costume solution designed only for the asphalt industry. As so sensors manufacturers must be attracted to the asphalt industry.	The market is big, and it is expected to grow.	Medium	The market is expected to be very accessible since there are no competitors in the field.	Slightly aligned. The sensors manufacturers must have interest in the asphalt industry.
Sensors Manufacturers *[CAS2]*	The sensor market is very large. Nevertheless, CAS2 is a costume solution designed initially only for the asphalt industry. As so sensors manufacturers must be attracted to the asphalt industry.	The market is big, and it is expected to grow.	Medium	The market is expected to be accessible since competitors in the field cannot warranty measurement in asphalt plants conditions.	Slightly aligned. The sensors manufacturers must have interest in the asphalt industry.

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4.1.2 Steel

In the fourth quarter of 2021 EU apparent steel consumption increased for the fifth consecutive time in a row (+9.5%), albeit at a lower rate than in the third quarter (+14.3%) due to the impact of severe supply chain issues and rising energy prices[7].

Apparent steel consumption amounted to 36.3 million tonnes (35.9 million tonnes in the third quarter). The whole year 2020 was considerably impacted by the COVID-19 pandemic and saw apparent steel consumption in the EU plummet (-10.7%, almost unchanged compared to the previous Outlook) for the second consecutive year after the slump (-5.2%) already seen in 2019. In 2021 apparent steel consumption rebounded (+15.2%, revised upwards from +13.8% in the previous Outlook) after the deep recession (-10.7%) experienced in 2020 caused by the pandemic.

However, ongoing supply chain issues and the war in Ukraine are set to take their toll on apparent steel consumption: in 2022 it is expected to see its third annual recession over the last four years, albeit moderate (-1.9%), as a result of quarterly drops forecast in the second and the third quarters of 2022. Apparent consumption is set to recover in 2023 (+5.1%), but the overall evolution of steel demand remains subject to a high level of uncertainty, which is likely to continue to undermine demand from steel-using sectors. Domestic deliveries also recorded growth in volumes over the fourth quarter of 2021, albeit very modest (+0.6%, after +6.5% in the third quarter), reflecting the slowdown in demand within the EU over the second half of 2021.

Over the entire 2021, deliveries sharply rebounded (+10.7%), following the pronounced drop of 2020 (-9.6%) which marked the second consecutive decline in yearly terms after 2019 (-4.2%). Imports – including semi-finished products – into the EU continued their dramatic surge also over the fourth quarter of 2021 (+43%, after +48% and +45% in the third and second quarter respectively). With the exception of the second quarter figure reflecting the comparison with the heavy impact of the pandemic the year before, import penetration has therefore remained considerably high. As a result, in 2021 imports from third countries significantly rose (+32%) after two consecutive drops (-17.1% in 2020 and -10.9% in 2019), mirroring the improvement in steel demand.

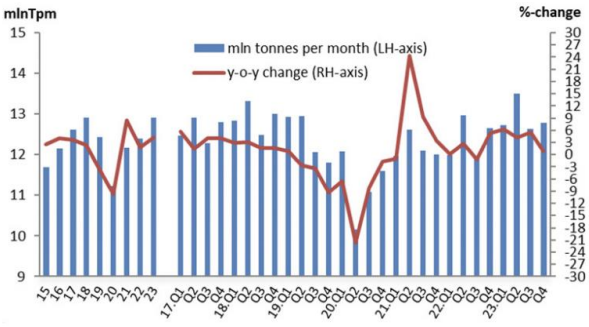

Figure 7: EU real steel consumption

European total production of steel via the route of electric steelmaking and continuous casting with subsequent reheating, rolling and finishing treatment accumulates to about **66 Mton/y (42.6% of the total crude steel production).**

- **Steel product tracking (CSS1)**

The steel production is a very energy consuming process, accounting for 5.7% of CO2 emissions of the European Union, so that even small reductions in the number of defective items produced can lead to substantial savings in economic and ecological terms.

[7] EUROFER_ECONOMIC_REPORT_Q2_2022-23_final.pdf

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Most steel production plants are already equipped with some kind of monitoring systems that record a significant amount of processing data, which could be exploited for process improvements and reduction of defects. However, it is usually not possible to correlate process data with product quality information due to a lack of tracking data, in particular for steel long products which are difficult to track due to the harsh environmental conditions and their different sizes and forms.

- **Continuous casting solidification sensor (CSS2)**

The continuous casting solidification sensor provides insights into the casting process that cannot easily be obtained by direct measurements, such as the position of the solidification front and the 3D temperature field in the casting strands. Together with the temperature field, it assigns information from the liquid steelmaking and casting processes to the digital twins of the individual semi-products cut from the strands (billets), making them available for later evaluation. Since casting is a critical process in terms of product quality and costs, this is an important enhancement of the monitoring capabilities.

Similar solidification models are already in use at commercial steel plants and their integration into a digital twin concept makes the information more valuable and useful.

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4.1.2.1 Stakeholders' analysis

Table 7: Steel Stakeholders' analysis

Stakeholder Name	*Impact* **How much does the project impact them?** *(Low, Medium, High)*	*Influence* **How much do they have over the project?** *(Low, Medium, High)*	**What is important to the stakeholder?**	**How could the stakeholder contribute to the project?**	**How could the stakeholder block the project?**	**Strategy for engaging the stakeholder**
Producers of long steel products (e.g., SIDENOR)	*Medium (CSS2)* *High (CSS1)*	*High (both)*	CSS1: Relate process data to quality data CSS2: include liquid steel making and casting data in optimization of downstream processes	Provision of production data for development and evaluation	--	Project partner
Software supplier (e.g., MSI)	*Medium*	*High*	New demonstrator for cognitive solutions	Development and integration	--	Project partner
Research institute (e.g., BFI)	*High*	*High*	New demonstrator for cognitive solutions, new concepts and applications	Development and integration of process models	--	Project partner
Plant supplier	*High (CSS1)* *Low (CSS2)*	*High (CSS1)* *Low (CSS2)*	New application (steel long products tracking) (CSS1) New application for integration of process models (CSS2)	Supply of and support for tracking system (CSS1) -- (CSS2)	--	Subcontractor (CSS1) -- (CSS2)

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4.1.2.2 Competitors analysis

Table 8: Steel Competitors analysis

Direct Competitors		Company 1	Company 2	Company 3
Company Profile	**Company Highlights**	Plant suppliers (CSS1)	Plant suppliers (CSS2)	Industrial software suppliers (CSS1 + CSS2)
Key Competitive Advantage		-	Not linked to any brand	Not proprietary but Open Source and modular (microservices)
Target Market	**Market Information**	Steel long products	Steel long products	Steel producers, foundries
Products & Services	**Product Information**	Development and installation of customized tracking system	Steel solidification models	Steel solidification models
Pricing		Unknown/very individual	Unknown	Unknown
Strengths	**SWOT Information**	Multiple references in industry	Good Access to market	Omnipresent in Steel industry
Weaknesses		Very particular market, they only supply machine manufacturers, no global solution	Linked to machinery, no global solution	Proprietary solution, no flexibility
Opportunities		Feasibility of accessing through digitization solutions	Transversal approach together with general digitalisation	Introduction of new Technology in traditional sector
Threats		Lack of references in the market	Not be recognised due to lack of references.	No clear differentiation vs “digitalization” solutions
Trends		Industry 4.0	Industry 4.0, Digitalization	Industry 4.0, Digitalization

