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List of Abbreviations

Abbreviation	Meaning
CMMS	**C**omputerized **M**aintenance **M**anagement **S**ystem
ERP	**E**nterprise **R**esource **P**lanning
MES	**M**anufacturing **E**xecution **S**ystem
MVP	**M**inimum **V**iable **P**roduct
NACE	Nomenclature of Economic Activities = **N**omenclature des **A**ctivités économiques dans la **C**ommunauté **E**uropéenne in French
OEE	**O**verall **E**quipment **E**ffectiveness
P3M	**P**redictive **M**aintenance **M**anagement **M**odel
PdM	**P**re**d**ictive **M**aintenance
PLC	**P**rogrammable **L**ogic **C**ontroller
RUL	**R**emaining **U**seful **L**ife
SCADA	**S**upervisory **C**ontrol **A**nd **D**ata **A**cquisition
UPTIME	**U**nified **P**redic**TI**ve **M**aintenance syst**E**m

Executive Summary

This document is the second release of Deliverable 8.1 “Market Research” of UPTIME project, a project supported by European Union’s Horizon 2020 research and innovation program under grant agreement No. 768634. For more information on this project, please refer to the following website https://www.uptime-h2020.eu/.

As the UPTIME market research report, this deliverable presents:

- An overview of the predictive maintenance market in Europe in order to understand its ecosystem and value chain, identify its drivers and opportunities;
- A competitive analysis to identify where UPTIME stands towards competition and its key differentiators;
- The UPTIME value proposition that introduces UPTIME added value with respect to the market needs and competition;
- A market receptivity analysis with a feedback about UPTIME Value proposition
- A market prioritization analysis that identifies the most promising market segments for the go-to-market strategy
- A business opportunity assessment that evaluates with concrete figures the size of the market within reach of UPTIME
- A strategic analysis that combines all the aspects depicted above to guide the exploitation strategy.

Two releases of the report have been planned in order to provide inputs to the development of the UPTIME system and components (D8.1a due at M9) and to propose recommendations to the Consortium on the positioning of UPTIME (D8.1b due at M18). Compared to the first release that has been published at M9, the second one provides a deeper strategic analysis thanks to a further competition and market analysis.

1. Introduction

As an introduction, this section presents the objectives of this deliverable and the links it has to other deliverables of the UPTIME project.

1.1. Objectives

The objective of this deliverable is to define a successful strategic positioning for UPTIME. To do so, we shall define:

- What is our unique value proposition
- Who are our target customers and how we can reach them

As such, the competitive analysis aims at:

- Understanding the ecosystem of predictive maintenance & identify market trends
- Identifying how UPTIME positions itself towards competition
- Proposing recommendations on how UPTIME should be exploited

Simultaneously, the market analysis aspires to:

- Understand potential client's needs
- Test receptivity of UPTIME value proposition
- Identify perceived strengths & weaknesses

This general approach has been considered rather as a guideline than as a formal methodology. It is important to understand that these goals are not decorrelated, as they nourish and feed themselves from each other. Specifically, the market and competition analysis can fine-tune and refine the identification of the IEAs and adjust UPTIME value proposition.

1.2. Links to other deliverables

The current deliverable is related to several other ones of the UPTIME project, as presented below in Table 1-1.

Table 1-1 – Link to other deliverables

Deliverable	Nature of the relationship
D1.1 Catalogue of PdM Models, Techniques, Platforms (RINA)	*Output*: List of potential competitors
D1.2 UPTIME PdM Management Model and MVP (MEWS)	*Input*: UPTIME MVP and functional map *Output*: UPTIME MVP recommendations
D2.1 Conceptual Architecture and System Specification (ICCS)	*Input*: UPTIME architecture and functionalities
D7.2 Dissemination, Awareness Creation and Communication Kit (ISADEUS)	*Output*: UPTIME Value proposition and market segmentation
D8.2 Business Model, Exploitation and Innovation Management (MEWS)	*Input*: IEA *Output*: Strategic analysis and recommendations

2. Maintenance Market Overview

To identify how UPTIME can and should create value in the maintenance market, it is first crucial to understand the market, its drivers, its current opportunities and challenges. Thus, section 2 presents the status of the maintenance market that may be currently shifting towards predictive maintenance.

2.1. Traditional maintenance market situation

Maintenance holds a strategic position in companies' activities. Its strategy can greatly vary from one structure to another. It can either be internalized with in-house dedicated teams or outsourced to maintenance service providers, either partially or fully. The drivers, opportunities and challenges of the industrial end-users in maintenance can then be derived from the study of the outsourced maintenance market that will be detailed in section 2.1.

Industrial maintenance service providers have long benefited from structural drivers (outsourcing maintenance to subcontractors, making industrial equipment more complex, etc.). But in a market that is gradually maturing, the game is changing. Today, strategic changes must be made, particularly to break the race to the lowest bidder. A historical trend that is gradually leading the profession into a dangerous deflationary spiral and pushing some customers to reinternalize repair and maintenance work, as managers are not fully satisfied with the quality of services in relation to costs.

While industrial maintenance service providers have been used to an average annual growth rate in Europe of more than 6% since the early 2000s, the dynamic has tended to slow down since 2009. The economic crisis and the difficulties encountered by client companies have resulted in a record number of company failures and closures of production units, accentuating the structural phenomenon of deindustrialisation.

Moreover, the growth potential in the petrochemical and steel site maintenance segment, the sector's two main opportunities according to Xerfi[1], is currently particularly low. Almost all the companies have already outsourced these functions, only carrying out the exploitation of their operations: as an example, groups operating petrochemical sites (Total, ExxonMobil, Ineos, Solvay, etc.) are already outsourcing all maintenance tasks.

It is also difficult for maintenance stakeholders to conquer new markets. The sectors that could be potentially the most promising, such as the agricultural and food industries or the pharmaceutical industry, are still only opening up to outsourcing to a limited extent.

More than the high cost, the main obstacle is confidentiality. Companies do not want their manufacturing secrets to be disclosed by outside parties. The risks of loss, over the years, of technical expertise and know-how are also put forward as reasons for not using subcontractors.

As a result, the average outsourcing rate (share of activity outsourced to external companies) in the field of industrial maintenance in Europe has been capped at around 35% since 2010. In the absence of this main driver of growth, the activity of maintenance generalists tends to run out of breath. According to Eurostat, industrial maintenance, repair and installation in Europe represented approximately 170 billion euros in 2015 as shown in Figure 2-1.

[1] Xerfi, Le marché de la maintenance industrielle à l'horizon 2018

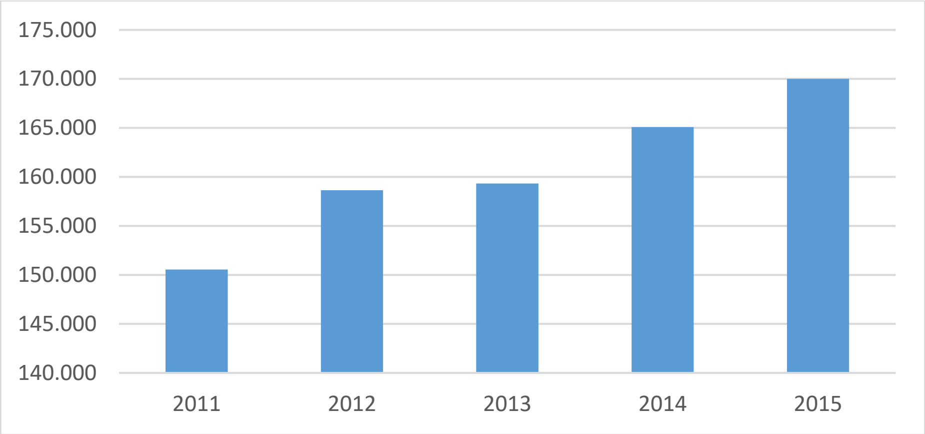


Figure 2-1 – Repair, maintenance and installation (C33) turnover in Europe (EUR million) – Source Eurostat

The deterioration of the economic environment has also aggravated the decrease in the activity of maintenance contractors in recent years. Faced with shrinking order volumes and uncertain prospects, decision-makers have been forced to make trade-offs. The budgetary restrictions imposed by industrial firms have been particularly focused on maintenance, one of the main items of expenditure, which effects are not immediately quantifiable. Moreover, the capacity utilisation rate in industry has remained below the long-term average since 2009, potentially resulting in fewer breakdowns and malfunctions. However, this trend is expected to reverse as economic conditions improved since 2015.

One factor that weighs on the profession's turnover is prices. While they increased by 2.8% in 2012, the rates for repairs and maintenance of industrial sites increased by only 0.8% in 2015. Maintenance service providers face strong market power from their customers, which has been increasing in recent years. Companies no longer hesitate to renegotiate their contracts and seek to use competition to obtain the most advantageous prices. It is thus becoming increasingly difficult for maintenance and repair operators to pass on price increases to customers.

Of course, the drivers of growth are less strong today compared to the prosperous periods of the 2000s. However, industrial maintenance professionals will always benefit from a comfortable growth rate. According to Xerfi estimations, the turnover of "unit outage" specialists averages 4.3% per year between 2016 and 2018. It must be said that maintenance contracts run over several years, so operators in the profession benefit from recurring revenues and are therefore less sensitive to economic conditions. Moreover, with the improvement of their business prospects, contractors will have the means to be more aggressive, in particular to implement new maintenance strategies, in connection with industrial modernization projects.

2.2. Opportunities offered by new technologies

As stated above, the maintenance market is gradually maturing with common expertise and technical know-how does not provide a competitive advantage to maintenance service providers anymore. Faced with market saturation and margins under pressure, subcontractors can be easily interchanged. In that context, maintenance stakeholders are seeking to expand their offer towards more remunerative services, particularly predictive maintenance.

Extensive literature details the types of maintenance strategies that can be followed, with new maintenance services that appeared thanks to new technologies:

- **Reactive** or **curative** or **corrective** maintenance: *Fix when asset is broken*
- **Preventive** maintenance: *Fix before asset is broken*
    - **Planned** or **systematic** maintenance: *Maintenance action conducted regardless of asset condition or with visual and instrument inspections*
    - **Condition-based** maintenance: *Diagnosis based on data collected from sensors placed on asset, with analytics assessing its present condition (anomaly detection)*
    - **Predictive** maintenance: *Prognosis based on the evolution of data, with advanced analytics on real-time and historical data assessing its future condition (failure prediction)*
    - **Prescriptive** maintenance: *Assisted decision-making with action recommendation based on prognosis and workflow management (maintenance vs. production optimization)*

Now, the traditional maintenance market which was essentially based on reactive and planned maintenance is currently shifting towards condition-based and predictive maintenance. The main tools needed to implement new maintenance services already exist: sensors, PLCs, big data, IoT, cloud computing. This makes it possible to detect faults before they occur, based on the information recorded by the sensors and the data history.

Like electronic components (microprocessor, battery, memory, radio device for data transfer), the cost of manufacturing sensors tends to be reduced thanks to improved production processes and economies of scale. The cost of sensors vary from euros cents to thousands of euros depending on their quality, the type of data they collect, the environment in which they are installed, etc. The cost of adding chips for capturing and wirelessly transmitting information from the physical world is becoming so low that any industrial equipment manufacturer may now wonder whether it is worth adding a form of "intelligence" to its products.

However, the benefits of these new maintenance services must be confronted with the complexity of their implementation and the investments needed upfront. The choice will then depend, among others, on the criticality of assets and the savings that these new maintenance services will enable. These considerations will be further developed in section 5.2.

2.3. Maintenance stakeholders

A clear overview of stakeholders involved in predictive maintenance value chain is important to analyse the context and market for UPTIME, to formulate value propositions and identify optimal communication channels. The different types of stakeholders relevant to this market research are presented below in Table 2-1:

Table 2-1 – Stakeholders in Predictive Maintenance (PdM)

Stakeholder group	Type	Interest in PdM	Description	Example of organizations
Industrial end-users	Potential adopter	Maximizing OEE Reduce maintenance costs	End-users that use equipment and machines that require maintenance	Cf. Figure 2-2
Maintenance service providers	Potential adopter / partner	Selling PdM solutions	Third-parties that have been contracted to ensure the maintenance of plant's equipment	Bouygues, CMI, Fives maintenance, Eiffage, SODI, Ponticelli, Fouré Lagadec, Christof industries, EuroMaint Rail, Infinite Group, Fluor, Endress+Hauser, QuantService, NCH Europe
Equipment manufacturers	Potential adopter / partner	Selling an integrated PdM solution	Manufacturers that produce the equipment used in plants by end-users	General Electric, Siemens, Bosch
Software editors and integrators	Potential partner	Selling PdM solutions	Companies that develop the information systems to allow predictive maintenance	IBM, Oracle, Microsoft, SAP, C3 IoT, Uptake, Dassault Systèmes, PTC, Intergraph, Aveva, Bentley, OSI Soft

- Industrial end-users may choose to carry out repair and maintenance work in-house by a dedicated team. If so, they prefer to keep control of this type of activity internally. The choice to internalize maintenance activities is increasingly made possible thanks to technological innovations. In that case, they will rely on technological providers such as software editors for their CMMS and/or Predictive Maintenance (PdM) solutions.

- On the other hand, some industrial end-users may choose to contract maintenance service providers to benefit from their know-how, optimise personnel management, make their costs more flexible or focus their activities on their core business. In that case, maintenance software providers either rely on technological partners to develop their PdM solution or develop in-house expertise. This category includes generalist maintenance service providers and also mono-sectoral maintenance service providers.