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4.1.2.3 Key Trends analysis

Table 9: Steel Key Trends analysis

KER	Trends in consumer Needs and Behaviour	Shifts in consumer perception of value	Trends in Industry cost drivers	Change and evolution of the industry
CSS1 + CSS2	Demand for insights into resource consumption for end products / Green steel	Higher value of CO2-neutral products	Energy costs and emission certificates	Decarbonisation + Digitalization, increasing competition
CSS1	Smaller production lots and traceability at unit level instead of batch	Personalised products with “certificates”	Zero defect monitoring and scrap removal as early as possible	Provision of individual quality information across the supply chain

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4.1.2.4 Market Segments

Table 10: Steel Market Segments

Market Segment	Size *How large is this target market? Worth pursuing?*	Expected Growth *Even if the market is small, it may be profitable if there are indications that it will grow.*	Competitive Position *(Low, Medium, High)* *Low competition equals attractive market.*	Cost to Reach *Is this market accessible with our tactics?*	Compatibility *How aligned is this market to our goals?*
Steel long products (CSS1)	In 2020 the EU steel sector produced more than 50 Mt of steel long products,[8] in more than one hundred production sites.[9]	The European steel production has been in decline for some years.	CSS1: Low. There are no off-the-shelve solutions available for tracking of long steel products. CSS2: High. Plant suppliers offer similar models.	Depends on the exploitation strategy	CSS1: Very aligned, there is a high demand for tracking solutions CSS2: aligned, there is a high demand for better observability and quality improvements
Non-iron long products (copper, aluminium, …)	Smaller than steel, but with higher added value creation for specialised industries	Important increase expected due to the need of weight reduction of vehicles.	Unknown	CSS1: Requires adaptations for other alloys and temperature ranges, plant setup CSS2: Requires adaptations for other alloys and casting techniques, causing significant costs.	CSS1: unknown CSS2: unknown

[8] https://www.eurofer.eu/publications/brochures-booklets-and-factsheets/european-steel-in-figures-2021/
[9] https://www.eurofer.eu/about-steel/learn-about-steel/where-is-steel-made-in-europe/

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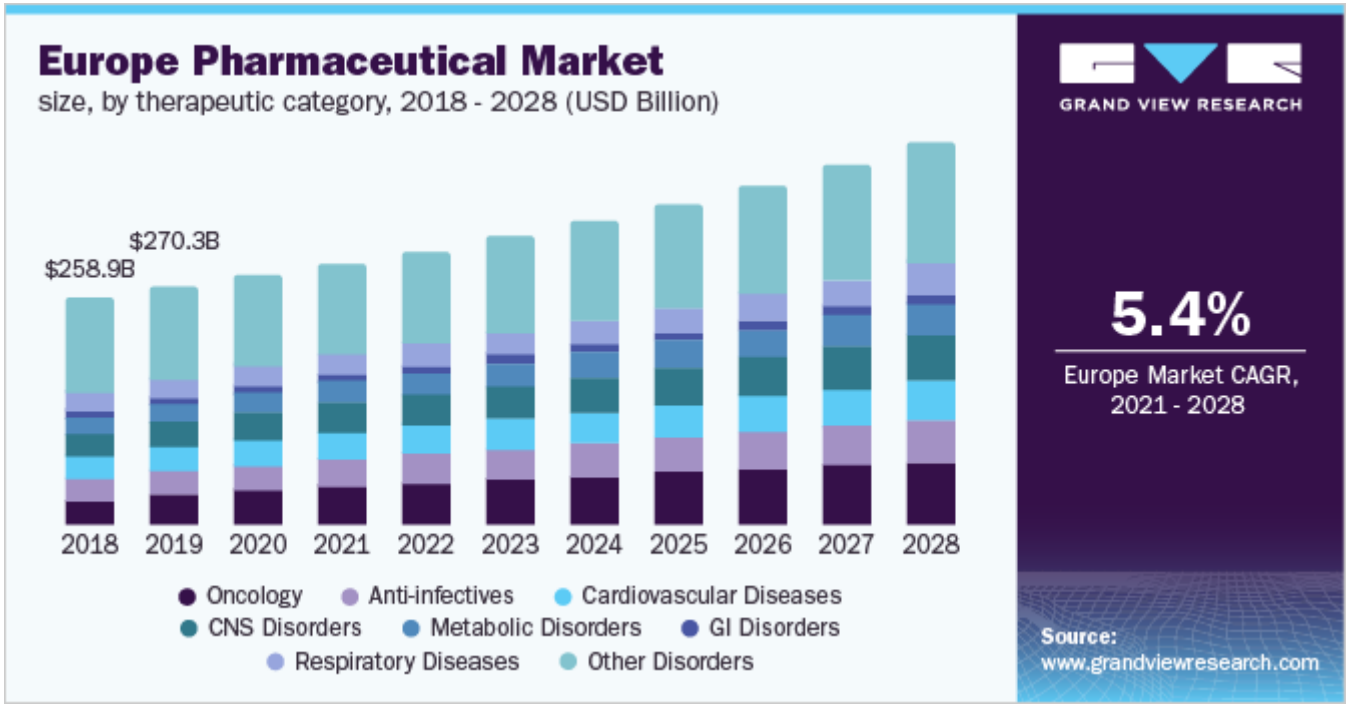
4.1.3 Pharma

The Europe pharmaceutical market size was valued at USD 282.75 billion in 2020 and is expected to expand at a compound annual growth rate (CAGR) of 5.4% from 2021 to 2028. The growth can be attributed to the increasing healthcare expenditure, a surge in R&D investments, and the emergence of biologics and biosimilars. [10]

Furthermore, supportive regulatory framework and reimbursement policies improve the adoption of pharmaceuticals in this region, thus facilitating market growth. The impact of COVID-19 has been variable on the industry.

Table 11: Europe Pharmaceutical Market size, by therapeutic category (2018-2028)



[10] https://www.grandviewresearch.com/industry-analysis/europe-pharmaceutical-market-report

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- **Cognitive sensor to measure granule quality (CPS2)**

A cognitive sensor to measure granule quality (CPS2) represents a straightforward implementation in the existing PAT ports of supported manufacturing equipment. Therefore, minimal engineering effort is required to implement this sensor and market acceptance should be generally very high.

- **Quality attributes sensor (CPS3)**

CPS3 is a soft senor solution and therefore will not require extensive capital investment or engineering installation effort. This cognitive solution should prove to be easily integrated into almost all continuous drying processes.

4.1.3.1 Stakeholders' analysis

Table 12: Pharma Stakeholders' analysis

Stakeholder Name	*Impact* **How much does the project impact them?** *(Low, Medium, High)*	*Influence* **How much do they have over the project?** *(Low, Medium, High)*	**What is important to the stakeholder?**	**How could the stakeholder contribute to the project?**	**How could the stakeholder block the project?**	**Strategy for engaging the stakeholder**
Prof. Martin Horn	Medium	Medium	Implement control concepts, joint publications	Scientific support	Withdrawal of scientific support, refuse to supervise PhD student	PhD student supervision
Prof. Johannes Khinast	Medium	High	Beyond state of the art continuous manufacturing concepts, joint publications	Scientific support	Withdrawal of scientific support, refuse to supervise PhD student	PhD student supervision
Prof. Oliver Kappe	Medium	Low	Beyond state of the art continuous manufacturing concepts, joint publications	Scientific support	N/A	Demonstration and development of new sensors relevant to their field

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Andrea Raffa	Medium	Low	Demo-application of OCT system	Device support OCT	Refuse to provide OCT system for experimental setup	Demonstrate new application of OCT technology in so far un-explored processes
Ivan Bogaerts	Medium	Low	Successful integration of new sensors	Device support manufacturing line	Withdrawal of technical support for continuous manufacturing equipment. IP blocks on implementation of new sensors in a commercial context	Developing advanced control concepts for their manufacturing equipment

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4.1.3.2 Competitors analysis

Table 13: Pharma Competitors analysis

Direct Competitors		Company 1	Company 2	Company 3	Company 4
Company Profile	**Company Highlights**	Ghent University	C-SOPS Rutgers	Glatt	PSE
Key Competitive Advantage		Close cooperation with GEA Modeling experience in pharma;	Expertise in secondary pharmaceutical menufacturing, process modeling and control	Expertise in equipment construction and building.	Flowsheet simulation framework
Target Market	**Market Information**	Cooperation projects with pharmaceutical industries	Cooperation projects with pharmaceutical industries	Pharmaceutical, food, feed and fine chemicals companies	Pharmaceutical companies, process industries
Products & Services	**Product Information**	Project execution, Research and Development, Publications	Project execution, Research and Development, Publications	Pharmaceutical unit operations	Software for flowsheet simulation based on process models
Pricing		Project specific	Project specific		
Strengths	**SWOT Information**	Process modeling / control	Process modeling / control, continuous manufacturing	Well known in pharma industry	Large number of unit operations covered
Weaknesses		Dependent on pharma companies who are providing equipment and who interested in their expertise.	Dependent on pharma companies who are providing equipment and who interested in their expertise.	Focus on equipment building, less on process modeling.	No in-house option to create experimental data to parameterize / validate the process models.
Opportunities		New manufacturing approaches increase importance of process modeling approaches.	New manufacturing approaches increase importance of process modeling approaches.	Transition from batch to continuous manufacturing in pharma poses requirement for new equipment	Increased use of process models in pharma industry
Threats		Supply chain problems due to current crisis.	Supply chain problems due to current crisis.	Supply chain problems due to current crisis.	Supply chain problems due to current crisis.
Trends		Transition to continuous manufacturing increases the need for new equipment and process models and real-time data processing in pharma.	Transition to continuous manufacturing increases the need for new equipment and process models and real-time data processing in pharma.	Transition to continuous manufacturing increases the need for new equipment and process models and real-time data processing in pharma.	Transition to continuous manufacturing increases the need for new equipment and process models and real-time data processing in pharma.

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4.1.3.3 Key Trends analysis

Table 14: Pharma Key Trends analysis

KER	Trends in consumer Needs and Behaviour	Shifts in consumer perception of value	Trends in Industry cost drivers	Change and evolution of the industry
CPS2 (granule quality sensor)	In the Pharma 4.0. context, real-time information on the process and materials are of importance. CPS2 can provide such information.	Availability of real-time information about process is crucial.	Away from end-product testing, trend to continuous, real-time monitoring and control.	continuous process monitoring, advanced and connected sensors in a data-driven control environment
CPS3 (granule moisture soft sensor)	Gain of process understanding by means of mathematical modelling, use of these models for estimating non-measurable quantities (soft-sensors)	Increased process understanding, shorter process development times.	Implementation of process analytical technology is typically expensive and maintenance-intensive. Soft-sensors can be a valuable alternative.	Trend from batch to continuous manufacturing implies the need for real-time information. This can be accomplished by soft-sensor concepts like CPS3.

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4.1.3.4 Market Segments

Table 15: Pharma Market Segments

Market Segment	Size *How large is this target market? Worth pursuing?*	Expected Growth *Even if the market is small, it may be profitable if there are indications that it will grow.*	Competitive Position *(Low, Medium, High)* *Low competition equals attractive market.*	Cost to Reach *Is this market accessible with our tactics?*	Compatibility *How aligned is this market to our goals?*
Continuous secondary manufacturing	According to marketwatch.com (25.5.2022), the continuous manufacturing market is estimated to be valued at ~USD 1 billion by end of 2021.	According to marketwatch.com (25.5.2022), it is expected to expand at a compound annual growth rate (CAGR) of ~14% from 2022 to 2030.	Medium	Yes, a prototype of the CPS2 and CPS3 is in place, industrial application can be achieved by joint projects with potential customers.	Currently high demand in the solutions provided in CAPRI by pharma companies. Very active field in research, too.

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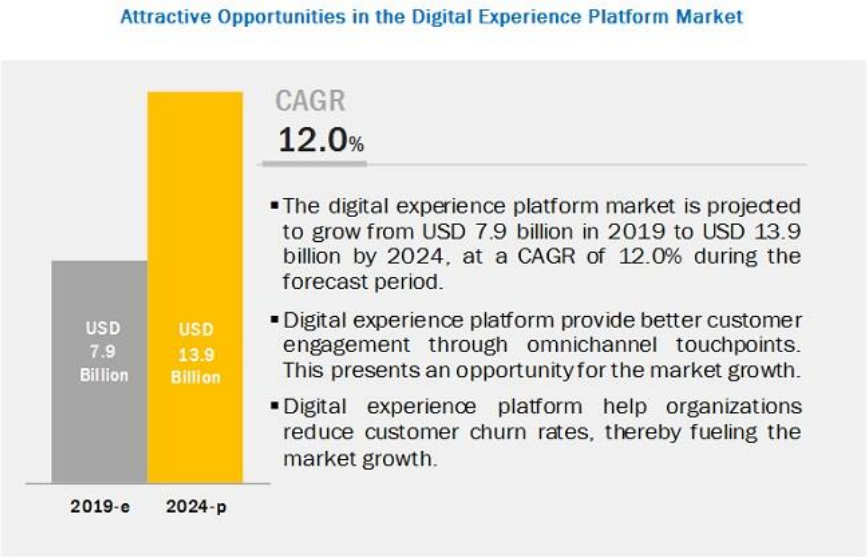
4.1.4 CAP

The Digital Experience Platform market to grow from USD 7.9 billion in 2019 to USD 13.9 billion by 2024[11], at a Compound Annual Growth Rate (CAGR) of 12.0% during the forecast period. Major factors expected to drive the growth of the Digital Experience Platform Market include help in understanding the immediate needs of the customer, reducing the customer churn rate, growing deployment of cloud-based solutions, and rising demand for big data analytics. The other factors supporting the market growth include the increasing implementation of advanced technologies, such as AI, data analytics, and cloud computing.