- Equipment manufacturers increasingly tend to offer "all-inclusive" solutions to industrial end-users including the supply, financing, installation and maintenance of equipment. The objectives are multiple: to provide new sources of revenue, offer services with higher added value, develop recurring revenue through multi-year contracts or even differentiate themselves from competition. This competition from equipment manufacturers is expected to continue and even intensify in the next years. In that case, similarly to maintenance software providers, they either rely on technological partners to develop their PdM solution or develop in-house expertise.

- The software editors and integrators are rushing into the new market segment offered by predictive maintenance: IBM, Microsoft, SAP have developed a predictive maintenance offer thanks to their expertise in Big Data, IoT and machine learning. These digital giants and start-ups could thus disrupt the competitive environment of PdM by capturing a growing share of the value. This category includes generalist software editors, start-ups specialized in predictive maintenance solutions and CMMS editors.

The relationships between these stakeholders in the value chain are represented below in Figure 2-2:

Figure 2-2 – Value Chain of Predictive Maintenance

Towards each one of these stakeholders, UPTIME approach and strategy will differ according to its value proposition. In particular, equipment manufacturers, maintenance service providers and software editors can be either seen as potential competitor or as potential partners.

2.4. Adoption of new types of maintenance

The leaders of maintenance service providers, such as Cofely Endel, PPM (Emcor) or Actemium (Vinci Energies) make predictive maintenance a major development axis. This theme is most often integrated into future plant projects. It is about designing smarter plants and making the product more relevant, more optimized, without interruption, without defects. These new generation production lines integrate computerized systems which consequently allow for improved maintenance.

As such, players such as Fives or Vinci Energies are seeking to take the leadership of the Industry 4.0. It is by becoming technological prescribers for "smart" plant projects that the maintenance stakeholders will succeed in becoming true partners of the principals, and not simple subcontractors subject to pressure on prices.

According to a BCG analysis report, Digital Manufacturing technologies could help reduce production costs (excluding raw materials) by 20 to 40 percent. Industrial end-users, though aware of the benefits that digital manufacturing technologies can deliver, struggle to effectively adopt and implement digital technologies. According to that same BCG study, almost half of the interviewed industrial organizations are not yet prepared for the arrival of new technologies for digital manufacturing, as presented below in Figure 2-3.

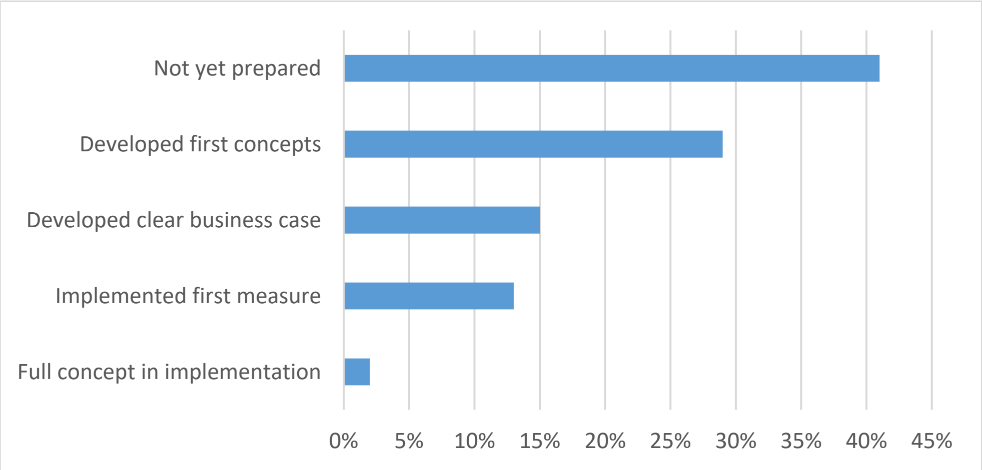


Figure 2-3 – Readiness to implement (Source BCG survey)

According to a PwC report that surveyed 280 industrial end-users in Europe, two-third of respondents are still conducting visual and instrument inspection in their maintenance strategy. Only 11% of respondents claim having deployed predictive maintenance capabilities. A 2014 study by RolandBerger found that only 15% of time was spent on predictive maintenance activities vs. 40% on reactive maintenance and 45% on preventive maintenance. As a result, only 22 percent of managers were happy with their maintenance programs.

However, according to a Momenta Partner report, predictive maintenance analytics solutions is expected to grow to be a $24 billion market, globally, by 2019 with the more advanced segments of the market – predictive and prescriptive maintenance – likely to grow the most. These categories will account for the majority (over 60 percent) of the maintenance analytics market by 2019 increasing from only 23 percent in 2014.

3. UPTIME Value Proposition Definition

The value proposition is a marketing statement for potential customers to make them understand the value and give them the willingness to buy. It should highlight that the product will bring more value than other similar offerings. We need to highlight what differentiates us from the competition, and clearly explain UPTIME positioning.

Then, UPTIME Value Proposition should stem from UPTIME vision and architecture (detailed in section 3.1), its functionalities (detailed in section 3.2) and its innovative exploitable assets (detailed in section 3.3).

3.1. UPTIME Vision

The UPTIME vision detailed below has been presented in the Deliverable 2.1 “Conceptual Architecture and System Specification”.

The UPTIME vision is based upon the predictive maintenance background, the technological pillars of Industry 4.0, IoT and proactive computing as well as the baseline existing tools in the consortium. The UPTIME aims to enable the predictive maintenance implementation in manufacturing firms with the aim to maximize the expected utility and to exploit the full potential of predictive maintenance management, sensor-generated big data processing, e-maintenance, proactive computing and industrial data analytics. UPTIME will be able to be applied in the context of the production process of any manufacturing company regardless their processes, products and physical model used. The unification of the novel e-maintenance services and tools will lead to overcoming of the existing commercial software and research prototypes limitations and will conclude in a novel predictive maintenance solution covering the whole prognostic lifecycle. Unification is achieved by bringing together approaches, tools and services each one of which implements a different phase of the predictive maintenance architecture in order to effectively support different enterprise management layers, i.e. operational (e.g. maintenance engineers), management (e.g. factory manager), strategic (e.g. board of directors) by aggregating and interpreting data captured from the production system and effectively sharing the massive amount of information throughout the whole organization, both horizontally and vertically. For example, a maintenance engineer is interested in the real-time visualization of results (diagnostics, prognostics, recommendations, etc.) for conducting his day-to-day duties; the factory manager is interested in an aggregation of information at a week level for studying the number and type of failures, the implemented actions, etc., while the board of directors require a more aggregated form of information, e.g. for studying (e.g. in the form of reports) the production process performance at a monthly level.

UPTIME aims to reframe predictive maintenance strategy in a systematic and unified way. Furthermore, it aims to enable the transition of maintenance strategy from time-based, preventive, to condition based, predictive by utilizing the most recent advancements in maintenance management and computer science. The UPTIME e-maintenance services will provide the required support for real-time information processing through all the steps of the unified predictive maintenance framework. In addition, they will provide the capability of configuring various parameters at the design time, offline, for taking into account expert knowledge and of visualizing the current and the predicted state of the production system through an associated dashboard. To provide effective guidance, support and information sharing to maintenance engineers as well as to other enterprise management levels, the extended UPTIME e-maintenance services will address the various steps of the unified predictive maintenance approach and will incorporate interconnections with other industrial operations related to production planning, quality management and logistics management.

The UPTIME vision converges and synthesizes predictive maintenance, proactive computing, the Gartner's levels of industrial analytics maturity and the ISO 13374 as implemented to MIMOSA OSA-CBM, in order to create a consistent basis for a generic predictive maintenance architecture in an IoT-based industrial environment. In this way, the Operational Technology and the Information Technology can also be converged in the context of Industry 4.0. Figure 3-1 depicts the relationships among these concepts and their aggregation to **UPTIME_SENSE, UPTIME_DETECT, UPTIME_PREDICT, UPTIME_DECIDE, UPTIME_ANALYZE, UPTIME_FMECA** and **UPTIME_VISUALIZE** phases.

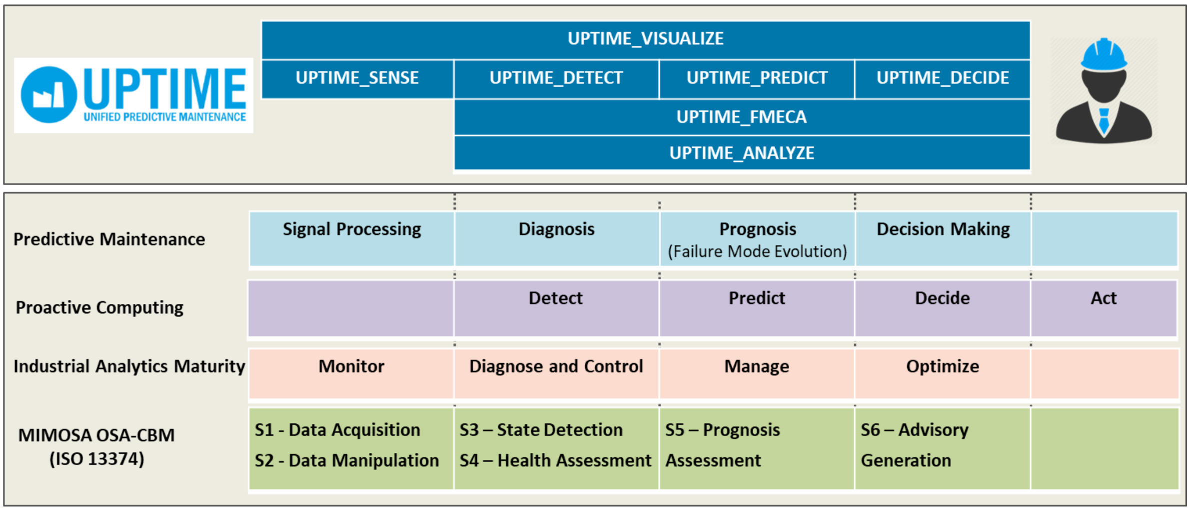


Figure 3-1 – The UPTIME Concept

3.2. Functional map

The Functional Map for the UPTIME Solution is a tool that constantly evolves to reflect the latest shared understanding of the partners involved in its development. As a result, the elements detailed here will evolve in time.

The reference version at the time of the creation of the first version of this deliverable is **version 9**, as shown in Figure 3-2. A detailed version of this functional map is available on Deliverable 1.2 (D1.2).

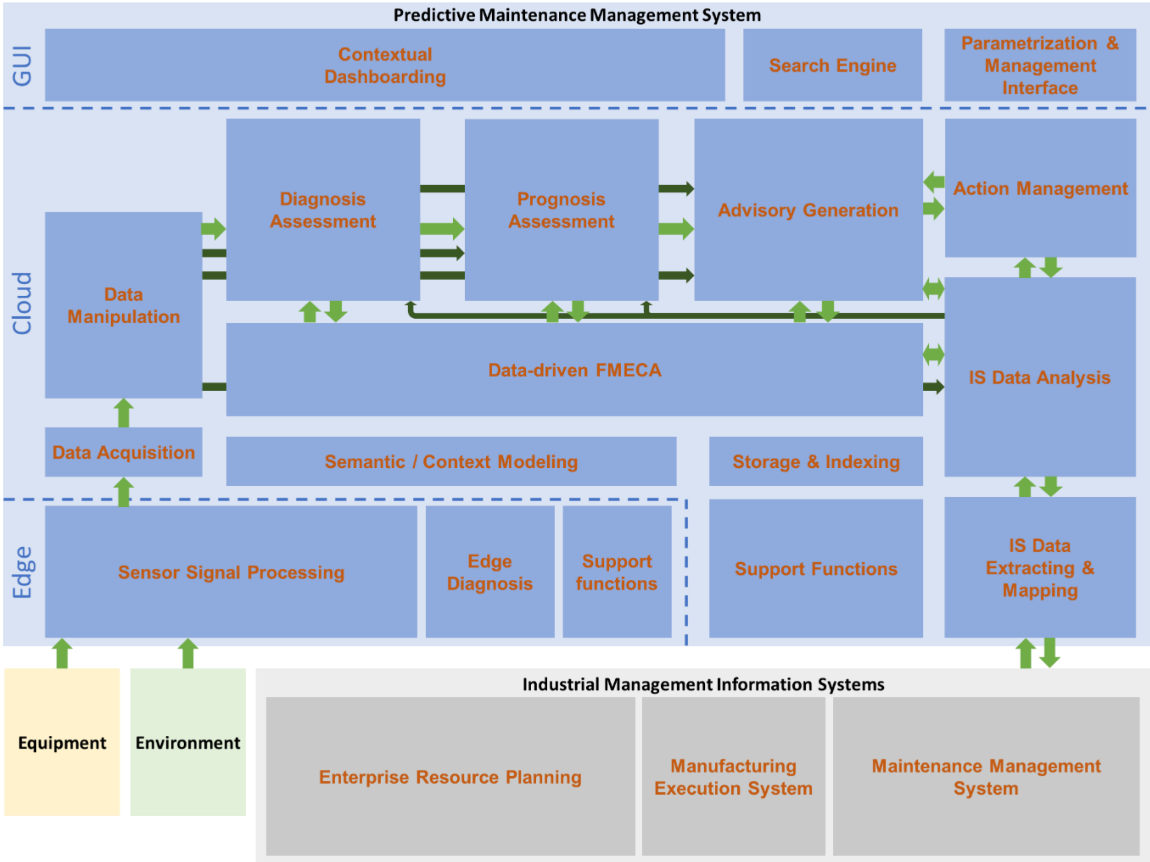


Figure 3-2 – UPTIME functional map (v9)

3.3. Innovative Exploitable Assets

The first step of the exploitation process we conducted consisted of:

- identifying the main research project expected outcomes,
- detecting the most promising results from an exploitation point of view: the "IEA" (Innovative Exploitable Assets),
- assessing their potential of innovation (in which extent, we are developing something new).