By deployment type, the Digital Experience Platform Market has been segmented into cloud and on-premises. The cloud segment is expected to grow at a higher CAGR during the forecast period, due to its cost-efficiency and hassle-free integration. Various enterprises prefer cloud services due to their wide-ranging benefits. Small and Medium Enterprises (SMEs) adopt the cloud model, as it helps reduce initial IT costs, such as the costs of hardware setup and power consumption and requires less physical space. Large enterprises can benefit from the cloud services, as they can host their large number of applications in the cloud network, which eases application management.

- **CAP FRAMEWORK**

  The CAP framework, supported by available open data, will be released as open source, and will be the main driver for showcasing the full potential of cognitive solutions in process industry. Its modular architecture supports knowledge models, machine learning systems and different cognitive modules of planning, operation and control.

  It enables a LEGO-like approach that facilitates the adoption in different domain and building of complex applications combining the software components needed, enabling the exchange of IoT raw data (Smart IoT connection layer) at machine level, elaborated events and information (Smart Events processing layer) at unit (edge/fog) level, knowledge models and semantics (Smart Knowledge modelling layer) at site level, and generation of predictions, reports and graphics (Smart Decision support layer) at inter-site level. It will possible even for SMEs to use it to build value on top of adapt it to various other domains rather than the pilot domains implemented within the Capri project.

[11] https://www.marketsandmarkets.com/Market-Reports/digital-experience-platform-market-234793101.html

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The large FIWARE and Apache community will offer the expertise and consultancy to support to build sophisticated solutions in process industry, or even to transfer the cognitive capabilities and solutions to similar domains other than the three pilots.

- **OPEN DATA**

Open Data will be generated and made available by demo cases and by industrial use cases. These data are meant for researchers, practitioners and young talents in the SPIRE sector, to be used even with the Open-Source software, to shape training courses and consultancy webinars to establish a mind-set of Cognitive and smart technologies that can change the industry, during and after the project ends.

The Open data will facilitate the development and spread use of innovative algorithms and software solutions, enabling the extensive use of advanced technologies in the SPIRE sector.

The sharing of data will be done according F.A.I.R. principles to also contribute to the so called Open Research Data Pilot (ORDP) launched by the European Commission[12].

As part of the initiative, CAPRI already started to share datasets and other research results through its Zenodo account[13].

[12] https://www.openaire.eu/what-is-the-open-research-data-pilot
[13] https://zenodo.org/communities/capri_project/

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4.1.4.1 Stakeholders' analysis

Table 16: CAP Stakeholders' analysis

Stakeholder Name	*Impact* **How much does the project impact them?** *(Low, Medium, High)*	*Influence* **How much do they have over the project?** *(Low, Medium, High)*	**What is important to the stakeholder?**	**How could the stakeholder contribute to the project?**	**How could the stakeholder block the project?**	**Strategy for engaging the stakeholder**
Big Companies (IT Dept & End Users) and SMEs in Process Industry	High	High	CAP integrates components from several Open Source projects such as FIWARE and APACHE, and aims to become a reference implementation for any I4.0 Process Industry need, integrating existing plants (brownfield) or in new plants (greenfield).	Opting for an open source oriented system architecture that can be deployed both on cloud and/or the edge	Choosing proprietary based solutions, using non standard protocols (lock-in)	Inviting them to meetings, technical workshops or PI oriented communities, and realizing the potential benefits coming from the adoption of the CAP
System Integrators and consultants in Process Industry	High	High	CAP will deliver a FIWARE for Industry set of components able to build complex data-driven services based on Data in Motion and Data at Rest, offering new opportunities to their customers.	Opting for open source based software solutions, leveraging the LEGO approach.	Proposing non-cloud and edge-based software frameworks and solutions.	Inviting them to meetings, technical workshops to showcase the CAP Reference Architecture, how it can integrate other software components and deliver value to PI companies.
Hardware manufacturers of (soft)sensors etc.	Medium/High	Medium/High	Interfacing their sensors to the CAP could help them in increasing their sells.	Opting for well-known protocols and standards.	Using proprietary protocols that could be difficult to be integrate.	Inviting them to meetings, technical workshops to showcase the CAP Reference Architecture and giving details on how to interface sensors.

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Research Centers	High	Medium/High	CAP integrates components from several Open-Source projects such as FIWARE and APACHE, and aims to become a reference implementation for any I4.0 Process Industry need.	Working in synergy with open-source communities to experiment new implementations for I4.0 Process Industry, replicable for several SPIRE sectors.	Avoiding the potential of open source and the LEGO approach of the CAP framework.	Inviting them to scientific conferences, but also meetings, technical workshops to showcase the CAP Reference Architecture, its LEGO approach, and how it delivers value to PI companies.

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4.1.4.2 Competitors analysis

Table 17: CAP Competitors analysis

Direct Competitors		Company 1	Company 2	Company 3
Company Profile	**Company Highlights**	SAP	HITACHI	RETELIT
Key Competitive Advantage		It integrates with all other SAP software such as ERP which are commonly widespread in business.	Shop floor operations optimization with real time data including anomaly and quality issues detection.	It is based on 4 main modules: just plm,just monitoring, just planning, just quality control.
Target Market	**Market Information**	Manufacturing and Process Industry.	Manufacturing and Process Industry.	Manufacturing and Process Industry.
Products & Services	**Product Information**	Manufacturing Execution System Software.	HITACHI Manufacturing Solutions.	JUST SUITE INDUSTRY.
Pricing				
Strengths	**SWOT Information**	Strong brand, customer base and ecosystem of software components.	Strong presence in Manufacturing and Process Industries segments, large customer base.	Cloud based, it can be integrated to existing PLC, SCADA, MES systems.
Weaknesses		Customers need to buy into the SAP 'ecosystem' and therefore lock in with the software producer.	Proprietary, dated software architecture.	Proprietary
Opportunities		Leverage its third-parties to extend their software offering being compliant with I4.0.	Renovate their software architecture and technology and leverage their customers loyalty to make a smooth transition with them, being compliant with I4.0.	Being native cloud based, the software could be extended to distribute processing between cloud and edge nodes with an orchestrator.
Threats		A hype of open-source software solutions could cause a major customers loss.	Being based on old technology, end-of-life on software components could cause customers loss.	A hype of open-source software solutions could cause a major customers loss.
Trends		-	-	-

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4.1.4.3 Key Trends analysis

Table 18: CAP Key Trends analysis

KER	Trends in consumer Needs and Behaviour	Shifts in consumer perception of value	Trends in Industry cost drivers	Change and evolution of the industry
CAP and Open Data	Process Industry needs to improve the innovation pace, with more efficiency of plants and quality of products, reducing considerably the consumption of electricity and CO2 emissions. The production processes need to be supported by digital platforms hosted in the cloud, with advanced training and support.	The availability of real-time, historical data and software tools able to model and process these data is the key enabler for targeting Process Industry needs.	Digitalization is being progressively offered with a Software-as-a-Service (SaaS) approach, paving the way to software services as fully Opex, with both Pay-per-Use or flat subscription options.	Process Industry is moving towards the Twin Digital-Green Transition, as well as foundations for human centric, safe, comfortable and inclusive workplaces. The CAP will address both needs.