We started the exploitation plan by the identification of IEAs (Innovative Exploitation Assets), as shown below in Figure 3-3:

1. to reduce the complexity of exploitation by managing smaller pieces that could have value for exploitation,
2. to bring a common understanding of UPTIME results, enabling partners from different domain and having different prospective to converge (different objectives, cultures, background).

Our approach with IEA has helped partners to have a clear understanding of all project outcomes, products, services and knowledge generated within the project that could potentially be exploited.

Figure 3-3 – IEA approach to reduce project complexity

The identification of the IEA has been done by cross-checking UPTIME general description, the architecture, the functional map presented in section 3.2 and the functionalities prioritized with KANO model (detailed in D1.2).

We set up a preliminary list of IEAs at the beginning of the project, as presented in Table 3-1. This list has been updated with the partners all along the project, through periodical reviews: it has been expanded and amended with emerging exploitation ideas throughout the project lifetime.

Table 3-1 – UPTIME IEA list

IEA	Owner	Individual Value Proposition
1) Modular Edge Data Collection & Diagnosis	**BIBA**	Capture data from a high variety of sources and bring configurable diagnosis capabilities on the edge for real-time applications: Sensor & recipient agnostic hardware abstraction gateway; Adaptive & flexible data collection & diagnosis tool chain; Efficient stream data processing on the edge with cloud functionality
2) Structured & contextualized industrial data platform	**UBITECH**	Create « templated » mappings from custom schema to reference schema through a simple graphical mapping tool
3) Mapping & Extracting of Equipment data	**BIBA**	Providing a simple and configurable interface to transfer time-series based data (such as sensor streams) from the edge to the further centralized modules by guaranteeing annotations with necessary meta information, interfaces to different and extensible hardware types (from basic sensors over PLCs to complex information such as images) as well as providing data cleaning and wrangling functionality.
4) Mapping & Extracting of Legacy DB	**SUITE5**	Uplifting maintenance-related data from legacy and operational systems in various ways (e.g. as files or via APIs), extracting the data schema and semi-automatically identifying the relevant model mappings to the UPTIME reference model
5) Configurable Diagnosis & Health Assessment	**BIBA**	Intelligent diagnosis to provide a reliable interpretation of the asset's health
6) Configurable Prognosis	**BIBA**	Advanced prognostic capabilities, using generic algorithms or specifically tailored ones depending on need for optimization and user expertise
7) Continuously Improved Proactive Action Recommendation	**ICCS**	Provide continuously improved recommendations of optimal maintenance actions and optimal times of their implementation based on historical data and real-time prognostic results
8) Analysis of Legacy DB	**SUITE5**	Ensuring that up-to-date enterprise data are always in the loop of predictive maintenance by extracting rules and patterns and by gathering insights from existing data with the help of various analytics algorithms, partly addressing the cold start problem
9) Maintenance Actions Parametrization & Management interface	**UBITECH**	Manage predictive maintenance actions & their implementation: scheduling, traceability with links to existing systems for a consistent management of the maintenance
10) Industrial data dashboarding & visualization	**PTA**	Configurable visualization to save time analyzing data and getting insights, to support decision making and develop new solutions
11) Data-driven FMECA	**RINA**	Estimation of possible failure modes and risk criticalities evolution based on measured physical parameters

To prepare the exploitation of the results of UPTIME, we captured the most critical information of each IEA in a single structured document to be used as printed A3 – called Knowledge Brief (or K-Brief).

K-Brief was a powerful tool being used to share efficiently key information, facilitate discussions and support decisions between partners. Its template is presented in Figure 3-5.

For each IEA, the value must be characterized by the IEA producer (who "pushes" its value proposition) and by the business scenario (who "pulls" its expectations).

The producer of the IEA is the Owner of the related K-brief. The role of the owner is to:

- Promote the IEA,
- Identify the key contributors and business partners to involve,
- Plan and lead reviews on his K-brief,
- Ensure the progress of the K-Brief,
- Share and communicate on his work package using the K-brief.

K-brief is an effective way to help partners convergence (as shown in Figure 3-4): technical and academics partners providing IEA (push) and business partners supposed to use IEA (pull). It has been a continuous convergence process all along the project, as depicted in the following figure.

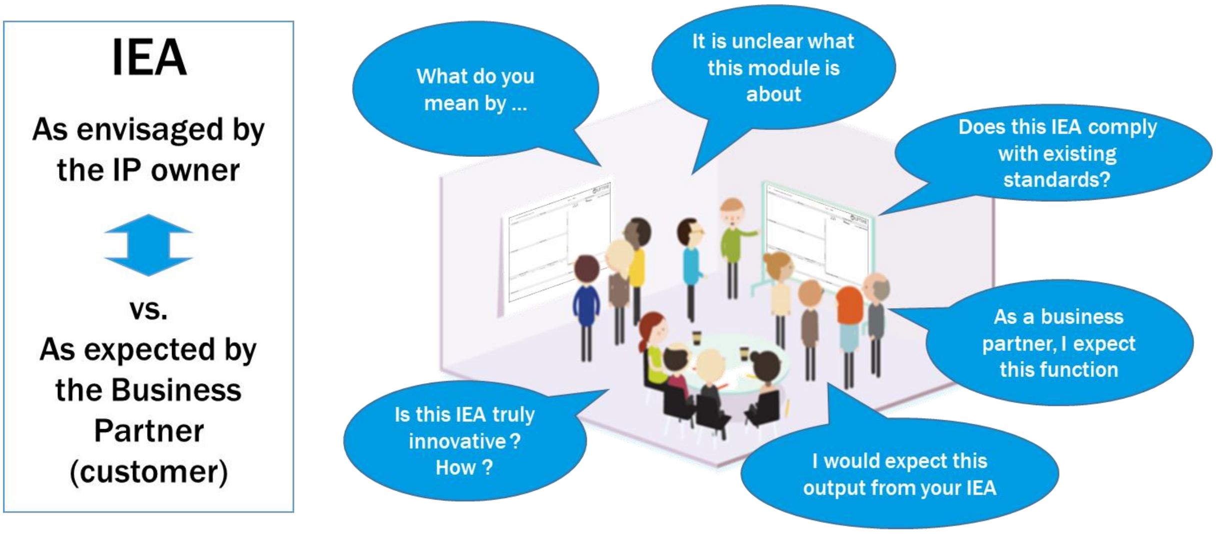


Figure 3-4 – Convergence process during UPTIME meeting

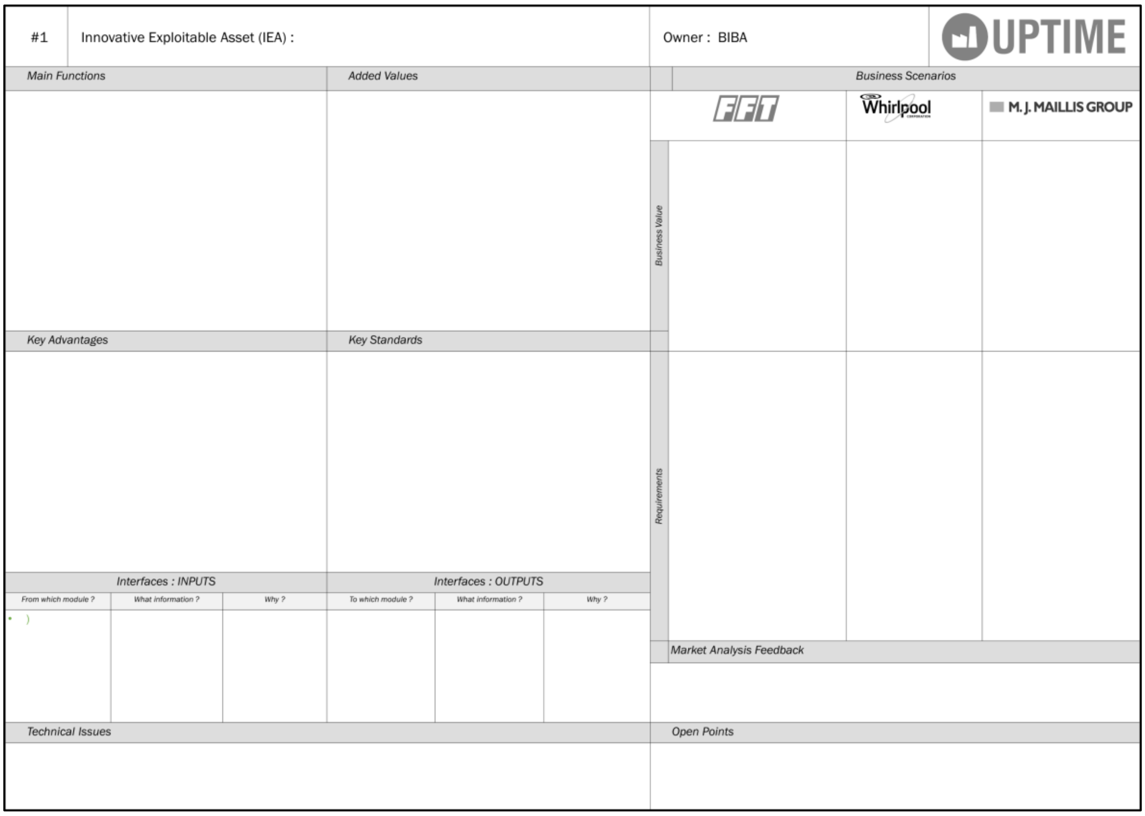


Figure 3-5 – IEA K-brief template

Left section of the K-brief (Figure 3-5)

The IEA innovation potential is captured in the left section of the K-brief, with analysis of the state of the art. It allows IEA owner to describe the differences of the innovation proposed by UPTIME compared to existing competing products and services.

Right section of the K-brief (Figure 3-5)

The link with business scenarios on the right of the K-brief aims to ensure that each feature will be exploited. In order to provide inputs and to test this research project, three very diverse business cases are addressed as proof of concept/demonstrators. These IEAs will be assessed regarding the three application scenarios (on the right side of the knowledge brief).

3.4. Resulting Value proposition

In order to dispose of an impactful UPTIME description for our contacts to target customers, we took time to formalize what is UPTIME Value Proposition based on each IEA value proposition and the functionalities prioritized with KANO model (detailed in D1.2).

The value proposition is a marketing statement for potential customers to make them understand the value and give them the willingness to buy. It should highlight that the product will bring more value than other similar offerings. We need to highlight what differentiates us from the competition, and clearly explain UPTIME positioning.

The objective here is to explain why UPTIME solution will be better than existing ones (distinguish UPTIME solution from the competition), indicating the level of innovation and our proposal beyond the state-of-the-art.

This content is useful for our market assessment during the project (for our interviews with target customers), but above all in the exploitation phases (after the end of the project) each time we need to discuss with a target customer. After discussions with partners (and before comparing to target customer and experts' point of view), the statement that has been selected is the following:

A fully adaptable, modular and integrable end-to-end predictive maintenance framework for industrial & manufacturing assets and high-value products, from sensor data collection to optimal maintenance planning. Through advanced prognostic algorithms, it predicts upcoming failures or losses in productivity. Then, decision algorithms recommend the best action to be performed at the best time to optimize total maintenance and production costs and improve OEE.

Benefits:

- *Acquisition and analysis of sensor-generated and historical data in an Industry 4.0 environment*
- *Advanced diagnostic and prognostic capabilities for detecting the current health state and the future behaviour of equipment based on streaming data and FMECA outcomes*
- *Continuously improved proactive decision-making capabilities for mitigating the impact of future failures and for planning appropriate actions*

Our vision is built upon the predictive maintenance concept and our technological pillars (i.e. Industry 4.0, IoT and Big Data, Proactive Computing) in order to result in a unified information system for predictive maintenance. Our open, modular and end-to-end architecture aims to enable the predictive maintenance implementation in manufacturing firms with the aim to maximize the expected utility and to exploit the full potential of predictive maintenance management, sensor-generated big data processing, e-maintenance, proactive computing and industrial data analytics. Our solution can be applied in the context of the production process of any manufacturing company regardless of their processes, products and physical models used.

Key features:

- *Sense:*
  - *Data aggregation from heterogeneous sources with universal connectivity gateways*
  - *Configurable diagnosis capabilities on the edge*
- *Detect:*
  - *Configurable Asset Diagnosis & Health Assessment*
- *Predict:*
  - *Configurable predictive algorithms to detect trends and estimate the asset's remaining useful life (RUL) and upcoming conditions*
- *Decide:*
  - *Proactive maintenance action/timing recommendations*
  - *Trade-offs of scenarios to consider alternative actions and impacts on costs*
  - *Continuously improved recommendations over time*
- *Act:*
  - *Action implementation management handled natively or through CMMS interface*

4. Competitive Analysis

As stated above, the objectives of the competitive analysis are to:

- Understand the ecosystem of predictive maintenance & identify market trends
- Identify how UPTIME position itself towards competition
- Propose recommendations on how UPTIME should be exploited

It goes without saying that this competitor analysis approach is intrinsically linked with the market need analysis. These two studies were conducted simultaneously as one enriched the other and vice versa.

4.1. Predictive maintenance competitive landscape

The platform ecosystem is very rich and fragmented. It was not conceivable to investigate all UPTIME's potential competitors individually. Based on UPTIME's IEA, we have identified the major companies that may be local or global competitors and sorted them in 6 categories:

- Maintenance service providers: e.g., Fives Maintenance, CMI Group
- Equipment manufacturer: e.g., Schneider Electric, General Electric
- Software editors: e.g., IBM, Microsoft Azure, SAP, Oracle
- Start-ups: e.g., Braincube, Uptake, SpaceTime Insight
- EU research projects: e.g., PROASENSE, Toreador, SPEEDD
- End-users internal projects: e.g., SAFRAN Analytics, EDF, SNCF

These categories of competitors offer the same main functionalities as UPTIME either partially or globally. Depending on the extent of its functionalities overlap, a competitor may be to a greater or lesser degree relevant towards UPTIME value proposition.

- Maintenance service providers and equipment manufacturers are not originally actors of the computing industry and they use the computing infrastructure of IBM Maximo / Microsoft Azure / Amazon Services for Cloud and processing capabilities to offer predictive maintenance solutions. They have developed a custom industry-oriented layer of applications and their competitive advantage is based on their knowledge and expertise of the industrial environment. They claim to be the best positioned with their expertise to deploy an adapted and integrated predictive maintenance strategy. To accelerate the deployment of new technologies in their processes, maintenance service providers have set up partnerships with technological partners. For example, Vinci Energies, through its Actemium brand dedicated to industrials, has partnered with the software editor Augmensys to develop industrial augmented reality solutions.

- The software editors are rushing into this new market segment: IBM, Microsoft, SAP have developed a predictive maintenance offer thanks to their expertise in Big Data, IoT and machine learning. These digital giants and start-ups could thus disrupt the competitive environment of PdM by capturing a growing share of the value. They provide a modular toolkit environment that enables the development of applications (on-site or Cloud solutions). They also provide a large range of modules that allows to meet customers' expectations thanks to their application marketplace. Thus, they are able to customize applications that meet companies' needs (user interfaces or application layers above their infrastructure). Their solutions may be more suited for large firms for custom-made applications and large deployments.

The predictive maintenance landscape is extremely fragmented and competitive. While numerous companies highlight their algorithmic capabilities as key differentiators, we find limited differentiation in technology and lack of adoption from customers. Furthermore, it is unclear if any technology differentiator will truly emerge to provide companies with enduring advantages.

The competitive environment for maintenance service providers has deteriorated in recent years:

- The market leverage of customers is overwhelming: industrial maintenance being a market governed by calls for bids, the price is today the main criteria for the choice of customers;
- New players are entering the market: equipment manufacturers increasingly offer "all inclusive" solutions including the supply, financing, installation and maintenance of equipment. Their objectives are to develop recurring revenues through multi-year contracts or to differentiate themselves from the competition;
- Competition from CMMS is intensifying: computer-aided maintenance software (CMMS) makes it possible to optimize the operation of internal repair-maintenance services. These tools are based on the prioritisation of the various maintenance operations required. As a result, customers have less need for maintenance service providers. Among CMMS leaders: Info, Mismo, CARL International;
- Intra-sector competition is exacerbated by the slowdown in activity and the homogeneity of supply. Of course, there are differentiation axes (progressive transformation of the actors from simple curative repair to predictive maintenance), but it has to be said that a large part of the basic offer is now commonplace and interchangeable
- As a result of strong competitive pressures in the sector, margins are deteriorating over the medium term. Operators have in fact resorted more frequently to subcontracting and temporary work in order to make their costs more flexible. They have also had to increase their expenditure on staff training and certification to operate in sensitive sites, such as for nuclear maintenance specialists.

In such a context, most maintenance players seek to take the leadership of the cost battle. For example, new technologies can offer better management of employee productivity. To this end, Cofely Endel rolled out the "Connected Operator" system to 5,000 employees in 2015. They now have a tablet and a software suite thanks to which they can consult the project's digital file as well as the various safety instructions and "good practices" during interventions. In the end, the operator's intervention time is reduced, and the reporting of operations is made more reliable thanks to the possibility of taking photos during interventions.

Industrial maintenance leaders are implementing new types of contracts to govern their relationships with customers. The aim is to better meet customers' expectations in terms of service quality and to highlight the value of their services to reduce deflationary pressures. The CMI group distinguishes itself from its competitors by offering several ranges of contracts (from the simplest to the most complex) to achieve a higher or lower level of performance (intermediate and final). For example, the group offers a global maintenance contract indexed to production where the remuneration of services is directly linked to the productivity of industrial equipment.

Historically, maintenance contracts were based solely on an obligation of means. The parties simply decide on the number of staffs, the frequency of visits to check the proper functioning of the equipment or the number of materials required. Today, more and more maintenance contracts are based on an obligation for results. Although these seem more restrictive for maintenance service providers, they nevertheless allow them to have their professionalism better recognised and to negotiate on criteria other than price. In a performance-based contract, only the result is contractual. The necessary means used are the responsibility of the maintenance service provider. It must use all the means necessary to obtain the result: the products used, the processes, the material assistance, etc.

The CMI group offers a wide range of services in industrial maintenance:

- *controls and monitoring of equipment*
- *periodic inspections, degradation analyses and repairs*
- *associated mechanical repairs (welding, machining, etc.)*
- *supply and management of spare parts*

In order to best meet the expectations of its clients, the CMI group has set up several types of contracts:

- ***maintenance in controlled expenses*** *where the cost of the intervention is directly function of the services and the means implemented*
- ***maintenance at the bills*** *where the intervention is described in terms of equipment, duration of services and cost*
- ***global flat-rate maintenance*** *which corresponds to the complete coverage of a given area for a given time and amount*
- ***global maintenance indexed to production*** *where the remuneration of services is directly linked to the production of equipment*
- ***delegated maintenance*** *by which customers outsource the management of their maintenance. Within this framework CMI takes all the necessary measures to ensure the optimal operation of the tool and achieve the performance objectives set. Delegated maintenance therefore includes audit, assistance, monitoring and training services that enable customers to significantly improve the technical performance of their industrial site without having the responsibility of coordination.*

Another avenue explored by professionals is to become pilots (or project management assistants) in the maintenance sector to advise customers on the increasing complexity of maintenance professions.

ADF develops know-how around four areas of expertise: calculation and related expertise, general installation and mechanical studies, project management assistance and technical document management.

ADF offers services in preparation for unit outages. To do this, it relies on maintenance know-how and a maintenance engineering office that masters the standards intended to guarantee health, safety and the environment on the site by carrying out risk analysis.

4.2. Functional benchmark

In our analysis, we have compared potential competitors by the functionalities that they claim to offer as marketed on their website.

Table 4-1 – Functionalities comparison

Feature	Number of competitors who claim that they offer it	Comments
Edge data collection & diagnosis	34 out of 61 competitors (59.6%)	Very few of them (5 out of 34) highlight their configuration and customization capabilities in their presentation, stating that it can be an option. 2 out of these 5 specify that it can be done through a third-party integrator
Data Acquisition	55 out of 61 competitors (96.4%)	Basic functionality for a predictive maintenance platform
Diagnosis	52 out of 61 competitors (91.2%)	30 out of the 52 highlight their health assessment capabilities. The others only send alerts if the sensor exceeds a pre-specified threshold
Prognosis	34 out of 61 competitors (59.6%)	Only 10 out of the 34 offer an existing & configurable algorithm repository Only 14 out of the 34 is compatible with several types of analytics techniques
Advisory generation & decision-making	17 out of 61 competitors (29.8%)	Only 6 out of the 17 can take into account production schedule and costs Only 1 out of the 17 provide maintenance scenario trade-off analysis to consider alternative solutions
IS interfacing and data analysis	20 out of 61 competitors (35%)	None of them highlight the possibility to interact with existing legacy systems, to generate maintenance ticket or to allocate resources or to automatically modify production planning
FMECA	0 out of 61 competitors (0%)	Functionality that is not highlighted in their website marketing message. However, during our face-to-face interviews, some of them actually do rely on a FMECA model to identify possible failure modes and risk criticalities

Most interviewed companies only offer condition-based maintenance with limited predictive capabilities as detailed in Table 4-1. Furthermore, a few offer an assisted decision-making for operators and even less are looking to optimize a full suite of operational and scheduling problems. These higher-level intelligence functions are just starting to emerge, and the level of vertical customization required is high. Nonetheless, this is where the true value of predictive maintenance solutions will eventually manifest. By integrating operational data with ERP, we will have solutions that finally "close the loop" for business. This is mostly due to the fact that most predictive maintenance solutions are relatively recent (few years).

Technologically speaking, algorithms and advanced analytics capabilities are not relatively innovative. It is rather the application of these technologies in the field with proven results which is very rare. Every PdM provider has already deployed condition-based monitoring projects but none of them, among the interviewees, have deployed an integrated and full predictive maintenance project. They claim that available data is not sufficient to obtain a robust analytic model as historic data collected by their customers is, in most cases, unexploitable and unreliable.

5. Market approach towards PdM

In parallel to UPTIME competitive analysis, we analysed the demand side in order to:

- Identify potential client's needs and challenges (section 5.1)
- Understand how end-users elaborate their PdM strategies (section 5.2)
- Test receptivity of UPTIME value proposition and identify perceived strengths & weaknesses (section 5.3)

To reach these objectives, we have conducted a desk research analysis, two waves of one-to-one interviews and an online market survey campaign, which methodology is detailed in Appendix B. The following sections then develop their combined findings and results.

5.1. Client's needs and challenges

Benefits of implementing a PdM solution

When asked about the perceived benefits of a predictive maintenance solution (Figure 5-1), industrial perceived asset uptime improvement as the most interesting with almost half of the respondents identifying it as their primary goal.

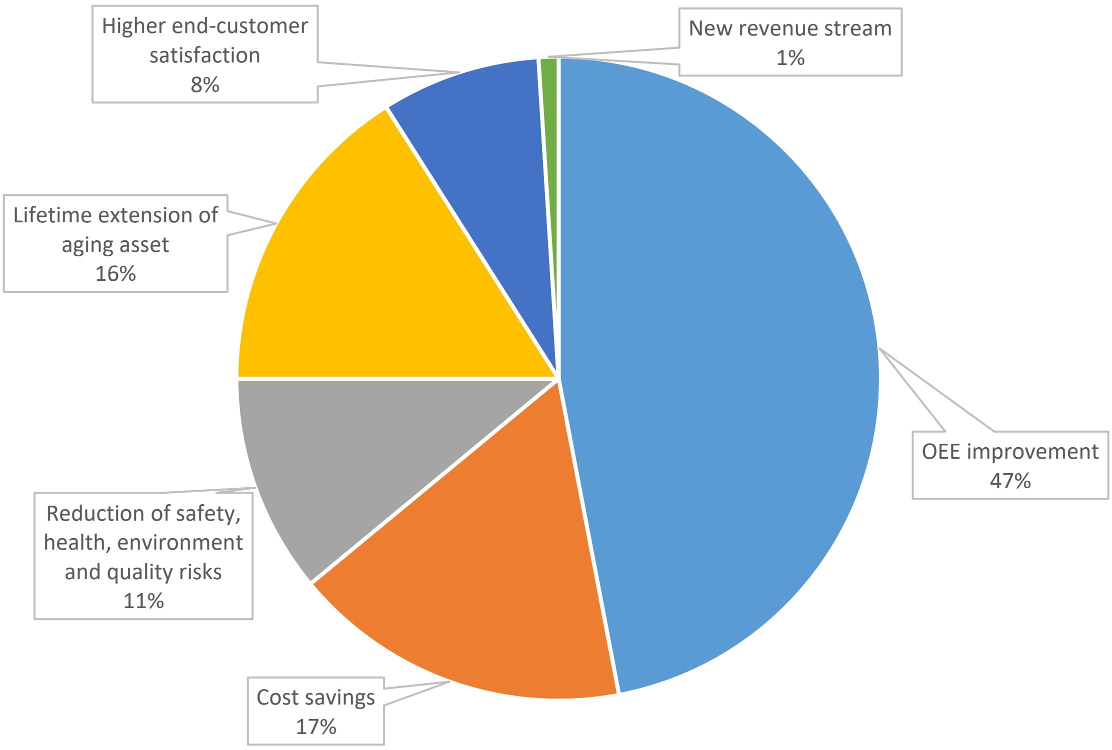


Figure 5-1 – Perceived benefits of PdM (source: PwC study)

Barriers of implementing a PdM solution

A further inhibiting factor is the **perceived lack of organization resources** required to support deployment. The rationale is that many plants are struggling with skill shortages to support Industry 3.0 practices. Given that Industry 4.0 is based on Big Data, the industrial sector lacks the expertise for wide-scale adoption.

Many enterprises are addressing seemingly more pressing issues ranging including **aging infrastructure, regulatory and commodity pricing pressure**.

Another intrinsic challenge is the limited **availability** and **ownership** of **data**. In our research, we found that while the solutions we assessed delivered economic benefits when fully up and running, implementing them in the first place was more difficult than expected. In most cases, a large company needs much more time to collect, scrub, and share necessary data than a startup needs to train the solution itself. The problem is even more pronounced in industries where ownership, operation, and maintenance of the machines and thus data ownership may be split across different parties; or where there is a large proportion of legacy assets – which is often the case today. Although the declining cost of sensors and data management technologies, increased connectivity and the adoption of standard platforms are helping to alleviate these challenges, it is still unclear who will eventually own the data and if the analytics application providers will have the access necessary to build mature solutions. Data availability and ownership remain key hurdles facing the industry.