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4.1.4.4 Market Segments

Table 19: CAP Market Segments

Market Segment	Size *How large is this target market? Worth pursuing?*	Expected Growth *Even if the market is small, it may be profitable if there are indications that it will grow.*	Competitive Position *(Low, Medium, High)* *Low competition equals attractive market.*	Cost to Reach *Is this market accessible with our tactics?*	Compatibility *How aligned is this market to our goals?*
Process Industry	Process Industry (PI e.g., Steel, Metals, Chemicals, Cement, Asphalt, Ceramics) is one of the leading sectors of the world economy, characterized by intense environmental impact, very high energy consumption, and traditional low innovation pace in PI. Huge segment.	In recent years a strong push at worldwide level towards the dual objective of improving the efficiency of plants and the quality of products, reducing a lot the consumption of electricity and CO2 emissions has taken momentum. Industry 4.0 guidelines and Digital Technologies are enabling drivers for a Twin Digital-Green Transition, as well as foundations for human centric, safe, comfortable, and inclusive workplaces. Major players in the market are working on the adaptation of existing software products for manufacturing, in many cases the vendor lock-in is present.	Low/Medium	We have already established partnership and engagement with integrators, consultants, open-source communities (FIWARE), specific industry bodies and research centres, based on trust, knowledge, and industrial reliability to approach this market segment.	Perfectly aligned, the CAP can be deployed both in existing (brownfield) plants and new plants (greenfield) being compliant with major standards. Our proposal can be extended to different domains, thus reaching a potentially wider audience.

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5 Initial Canvas Business Models

To date, background work has taken place to provide preliminary market analysis for CAPRI solutions to enter the market. This analysis provides a brief overview of CAPRI's value proposition, potential customers and customer channels, key stakeholders required and financial analysis in terms of potential revenue streams and cost structures.

Relevant partners responsible for the Key Exploitable Results (KERs) identified to date have also provided initial analysis of each one, providing a first look at initial action planning for market penetration.

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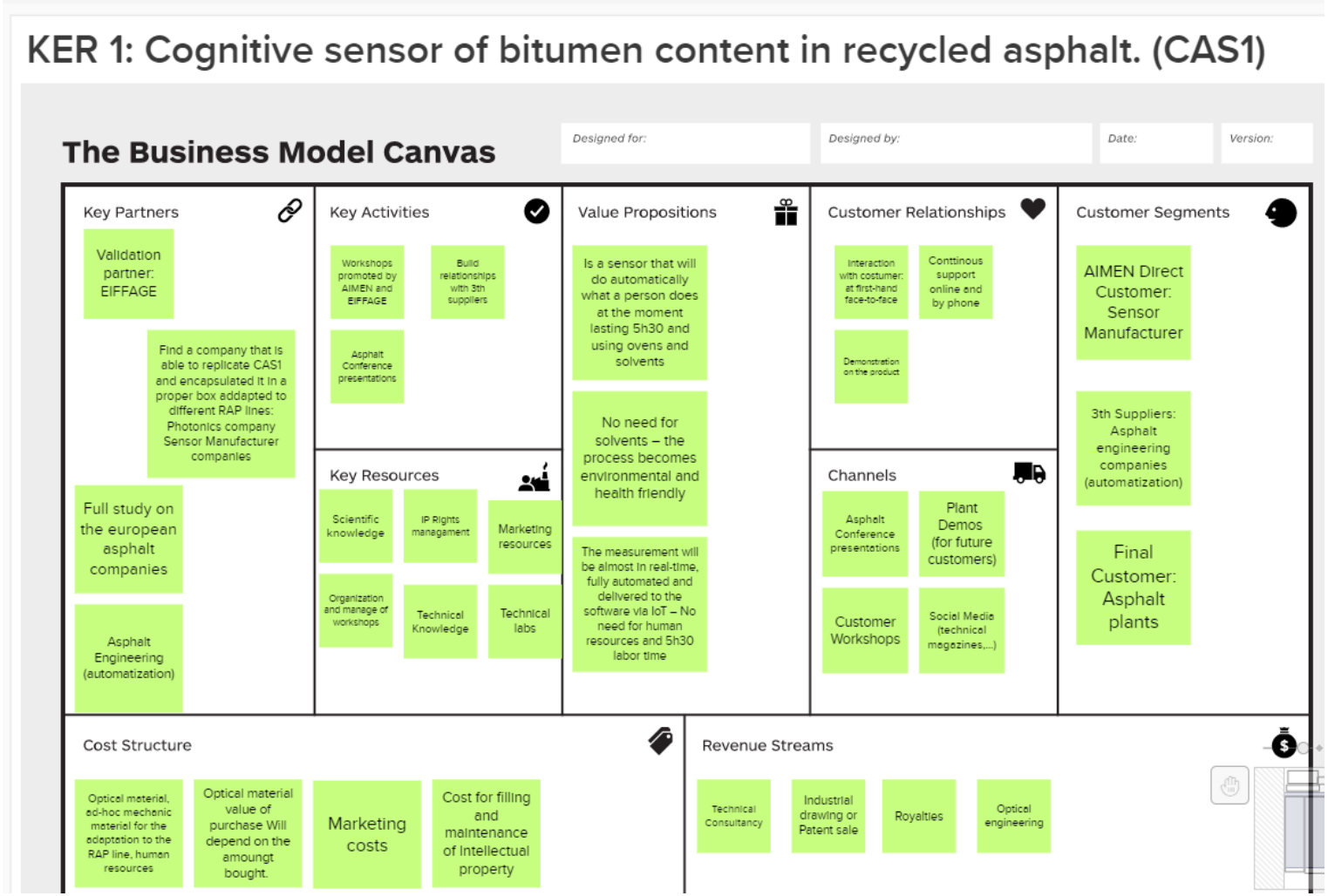
5.1 Asphalt

Team members: CARTIF, EIFFAGE and AIMEN



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Team members: CARTIF, EIFFAGE and AIMEN

KER 2: Cognitive optical sensor for particle size measurement (CAS2)

The Business Model Canvas

Designed for:

Designed by:

Date:

Version:

Key Partners

- Accelerometers sellers
- Plants with dust aspiration developers
- Sensors integrators
- Sensors developers
- Enterprises whose objective is the optimization of process, increase the quality
- Engineering companies (automatization)

Key Activities

- Dissemination: Papers, videos, online promotion, workshops,...
- After-sale service
- Continuous improvement (learning about users) to build better product
- Build relationships with 3th suppliers

Key Resources

- Scientific knowledge
- IP Rights management
- Marketing resources
- Organization and manage of workshops
- Technical Knowledge

Value Propositions

- This sensor can measure the Flow of dust (any kind of dust) flowing throw pipes with depressure inside en condiciones extremas (temperatura, tipo de concentración partícula, sección de tubería)
- This measure can be very interesting about the quality of the materials, quality of the process (energy consumption)
- These measures are in real time that can help to optimize the production in real time.