The technology industry is accustomed to **rapid cycles** of product and architectural evolution, with today's state-of-the-art expected to become dated in 3 years. In the industrial world, especially where critical equipment is involved, these cycles can last up to 40 years. As a result, many industrial businesses will often postpone adopting new technology, because upfront costs are expensive, technologies may not be proven, and leaders may be reluctant to change processes that may have been intact for over 30 years. Ironically, the lure of new features and the dynamic pace of change in PdM may cause many industrial firms to delay decisions until the dust has settled.

PdM solutions have typically required a high degree of vertical **customization** - with specific models developed for each use case (we refer to this as a model-driven approach). This approach offers a high degree of accuracy, but at higher cost; the lack of horizontal replicability across industries reduces economies of scope and hinders widespread adoption. Furthermore, developing new models for any specific use case is laborious. This partly explains why condition monitoring – which is largely a horizontal and repeatable solution – has been the most widely adopted. The industry is changing, however, as a newer generation of artificial intelligence powered solutions moves to data-driven machine learning approaches that accelerate deployment and training cycles. Second, PdM applications need to address a richer array of business problems and serve up actionable solutions to users, not simply flag failures. We are starting to see this happen as predictive and prescriptive maintenance applications integrate ever-larger sets of input - delivering more useful output not just at the asset level, but for the factory and eventually the enterprise.

5.2. How do end-users tackle PdM?

The predictive maintenance approach varies across industries and largely depends on the types of equipment and assets in use. Though predictive maintenance seems intuitive, it may not be worth setting up predictive maintenance if its benefits will be negligible compared to the investment needed to implement it. A structured process for organizations to design the predictive maintenance strategy is detailed below.

1) **Define the desired business outcome**: is our goal to increase margins, reduce downtime or provide new offerings to customers? These considerations will help decide if the PdM implementation cost is lower than the expected costs savings and will allow to define the ROI (return of investment)

2) **Create list of equipment**: list all the equipment on the plant floor and, particularly, critical equipment that require continuous monitoring for seamless operations

3) **Evaluate equipment criticality**: evaluate how indispensable the equipment is with respect to overall operations and maintainability

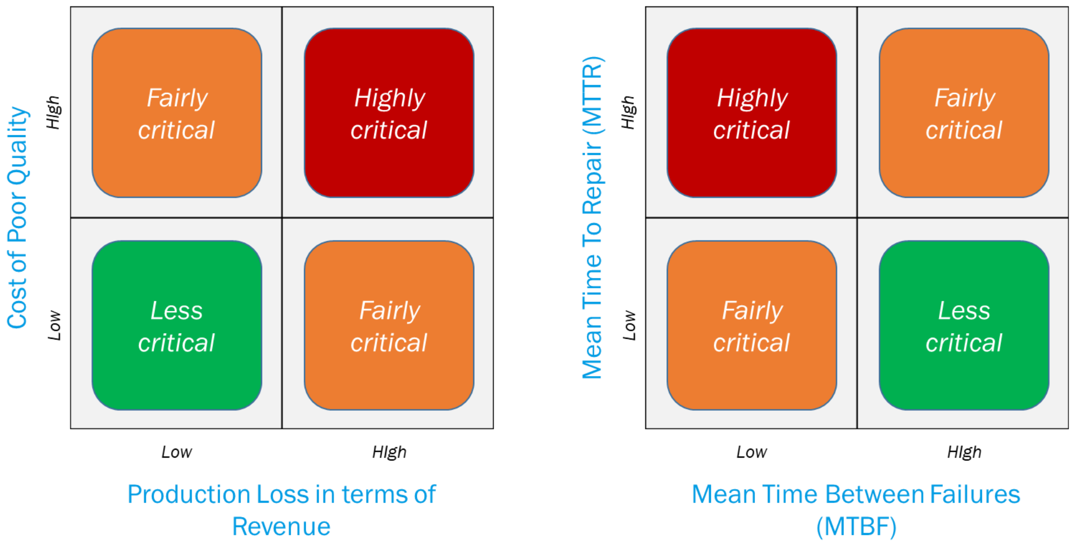


Figure 5-2 – Criteria to determine the criticality of assets

4) **Identify the equipment that is feasible for monitoring**: Having arrived at the critical equipment list, the next step is to identify if the equipment is feasible to be monitored. Monitoring equipment with high criticality will be of less gain if the equipment doesn't produce reliable or quality data or the equipment is not compatible to be retrofitted with required data sources. A few critical factors that should be analyzed when determining the equipment feasibility for monitoring are detailed below.

- *Do we have enough reliable data – both historically and currently being generated – to tell the complete story of the machine? This can either involve datasets from a few machines operating for a couple of years or datasets from many machines operating during a shorter period.*

- *Can we access this data off the factory floor? For example, can we upload historic data or connect machines via IoT gateways to start posting the data?*
- *Do we have any other data sources that can augment this data, such as log files, maintenance records or weather data?*
- *Do we have experts available who can describe the patterns of success or failure for a particular asset?*

The extracted data should have the following characteristics:

- *Reliability: the ability to produce stable and consistent result over subsequent iterations*
- *Resolution: the accuracy with which the gathered data can depict the exact health of the equipment*
  Networking: the ability to collect data from equipment and share it with other sources for analysis

5) **Selecting the appropriate analytical model** Once the critical equipment identified is feasible for remote monitoring and implementing preventive maintenance techniques, the next key step is to select an appropriate analytical model. The selection of the analytical model depends on the type of equipment, failure mode and cause, and the signal type and failure time frame.

5.3. Receptivity towards UPTIME Value Proposition

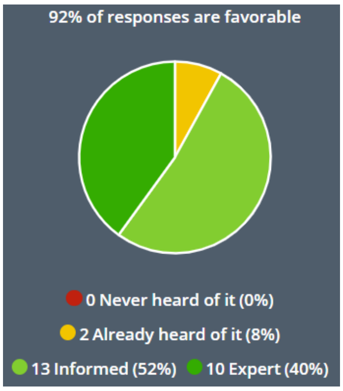
After having developed how end-users perceived predictive maintenance in sections 5.1 and 5.2, section 5.3 will present how they perceive the UPTIME platform. To do so, the value proposition defined in section 3.4 has been tested among potential adopters and potential partners to identify if UPTIME is relevant to the market, through the waves of one-to-one interviews and the online market survey campaign.

Results of the online market survey campaign:

The following questions have been asked to potential clients and partners as part of an online market study campaign. The methodology of this campaign is detailed in Appendix B. Out of the 4344 professionals that have been reached by e-mail, 899 (21% out of 4344) opened it, 413 (46% out of 899) followed the link of the UPTIME technical brief, 41 (10% out of 413) replied using the online survey tool. The respondents have been presented with UPTIME technical brief (shown in Appendix B) and were asked to answer the following questions:

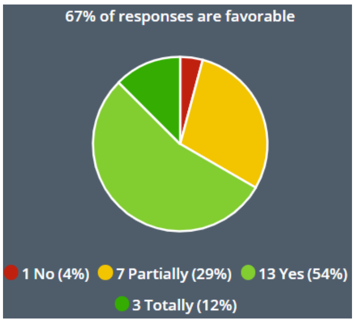
Expertise: ***Are you concerned with industrial equipment maintenance?***

92% of the interviewed professionals consider themselves to be experienced or experts in the maintenance of industrial equipment.



Context/Issue: ***Do you agree with the following statement about existing solutions?***

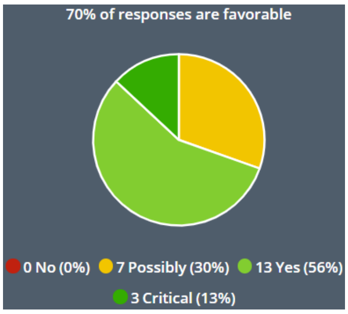
The market context seems promising, 67% of professionals agree with our assessment (cf. Appendix B) on current maintenance solutions.



Market need: ***Is it a critical issue?***

70% of professionals confirm that, beyond the assessment, the market need is quite marked. No professional considered that the need was inexistent.

Note a remark on the difficulty of integrating solutions between them, which would be the real current challenge on this market according to a professional.



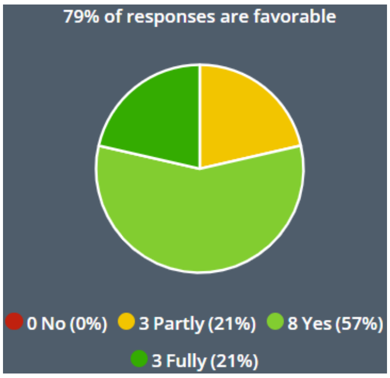
"All companies I have worked with have their systems and teams working on predictive with Data Centers, team of computers guys and so on - Most are ahead of the curve on how to do and usage. The issue is ***integration between all the systems*** *for users (Ex: FLS and ABB in a plant)"*

André Pedneault, *Coach, Contract/Transition Manager - Komatsu Australia*

Relevance: ***Is it a relevant solution?***

According to professionals, the solution is well adapted to the issue stated before. No professional considers that the UPTIME solution is not relevant.

It should be noted, however, that several professionals did not express an opinion: some comments point to a too superficial value proposition, preventing them from fully comment at this stage.



"For me it is a general description of 'the' predictive maintenance concept: what is that concept? Is it an ISO-standard, is it another (inter-)national standard, is it your own standard?"

Leo Meerman, *Owner - CELT Consultancy B.V.*

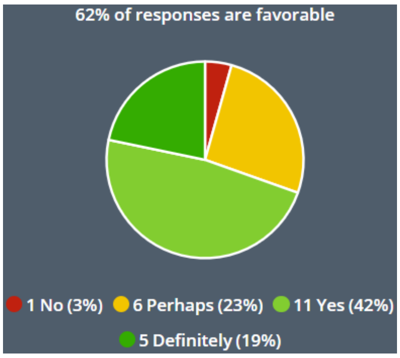
"It all sounds good, but I need to understand the actual integrated working parts of your system to be able to fully understand and grade it properly."

Derrick Zaharia, Plant and Property Manager - Balmoral Hall School

<u>Differentiation</u>: ***Is it truly innovative?***

According to 62% of professionals, the solution is perceived as innovative compared to existing solutions.

Some professionals have difficulty perceiving the precise differences with the many predictive maintenance solutions already available. One of the key success factors is then to clarify the differentiation and competitive advantages of UPTIME from this existing ecosystem.



> *"The question you should be asking is why is yours different? Why is it better than SAP, GENEVA, MAXIMO or other CAFM's out there that can already integrate sensors?"*
>
> Matt Wilkie, *Asset Integrity Specialist - AssetSurveyor.co.uk.*

Conclusion

Overall, the comments on the value proposition are rather positive and the concept is validated by the market. The main areas of improvement of the pitch would be to:

- Clarify the differentiating value of UPTIME and highlight its competitive advantages that differentiate it from the already dense competition
- Bring technical proofs (testimonies, figures, videos, etc.) to illustrate the value proposition, maximize its impact

Focus #1: ***Data aggregation from heterogeneous sources are highly appreciated. However, it may appear unrealistic.***

Positive feedbacks from market players:	Points to be considered:
• *"Data aggregation from heterogeneous sources & universal connectivity gateways"* • *"Edge diagnosis is also a good point, but it depends on how it is implemented"*	• *"It seems a little overpromising about data collection: a big pain especially when you have to deal with retrofitting projects. Physical and protocol compatibility doesn't assure a real data ingestion, because of proprietary protocols that need to be decoded."* • *"It needs a lot of historical data to create meaningful statistical samples"*

Focus #2: ***Configurable algorithms are perceived as a competitive advantage. However, it may appear unfeasible.***

Positive feedbacks from market players:	Points to be considered:
• *"One point that can make the difference with this solution is the capability to predict events and detect trends using configurable algorithms."*	• *"Implementing generic predictive algorithms is not so simple: features engineering strategy / choice of the most important variables / choice of the best model & parameters => complex and time-consuming activity, scalability of the solution is limited"*

Focus #3: ***Beyond all the perceived benefits of a predictive maintenance strategy, cost of implementation, data confidentiality & accuracy and integration difficulties are still barriers of adoption***

Positive feedbacks from market players:	Points to be considered:
• *"One of the main advantages of these type of systems is the savings on planned maintenance versus unplanned maintenance cost. Huge savings!"* • *"The long-term economical outcome looks interesting"*	• *"Cost of implementation and maintaining it going forward. Ok for new equipment. Not sure how you would manage retrofit"* • *"The issue is integration between all the systems for users (Ex: FLS and ABB in a plant)"*

• *"The strength is the modular vision and the ability to have a unified framework that really covers all issues of IoT, bigdata and processing/computing. Very beneficial!"*	• *"It may be the future but it will be difficult to generalise to all types of companies."* • *"Last but not least, most competitive production companies, are not fund of IoT and Bigdata because of confidentiality."*

Focus #4: ***Human aspects are not to be neglected. Even if some professionals praise the further automation of maintenance actions, some point out that skilled teams with experience will still be essential in the future.***	
Positive feedbacks from market players*:* • *"This is definitely a must for future. We cannot count on human's observation method as we used to do, we cannot allow unpredicted and unexpected failure of autonomous machinery, we definitely need close to perfect predictive maintenance system. "*	Points to be considered: • *"The maintenance recommendations and process simulation scenarios will be as good as the insights of engineers (who will make these scenarios)"* • *"However, there is still a black hole if the predictive management system fails or is not able to work, for example due to a lack of power supply. In that case there will be always the human hand to solve it."* • *"Technology is advancing and giving us experts more usability.........but we also have to train our technicians."*

6. Business opportunity assessment

In parallel to our market receptivity analysis, we assessed the business opportunity within reach of UPTIME (section 6.3) after having identified the market segments with the most potential (section 6.1 and 6.2)

6.1. Market segmentation

To have a clear view of the impacted markets in a "vertical" way, we have conducted a market segmentation analysis to identify homogeneous types of industries with respect to UPTIME. It is crucial to segment our market as there is not only one homogeneous market across industries. Each company will not have exactly the same expectations and needs towards UPTIME. Thus, in order to identify categories of customer that share common characteristics, we have identified the following segmentation criteria:

- Needs, expectations, challenges in terms of maintenance
- Maintenance strategy, propensity to invest in innovation
- Type of equipment and assets, lifecycle duration, maintenance needs, industrial information systems, etc.