Customer Relationships

- Interaction with the costumer during the first stage: giving advices , demonstrations of the product How implement the sensor, how do you have to calibrate the sensor Evaluations of results
- Conttinous support online and by phone
- SAT

Channels

- Plant Demos (for future customers)
- Conference presentations
- Social Media (technical magazines,...)
- Customer Workshops
- Sensor events

Customer Segments

- Plants with Dust aspiration.
- Cement Plants
- Minerals process plants
- Asphalt Plants
- Agro factories, fertilizers.

Cost Structure

- Commissioning, calibration ((technical infraestructure, human resources, licences..)
- Vibration analysis, studies (technical infraestructure, human resources, licences..)
- Cost for filling and maintenance of intellectual property
- Marketing costs

Revenue Streams

- Analytical Consultancy
- Energy Consultancy
- Service fee: Sensor direct sale
- Royalties
- Industrial drawing or Patent sale

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5.2 Steel

Team members: BFI, SIDENOR and MSI

KER 1: Product tracking. (CSS1)

The Business Model Canvas

Designed for: | Designed by: | Date: | Version:

Key Partners
- Laser and camera providers as partners
- Software & data integrator (per project)

Key Activities
- Feasability study
- Data collection & processing
- Build relationship with hardware providers

Key Resources
- Domain knowledge (Steel production, in particular related to temperature, tracking, optical inspection systems, data management)
- Service organisation with 24/7 capabilities

Value Propositions
- Increase the value of the existing production data to get higher Quality and to improve the production, (traceability...)
- Enabling technology for root-cause analysis => allows reduction of production defects
- No off-the-shelves products available (only individual components like lasers and cameras)
- Be able to give more information to the customer.

Customer Relationships
- Key Account Management
- Personal relationships
- Newsletters
- Customer workshops

Channels
- Advertising
- Conference presentations
- Customer workshops
- Technical publications

Customer Segments
- Companies working with hot metals (solid state) including other steel makers
- Aluminium, Copper, Non-Iron-Metal ...
- Writing (lasers) and Reading (cameras) developed by third parties. Data integration done by SIDENOR.

Cost Structure
- Need trained system developers and service personnel
- Hardware components
- Long running projects (adaptations...)
- SW Licences
- Marketing and sales costs (events, conferences, sales manager)

Revenue Streams
- Hardware sales
- Installation & integration
- Service & license fees
- New versions and updates
- Consultancy (Analytical)
- know-how-Technical Information

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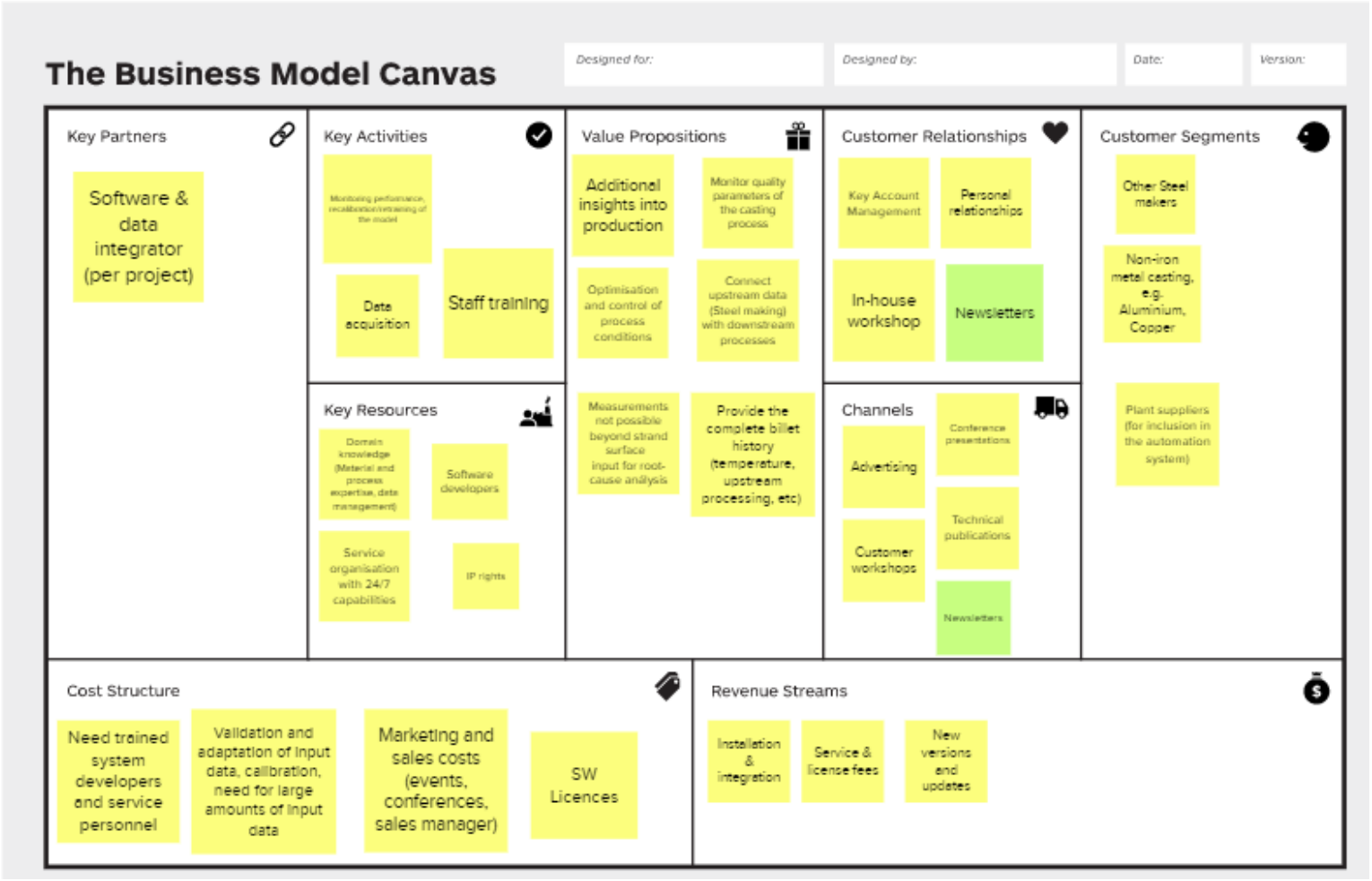
Team members: BFI, SIDENOR and MSI

KER 2: Continuous casting solidification sensor (CSS2)