By identifying segments of industries, we will be able to outline profiles and better understand segments' needs and purchase motivations, allowing us to adapt our marketing messages by segment and facilitate strategic decisions. The end objective is to identify high yield segments that are likely to be the most profitable or that have high growth potential to target specifically.

Our starting point for our market segmentation analysis was the industry types defined in the NACE Rev. 2[2] classification. This tree-like classification categorizes the types of activities in divisions, groups and classes.

The first 3 macro-groups of industrials that have been primarily targeted by UPTIME at the beginning of the project are the following:

- Manufacturing
    - Discrete manufacturing: *identical products are duplicated by way of an assembly line*
    - Process manufacturing: *the end product is unable to be unassembled to its original raw materials*
- Complex systems operators: e.g., airlines operating airplanes
- Utilities & Infrastructure: e.g., electricity, oil & gas, telecommunications infrastructure

Each one of these macro-groups have been detailed in the **Table 6-1**.

[2] Statistical classification of economic activities in the European Community used by the European Commission (link) in its 2nd revision

Table 6-1 – Market segmentation

Sectors		NACE code	Examples of organizations	Turnover in EU28 in 2015[3] (EUR million)
Discrete Manufacturing	Manufacture of air and spacecraft (civil and military)	C30.3 C30.4	Airbus, Thalès, Dassault, BAE Systems, Safran	147 645
	Manufacture of motor vehicles, trailers and semi-trailers	C29 C30.9	Renault, PSA, Volkswagen	925 430
	Building of ships and boats	C30.1	Naval Group, Hyundai Heavy Industries, Fincantieri, Navantia	36 626
	Manufacture of railway locomotives and rolling stock	C30.2	Alstom, Bombardier Transportation	22 327
	Manufacture of metals and fabricated metal products & others	C23 to C25	ArcelorMittal, Lafarge	809 449
	Manufacture of electrical equipment	C27	Valeo, Siemens	294 826
	Manufacture of machinery and equipment	C28	Siemens, Continental	640 000
	Manufacture of wearing apparel and leather products	C14 C15	H&M	124 977
	Manufacture of computers, electronic and optical products, electrical equipment	C26	Apple, HP, Fujitsu, Sony, Dell, Nokia, Ericsson, Philips, Alcatel	290 637
	Manufacturing of furniture	C31	Kinnarps, Steelcase, Vitra	95 485
	Other manufacturing (jewellery, bijouterie, sports goods, games, etc.)	C32	Bulgari, Cartier, Swarovski	117 029
Process manufacturing	Manufacture of food products and beverages	C10 C11	Nestlé, Unilever, Danone, Heineken	1 095 329
	Manufacture of tobacco products	C12	British American Tobacco, Imperial Tobacco, Swedish Match	44 366
	Manufacture of textiles	C13	Müller, Beaulieu, Tetcon	77 000
	Manufacture of wood and paper products	C16 C17	Stora Enso, UPM, SCA, Mondi Group, Sequana Capital	305 118
	Printing and reproduction of recorded media	C18	Bertelsmann, Toppan, Lagardere	82 434
	Manufacture of chemicals, rubber, plastic	C20 C22	BASF, Bayer, Linde, Henkel, Solvay	837 109
	Manufacture of pharmaceuticals	C21	Novo Nordisk, Actavis, GSK, Sanofi, Novartis	245 206
Complex systems operators	Air transport	H51	Lufthansa, Air France-KLM	148 200
	Land transport	H49	DHL, XPO Logistics, SNCF, UPS	577 000
	Water transport	H50	CMA CGM, SNCM	120 000
Utilities & Infrastructure	Electric power generation, transmission and distribution	D35.1	EDF Group, E.ON	1 102 084
	Manufacture of gas; distribution of gaseous fuels through mains, manufacture of coke and refined petroleum products	D35.2, C19	BP, Total, ENI, Shell, Statoil	616 951
	Water supply, sewerage, waste management	E36 E37 E38	Veolia, Suez, United Utilities, GE Water	259 000
	Telecommunications	J61	Vodafone, Orange, Deutsche Telekom	390 000
Other	Postal and courier activities	H53	La Poste, Deutsche Post	122 485
	Mining and quarrying	B05 to B08	Glencore, Rio Tinto, Frepport-McMoran	147 030
	Construction of buildings, civil engineering & specialized construction activities	F41 to F43	Vinci, Bouygues, ACS, Eiffage	867 078

[3] Figures from Eurostat : http://ec.europa.eu/eurostat/web/main/home

6.2. Market prioritization

Prioritizing the market helps us focus efforts, especially for orienting the development and steering the market effort. To identify high yield segments that are likely to be the most profitable for UPTIME, we have conducted a market prioritization analysis that is described in this section.

The analysis begins as a two-dimensional matrix which dimensions are multifactorial with sector attractiveness measures (Y-axis) and business strength measures (X-axis). These two dimensions are detailed below.

6.2.1 Sector attractiveness (Y-axis)

This dimension aims at estimating the attractiveness of the market by analyzing the benefits a predictive maintenance platform is likely to get by entering within this market. Sector attractiveness indicates how hard or easy it will be for UPTIME to earn profit in that market. The more profitable the industry is the more attractive it becomes. This requires analysing the potential of the sector with regards to predictive maintenance. To do so, we have identified a list of factors that have an influence on the adoption of predictive maintenance, the weighted combination of which allowed us to define an overall sector attractiveness score, detailed in Table 6-2:

- **Sector turnover**: The larger a sector is the more potential there is to develop a business as the business efforts to enter it are diluted compared to its business potential. However, the smallest industries are not to be discarded yet as they could represent a niche market where a successful business strategy can lead to a greater market share. Hence, in our analysis, we did not consider low sector turnovers to have a negative effect on sector attractiveness.

NB: It must be noted here that the factor analysed here is sector size rather than growth rate. Growth rate, in our particular context, cannot be interpreted to imply a direct positive effect on predictive maintenance adoption. Indeed, a shift from traditional maintenance strategy towards a predictive one falls within a cost optimization strategy, which would be more sought in a mature industry when the growth is slow, stagnating or declining than when it is high. However, for high growth industries that are developing their means of production, building new plants, they will of course use state-of-art technologies and try to deploy a predictive maintenance strategy. Hence, growth rate has not a direct effect and we would need to analyse the sectors case by case to take it into account, in our context.

- **Investment capacity**: The activity of maintenance also depends on investments by industrial companies to set up a new production line. Indeed, the expansion of a plant's capacity implies the installation of new equipment, and therefore potentially repair and maintenance work. The reduction of industrial sites due to the deindustrialisation of certain countries implies a reduction in the potential number of repair and maintenance operations. Hence, a low investment rate will have a negative effect on the sector attractiveness as it is less likely to adopt and invest in new types of maintenance.

- **Equipment usage rate**: The production capacity usage rate in manufacturing industry has a major influence on the maintenance activities. Underutilization of equipment means fewer potential failures. Conversely, intensive use of industrial equipment (during periods of economic recovery) can lead to breakdowns and malfunctions where an optimization of maintenance is more critical.

- **Capital intensity**: Capital-intensive industries use a large portion of capital to buy expensive machines, compared to their labour costs. Hence, the more capital-intensive a sector is, the more industrial maintenance is critical to it and conversely.

- **Predictive maintenance relevance**: Even if maintenance is relevant to every sector that has to maintain its assets, predictive maintenance can be more relevant for some than others. In particular, industries that use complex, automated and critical production lines to produce a long range of products with high volumetry are more prone to adopt predictive maintenance. Similarly, industries that operate critical equipment in dangerous or inaccessible conditions (nuclear powerplants, hydrokinetic turbine, etc.) will have more stakes in these technologies.

			Sector Attractiveness				
		NACE code	Sector Turnover	Investment capacity	Equipment usage rate	Capital intensity	Predictive maintenance relevance
Discrete Manufacturing	Manufacture of air and spacecraft (civil and military)	C30.3 C30.4	1,4	1,5	0,8	1,5	1,0
	Manufacture of motor vehicles, trailers and semi-trailers	C29 C30.9	3,0	1,5	1,5	1,8	4,0
	Building of ships and boats	C30.1	1,1	1,5	0,8	0,8	1,0
	Manufacture of railway locomotives and rolling stock	C30.2	1,0	0,9	0,8	1,0	2,0
	Manufacture of metals and fabricated metal products & others	C23 to C25	2,8	1,5	0,5	1,9	3,0
	Manufacture of electrical equipment	C27	1,5	1,1	1,0	1,2	4,0
	Manufacture of machinery and equipment	C28	2,2	1,1	0,7	1,3	3,0
	Manufacture of wearing apparel and leather products	C14 C15	1,2	0,9	0,8	2,4	1,0
	Manufacture of computers, electronic and optical products, electrical equipment	C26	1,7	1,8	1,2	1,3	3,0
	Manufacturing of furniture	C31	1,2	1,2	0,7	1,2	1,0
	Other manufacturing (jewellery, bijouterie, sports goods, games, etc.)	C32	1,2	1,1	0,7	1,4	1,0
Process manufacturing	Manufacture of food products and beverages	C10 C11	3,0	1,8	1,0	2,7	3,0
	Manufacture of tobacco products	C12	1,1	1,3	1,0	2,4	1,0
	Manufacture of textiles	C13	1,1	1,4	0,8	1,9	2,0
	Manufacture of wood and paper products	C16 C17	1,6	2,0	0,7	2,2	1,0
	Printing and reproduction of recorded media	C18	1,1	2,0	1,0	2,1	2,0
	Manufacture of chemicals, rubber, plastic	C20 C22	2,4	1,0	0,5	1,9	3,0
	Manufacture of pharmaceuticals	C21	1,5	1,0	1,1	1,6	2,0
Complex systems operators	Air transport	H51	1,3	3,1			3,0
	Land transport	H49	2,0	2,5			1,0
	Water transport	H50	1,2	4,2			2,0
Utilities & Infrastructure	Electric power generation, transmission and distribution	D35.1	3,0	4,1		4,4	3,0
	Manufacture of gas; distribution of gaseous fuels through mains, manufacture of coke and refined petroleum products	D35.2 C19	2,1	4,6		3,6	3,0
	Water supply, sewerage, waste management	E36 E37 E38	1,4	4,1		1,9	2,0
	Telecommunications	J61	1,7	3,0		1,9	2,0
Other	Postal and courier activities	H53	1,2	0,7		0,8	2,0
	Mining and quarrying	B05 to B08	1,3	4,2		4,2	1,0
	Construction of buildings, civil engineering & specialized construction activities	F41 to F43	2,6	1,6		1,4	1,0

Table 6-2 – Sector Attractiveness by Market Segment

6.2.2 UPTIME's business strength (X-axis)

The other dimension that makes up the prioritization matrix is the competitive or business strength of UPTIME itself, detailed in Table 6-3. An assessment along this dimension aims at estimating whether UPTIME has the required competence to compete in this particular market. We have identified two factors that provide UPTIME with a competitive advantage:

- **Value proposition adequation**: The value proposition that has been formulated in section 3.4 describes what brings value to the end-user customer and also what differentiates us from the competition. This value proposition may not be equally relevant to all the targeted sectors. For example, the integration with legacy systems capability provided by UPTIME may not be interesting for industries that are not known for having deployed CMMS or MES systems. In the same way, the universal sensors gateway capability may be more interesting for complex production lines that use various types of machinery than for a pipeline. Hence, the relevance of each part of UPTIME's value proposition has been assessed with respect to each sector.

- **Ability to access the market**: UPTIME's ability to win contracts may not be equal for all the sectors. For example, as we are already deploying the platform at the premises of our three business partners, the companies that are in the same sector may share a similar use-case and may be more likely to be convinced by UPTIME. Furthermore, the size of industrial end-users in the segment is also a factor that influence UPTIME's ability to enter it. Large industrial groups benefit from experience and have a dedicated purchasing department. They may therefore be more demanding of predictive maintenance platform providers and will be more likely to develop in-house solutions.