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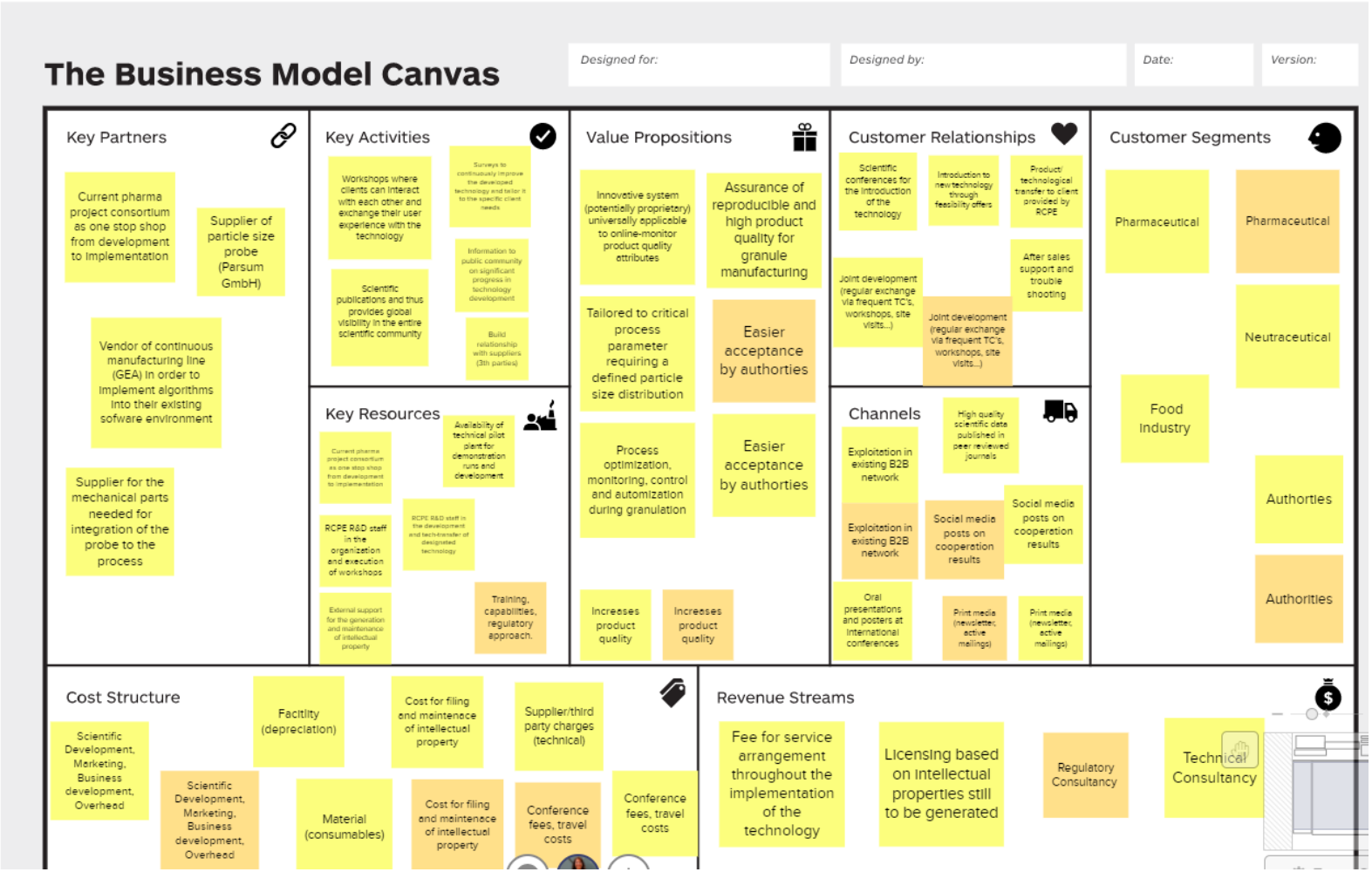
5.3 Pharma

Team members: RCPE and AMS

KER 1: Cognitive sensor for granule quality (CPS2)



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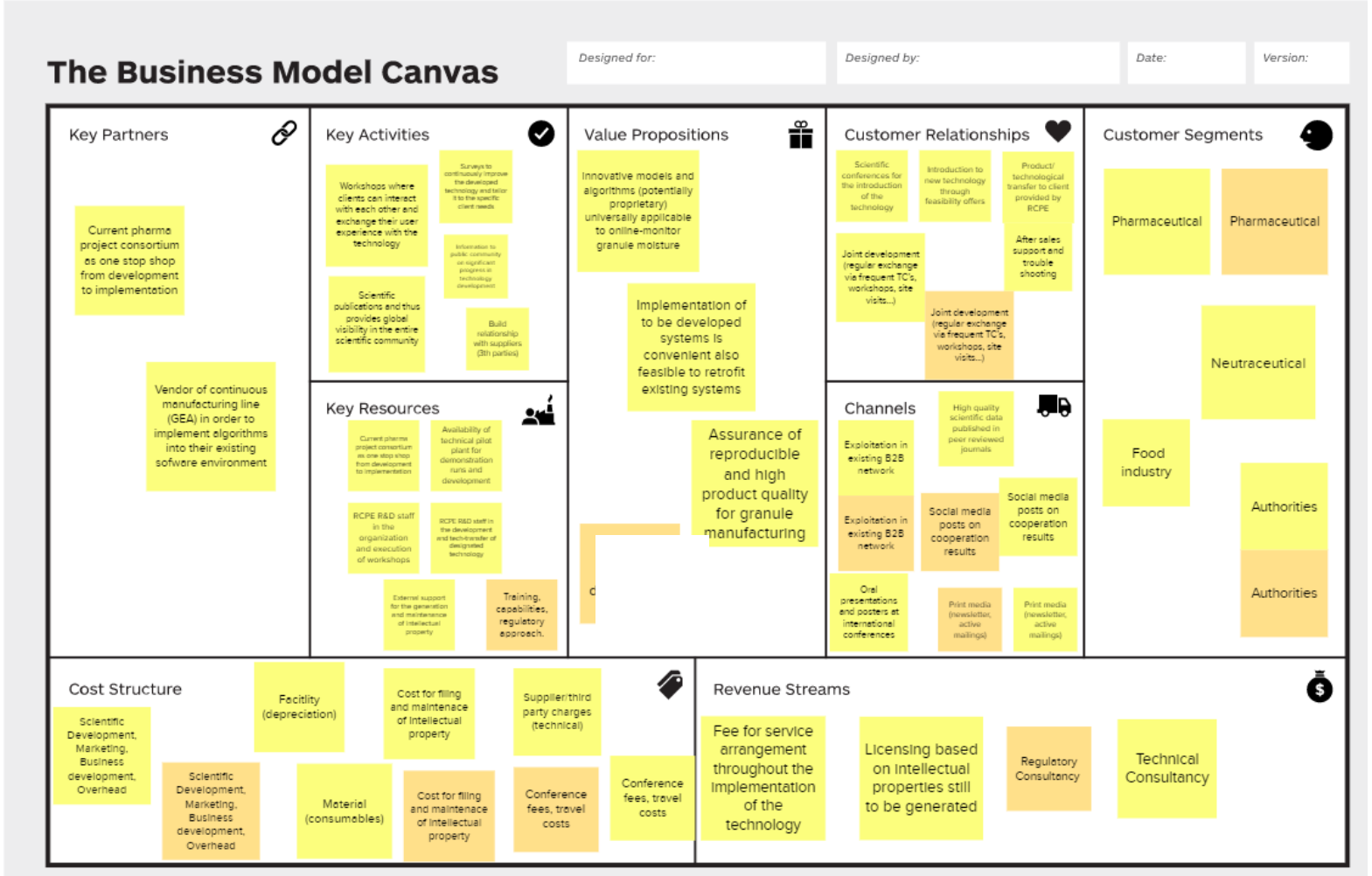
Team members: RCPE and AMS

KER 2: Quality attributes sensor (CPS3)



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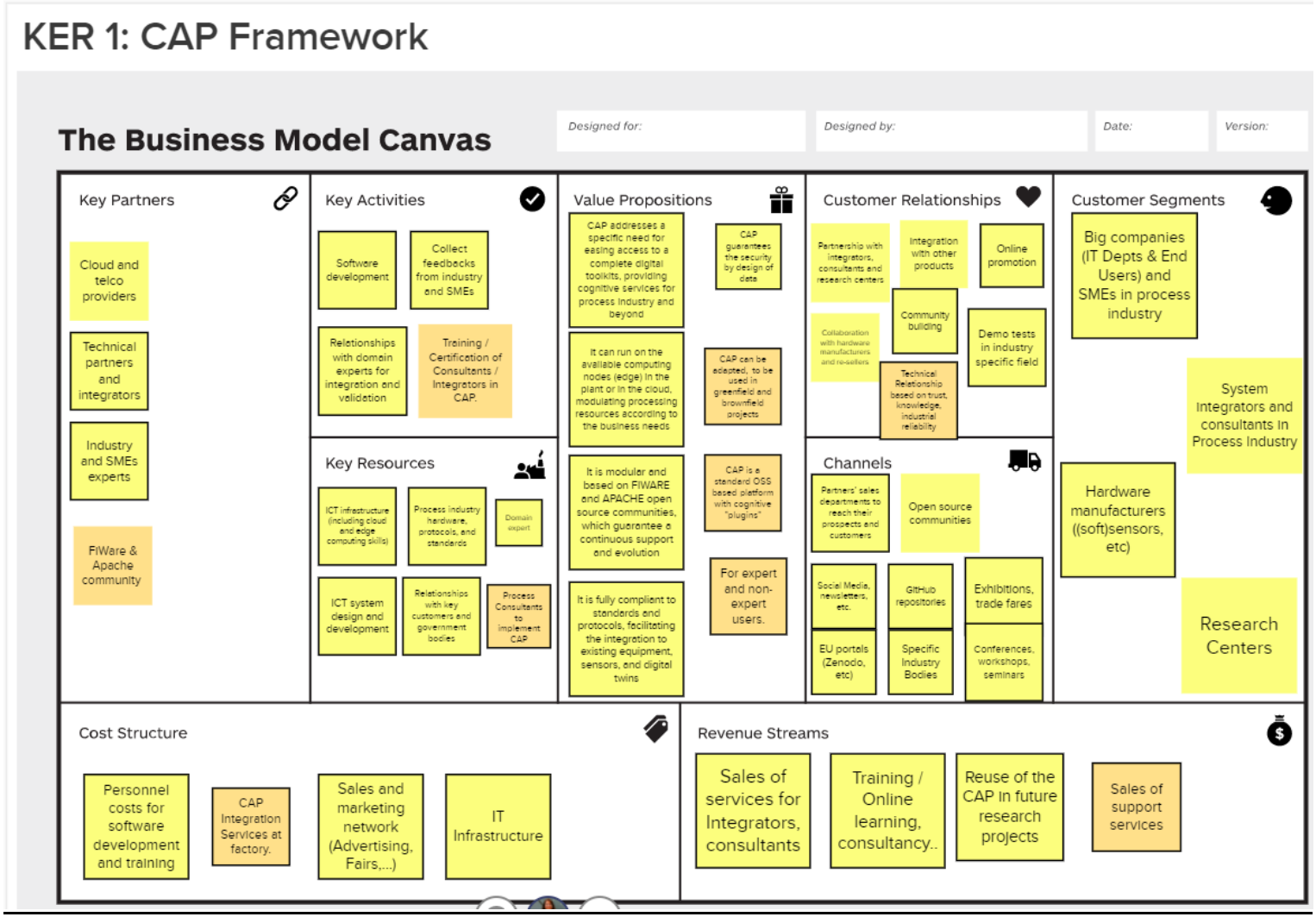
5.4 CAP

Team members: ENGINEERING, MSI and NISSATECH



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Team members: ENGINEERING, POLIMI, MSI and NISSATECH

KER 2: Open Data

The Business Model Canvas

Designed for:

Designed by:

Date:

Version:

Key Partners

- Technical partners, integrators, communities
- Research centers, universities
- EU open data referers and organizations

Key Activities

- Collect, clean and publish open data
- Provide documentation on best use of data
- Training preparation
- Consultancy activities to organize technical workshops
- Advertise data availability and dependencies with software

Key Resources

- Process industry skills
- Open data best practices and standards
- Repositories (Zenodo, CKAN), data generator and algorithms maintenance
- Training and consultancy expertise

Value Propositions

- Digital transformation in process industry will be data-driven, thus the need of open data
- CAP Open Data is Process specific : Representative, Complete and Validated.
- Open data coming from some industry domains could be helpful in different domains with similar working
- Open data in combination with open source software solutions can showcase the potential of new solutions and make easier for SMEs the decision to adopt them
- Need of upskilling and reskilling in process industry
- Need to support from external consultants to manage the data produced in their plant

Customer Relationships

- Partnership with integrators, consultants, research centers, communities
- EU promotion through portal, workshops, specific events
- Sector specific Open Data Community

Channels

- Partners' sales dept to reach their prospects and customers
- Open Data portals
- Social Media, newsletters, etc
- EU portals
- **Open source communities**
- Specific Industry and Government Bodies/ Orgs

Customer Segments

- Big Companies and SMEs in process industry
- System Integrators and Consultants in process industry
- Research Centers and Universities
- Government Bodies (CAP could support the Green Deal)
- Standardization Bodies

Cost Structure

- Personnel costs for data collection, cleaning, publishing and documentation
- Support and marketing network

Revenue Streams

- **Value added services for Integrators, consultants**
- **Training and higher education**
- Reuse of open data in future research projects
- Some premium services could be foreseen, where open data will be free, while ontologies on top to be payed

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6 Conclusions. Next period roadmap

In these 12 months of work, the first market indicators have been analyzed for each of the key exploitable results defined (competitors, stakeholders, key trends, market segments, etc.)

Each of the participants involved in this work package have collaborated and shared relevant information for each of the indicators mentioned.

Next steps will be aimed at continuing to analyze the market entry potential of each of the identified KERs. Risks and possible mitigation measures will be worked on, as well as the introduction of other feasibility methodologies such as the Profit Simulation Tool led by CORE, which will explore the profitability of the developed business models.

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