Table 6-3 – UPTIME's Business Strength by Market Segment

			UPTIME Strength	
		NACE code	Value proposition adequation	Ability to access market
Discrete Manufacturing	Manufacture of air and spacecraft (civil and military)	C30.3 C30.4	4,0	1,0
	Manufacture of motor vehicles, trailers and semi-trailers	C29 C30.9	4,0	2,0
	Building of ships and boats	C30.1	3,0	1,0
	Manufacture of railway locomotives and rolling stock	C30.2	2,5	2,0
	Manufacture of metals and fabricated metal products & others	C23 to C25	3,0	4,0
	Manufacture of electrical equipment	C27	3,0	3,0
	Manufacture of machinery and equipment	C28	3,0	4,0
	Manufacture of wearing apparel and leather products	C14 C15	3,0	3,0
	Manufacture of computers, electronic and optical products, electrical equipment	C26	3,0	2,0
	Manufacturing of furniture	C31	3,0	3,0
	Other manufacturing (jewellery, bijouterie, sports goods, games, etc.)	C32	2,5	1,0
Process manufacturing	Manufacture of food products and beverages	C10 C11	3,0	2,0
	Manufacture of tobacco products	C12	2,0	3,0
	Manufacture of textiles	C13	2,0	2,0
	Manufacture of wood and paper products	C16 C17	2,0	1,0
	Printing and reproduction of recorded media	C18	3,0	3,0
	Manufacture of chemicals, rubber, plastic	C20 C22	3,0	2,0
	Manufacture of pharmaceuticals	C21	3,0	1,0
Complex systems operators	Air transport	H51	2,0	4,0
	Land transport	H49	1,0	1,0
	Water transport	H50	1,0	2,0
Utilities & Infrastructure	Electric power generation, transmission and distribution	D35.1	3,5	3,0
	Manufacture of gas; distribution of gaseous fuels through mains, manufacture of coke and refined petroleum products	D35.2 C19	3,0	1,0
	Water supply, sewerage, waste management	E36 E37 E38	2,0	2,0
	Telecommunications	J61	2,0	1,0
Other	Postal and courier activities	H53	4,0	3,0
	Mining and quarrying	B05 to B08	3,0	1,0
	Construction of buildings, civil engineering & specialized construction activities	F41 to F43	1,0	2,0

6.2.3 Segment prioritization matrix

The segment prioritization matrix is strategy tool that offers a systematic approach to prioritize its marketing effort and deployment strategy in order to ensure their maximum effectiveness. Figure 6-1 describes the framework that has been used to identify the sectors that hold the highest potential. They are those that present the highest sector attractiveness and that are the most receptive towards UPTIME strengths.

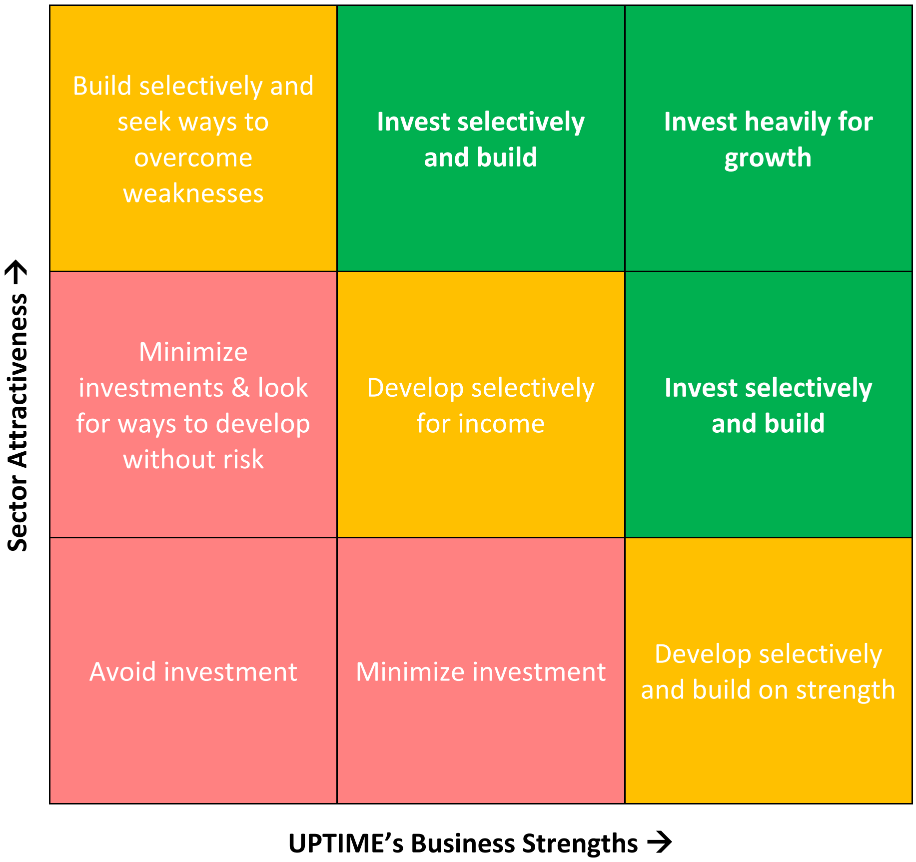


Figure 6-1 – Attractiveness-Strength Matrix Framework

The results of our analysis are presented in the Figure 6-2 below. The sectors that present the highest potential are highlighted in green and framed in red in the upper-right corner of Figure 6-2. Those results will be analyzed in section 6.4.

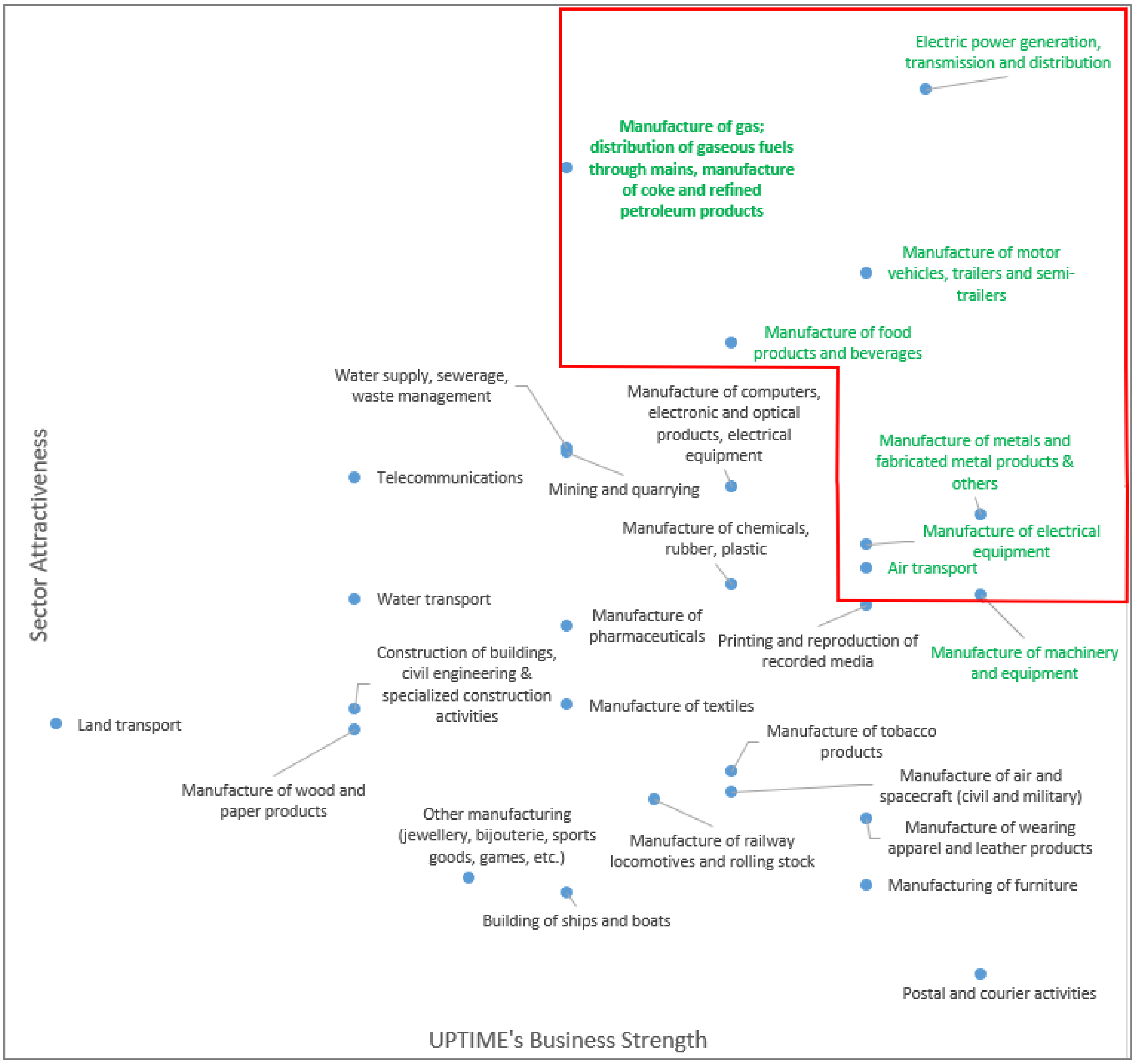


Figure 6-2 – UPTIME Attractiveness-Strength Matrix

6.3. Business opportunity assessment

In this section, we evaluate with concrete figures the business market opportunity for predictive maintenance, based on two separate approaches that will be developed in paragraph 6.3. These two methods are, on one hand, based on the part of net profit gained by an OEE improvement (top-down approach) and, on the other hand, on the number of plants/machines that will be monitored by a PdM platform. The latter approach implies that we first need to estimate the price that end-users would be willing to pay for a PdM plat and that is why we developed this evaluation on the following section.

6.3.1 Pricing analysis

To determine the price of a PdM platform, we examined the pricing model of UPTIME's competitors. By comparing the price that competitors' clients are already paying to them for a given value proposition, we were able to evaluate a rough approximation of the price that these clients would be willing to pay.

There are several possible approaches to pricing predictive maintenance services and products. According to our benchmark of competitors' pricing, PdM vendors follow different approaches:

- Value-based pricing: Ensures maximum value for vendor while aligning incentives of vendor and customer. It is not popular since it is difficult to objectively and accurately estimate or measure value. It is more efficient to agree on a simpler pricing model.

- Fixed + variable pricing: Most commonly used model as it reflects vendors' cost structure. It is a significant effort to set up a predictive maintenance system as that involves pulling data from diverse robots and machines. However, adding additional robots or additional analytical packages can be relatively cheaper. Fixed portion of the price ensures that vendors can profitably serve customers who are using the service on a limited set of machines. Variable portion of the price ensures that new machines can be added to predictive maintenance at a lower cost per machine.

For our analysis, we will use the second approach which is the most commonly adopted by PdM vendors. The typical cost structure is as follows:

Table 6-4 – PdM deployment project cost structure

Type of cost	Description	Provided by UPTIME	Average price
Variable	PdM Platform license	Yes	3000€ / year / plant
Variable	Technical maintenance and support	No	
Fixed	Platform deployment, configuration and algorithm design, hardware installation, legacy systems integration	No (partly)	
Fixed	Workstations (laptops, tablets, etc.), display hardware (TV screens, monitors, etc.), on-premises servers (or cloud subscription)	No	
Fixed	Sensors, communication hardware (gateways, cables, etc.)	No	

In a PdM deployment project, only a part of the budget would fall within the scope of UPTIME, as shown in Table 6-4. Concerning the variable revenue, UPTIME could claim the licensing part as the other costs would go to a technological partner that would perform the role of a software integrator. In addition to the variable costs, the fixed costs are associated to the deployment stage that will occur once. At this stage, UPTIME could take part in the algorithm design and the workshops with the end-users. Based on our competitive research, we have estimated that the average price of a PdM Platform license is around 3000€ / year for a medium-sized plant with at least 100 employees. The details of the exploitation model and UPTIME pricing will be detailed in deliverable D8.2 "Business Model, Exploitation and Innovation Management". For the needs of our analysis to assess UPTIME's market potential, we will consider that the only revenues accessible are from the licensing part.

6.3.2 Market assessment

To assess the market accessible by UPTIME, we followed two separate approaches that are detailed in this section.

- ***<u>OEE improvement approach (top-down)</u>***:

Starting from a hypothesis on OEE improvement, we estimated the net profit gained from the production value and the net margin of each sector for companies that are relevant for PdM.

Overall Equipment Effectiveness (OEE) is a framework for measuring the efficiency and effectiveness of a process, by breaking it down into three constituent components: availability, performance and quality of a production process. One goal of a PdM strategy is to improve OEE which is directly related to the actual production per year. Apart from improving OEE, a PdM strategy will also have an influence on direct maintenance costs, depreciation and valuation of fixed assets, profit margin, etc. However, even if the effects of a PdM strategy are not isolated on OEE, this simplification will provide us with a good rough order of magnitude of the profits generated by it.

An OEE improvement leads to an increased actual production per year, which means more revenue. From the typical net margin percentage by industry, we then evaluated the profit generated by a PdM strategy thanks to an OEE improvement. Then, we were able to assess the revenue that UPTIME could claim as a small fraction of this annual profit.

- ***<u>Pricing approach (bottom-up)</u>***:

From our pricing analysis (section 6.3.1), we identified an estimated price for a PdM license: 3 000 € / year / for a plant with around 100 employees. From the number of enterprises in each market segment, we assessed the number of enterprises that are relevant to be installed with a PdM platform thanks to the "Predictive Maintenance Relevance" score identified in the "Sector Attractiveness" analysis (section 6.2.1). Furthermore, we have narrowed down this number by cutting out companies with less than 100 employees. Indeed, as industrial companies employ on average 10% of their employees in their maintenance department, enterprises that have less than 100 employees are not likely to invest in PdM strategies. Then, from the number of employees that work on enterprises with more than 100 employees, we were able to assess the virtual number of "plants" of 100 employees that are prone to deploy a PdM strategy and then to evaluate the annual revenue generated by the PdM license.

The logic behind these two approaches can be illustrated with the figure below (Figure 6-3):

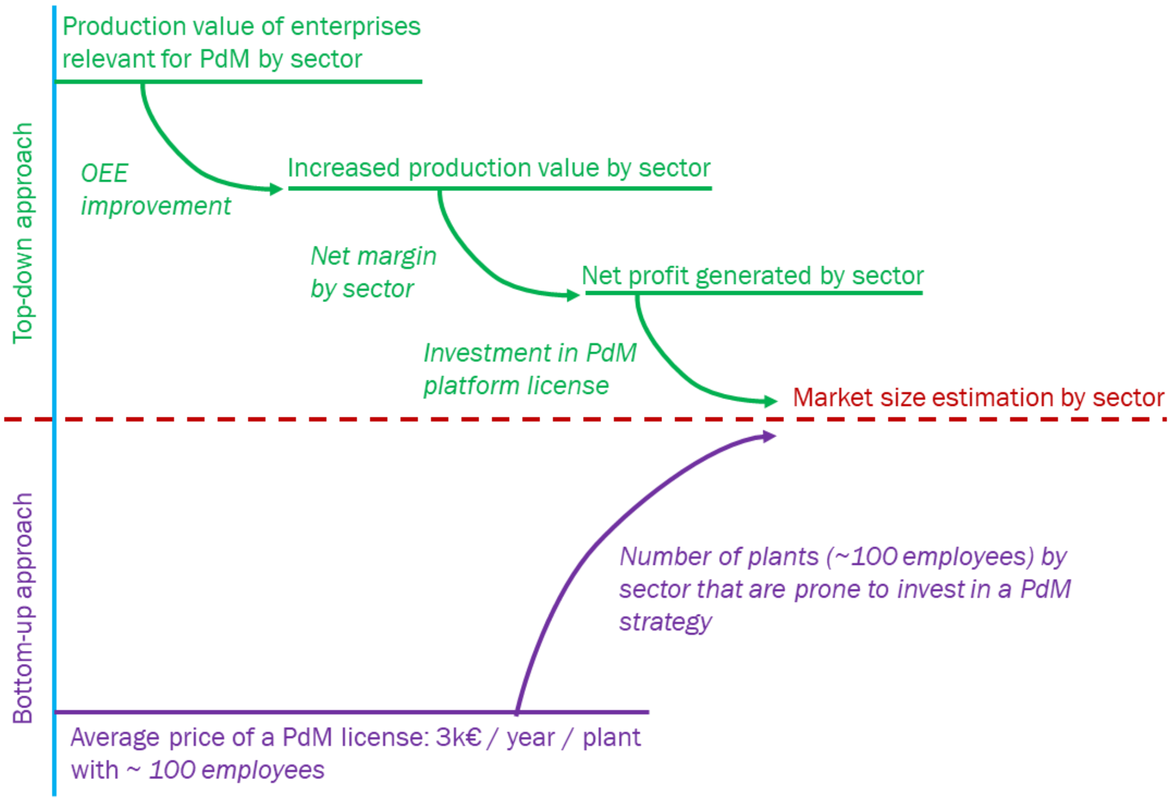


Figure 6-3 – Evaluation of the PdM market for UPTIME based on OEE approach (top-down) and pricing approach (bottom-up)

The results of our analysis are shown in Table 6-5 below.

Table 6-5 – UPTIME's Market Sizing by Market Segment

			OEE improvement approach (top-down)								Pricing approach (bottom-up)					
		NACE code	Production value - million euro	Share of production value of enterprises relevant for PdM	OEE improvement	Improved production value - million euro	Gross operating rate - percentage	Profit generated - million euro	Percentage of profit invested in PdM licensing (e.g. UPTIME)	PdM market size - million euro	Number of enterprises	Percentage of enterprises relevant for PdM	Percentage of entreprises above 100 employees	Average number of licenses per enterprise	Price of a PdM license (e.g. UPTIME)	PdM market size - million euro
Discrete Manufacturing	Manufacture of air and spacecraft (civil and military)	C30.3 C30.4	206 512,0	10%	3%	212 707,4	6%	391,46	5%	2,0	2 259	10%	19%	10	3 000,0 €	1,3
	Manufacture of motor vehicles, trailers and semi-trailers	C29 C30.9	914 283,0	80%	3%	941 711,5	8%	2 137,45	5%	85,5	23 734	80%	16%	6	3 000,0 €	57,8
	Building of ships and boats	C30.1	36 764,0	10%	3%	37 866,9	6%	65,52	5%	0,3	8 195	10%	4%	4	3 000,0 €	0,4
	Manufacture of railway locomotives and rolling stock	C30.2	23 176,0	20%	3%	23 871,3	7%	45,78	5%	0,5	856	20%	26%	4	3 000,0 €	0,6
	Manufacture of metals and fabricated metal products & others	C23 to C25	980 389,0	40%	3%	1 009 800,7	10%	2 954,71	5%	59,1	501 740	40%	4%	2	3 000,0 €	41,1
	Manufacture of electrical equipment	C27	277 000,0	80%	3%	285 310,0	8%	670,77	5%	26,8	47 000	80%	8%	3	3 000,0 €	28,8
	Manufacture of machinery and equipment	C28	620 100,0	40%	3%	638 703,0	9%	1 618,57	5%	32,4	90 000	40%	11%	2	3 000,0 €	27,2
	Manufacture of wearing apparel and leather products	C14 C15	118 103,0	10%	3%	121 646,1	9%	331,23	5%	1,7	160 299	10%	3%	2	3 000,0 €	2,1
	Manufacture of computers, electronic and optical products, electrical equipment	C26	332 579,0	40%	3%	342 556,4	6%	643,11	5%	12,9	40 000	40%	8%	3	3 000,0 €	10,4
	Manufacturing of furniture	C31	100 000,0	10%	3%	103 000,0	10%	300,00	5%	1,5	120 000	10%	2%	2	3 000,0 €	1,6
	Other manufacturing (jewellery, bijouterie, sports goods, games, etc.)	C32	116 392,0	10%	3%	119 883,8	16%	546,99	5%	2,7	150 000	10%	1%	2	3 000,0 €	1,3
Process manufacturing	Manufacture of food products and beverages	C10 C11	1 045 606,0	40%	3%	1 076 974,2	9%	2 876,51	5%	57,5	295 411	40%	5%	2	3 000,0 €	34,8
	Manufacture of tobacco products	C12	32 580,0	10%	3%	33 557,4	12%	121,76	5%	0,6	328	10%	27%	4	3 000,0 €	0,1
	Manufacture of textiles	C13	77 434,0	20%	3%	79 757,0	10%	238,26	5%	2,4	62 100	20%	4%	2	3 000,0 €	2,0
	Manufacture of wood and paper products	C16 C17	293 340,0	10%	3%	302 140,2	10%	892,67	5%	4,5	188 377	10%	3%	2	3 000,0 €	2,7
	Printing and reproduction of recorded media	C18	80 000,0	20%	3%	82 400,0	12%	293,73	5%	2,9	119 052	20%	2%	2	3 000,0 €	2,3
	Manufacture of chemicals, rubber, plastic	C20 C22	783 255,0	40%	3%	806 752,7	11%	2 697,88	5%	54,0	91 928	40%	11%	2	3 000,0 €	26,5
	Manufacture of pharmaceuticals	C21	260 172,0	20%	3%	267 977,2	22%	1 717,41	5%	17,2	4 696	20%	29%	4	3 000,0 €	3,3
Complex systems operators	Air transport	H51	142 174,0	40%	3%	146 439,2	7%	309,92	5%	6,2	5 000	40%	6%	12	3 000,0 €	4,2
	Land transport	H49	552 000,0	10%	3%	568 560,0	15%	2 476,82	5%	12,4	980 476	10%	1%	2	3 000,0 €	8,1
	Water transport	H50	98 035,0	20%	3%	100 976,1	10%	290,29	5%	2,9	21 000	20%	2%	3	3 000,0 €	0,9
Utilities & Infrastructure	Electric power generation, transmission and distribution	D35.1	877 804,0	40%	3%	904 138,1	12%	3 106,33	5%	62,1	100 000	40%	1%	6	3 000,0 €	9,9
	Manufacture of gas; distribution of gaseous fuels through mains, manufacture of coke and refined petroleum products	D35.2 C19	500 923,0	40%	3%	515 950,7	7%	992,64	5%	19,9	3 075	40%	15%	5	3 000,0 €	3,0
	Water supply, sewerage, waste management	E36 E37 E38	249 000,0	20%	3%	256 470,0	22%	1 636,88	5%	16,4	75 534	20%	6%	2	3 000,0 €	6,8
	Telecommunications	J61	340 000,0	20%	3%	350 200,0	27%	2 758,16	5%	27,6	49 000	20%	2%	8	3 000,0 €	5,3
Other	Postal and courier activities	H53	117 048,0	20%	3%	120 559,4	8%	294,98	5%	2,9	80 967	20%	2%	13	3 000,0 €	9,7
	Mining and quarrying	B05 to B08	123 692,0	10%	3%	127 402,8	17%	624,99	5%	3,1	17 163	10%	4%	5	3 000,0 €	1,0
	Construction of buildings, civil engineering & specialized construction activities	F41 to F43	861 883,0	10%	3%	887 739,5	10%	2 689,78	5%	13,4	1 002 224	10%	1%	2	3 000,0 €	5,6
										531,3					**Total**	**299,0**

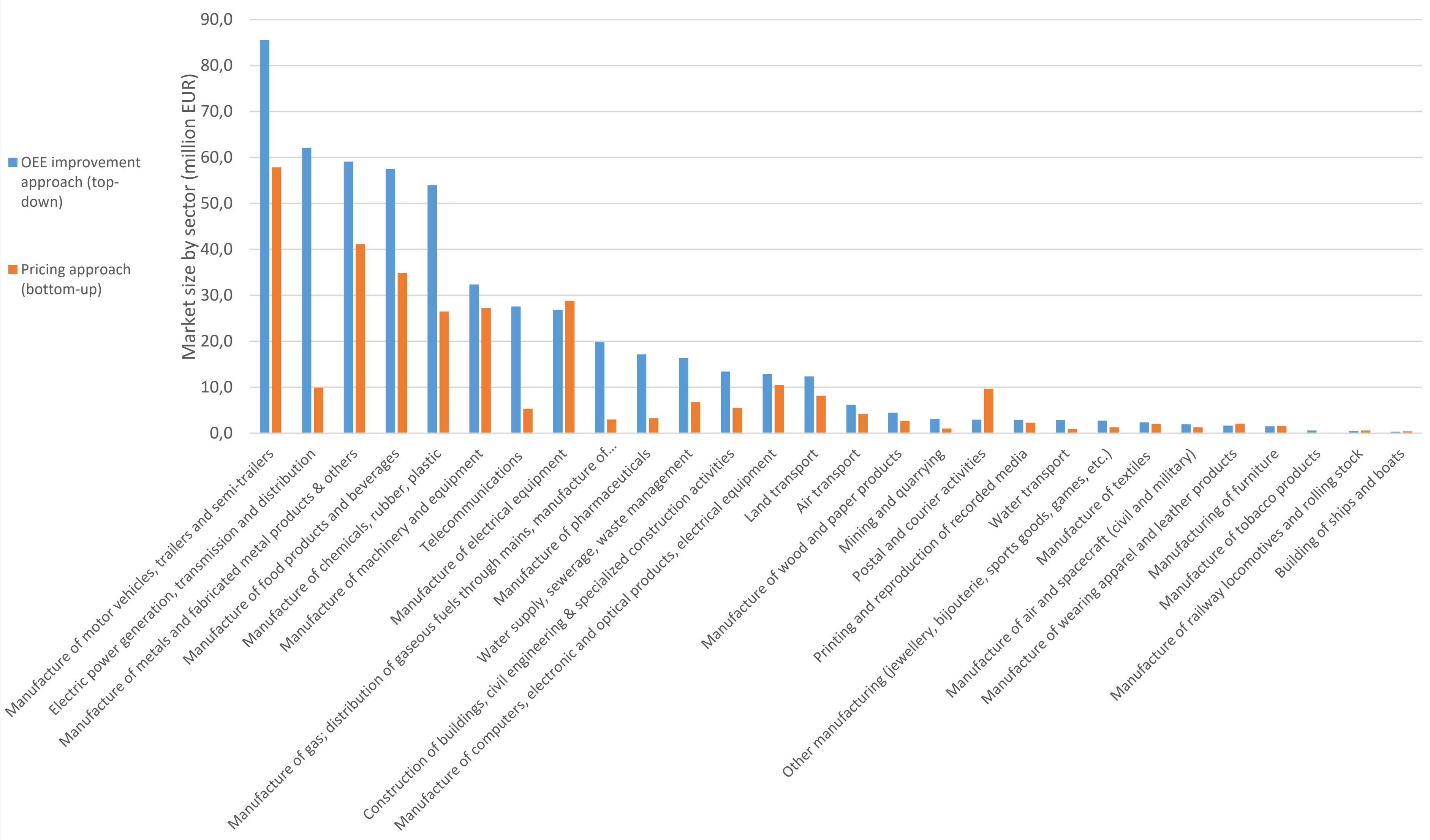


Figure 6-4 – Estimated UPTIME market potential by sector (million EUR)

6.4. Recommendations on market positioning

The market positioning aims at answering 3 main questions: what are the target market segments? what is the key message to communicate? to answer what problems?

From the market prioritization analysis (paragraph 6.1), we can define a list of priority segments to focus on in the first period of the business development. On one hand, the resources will be too limited to investigate too many segments and the penetration of each segment would progress too slowly. On the other hand, the risk of marketing too few segments would be to miss significant business opportunities but also, more importantly, to delay very dangerously the breakeven point if the entry barriers of the selected segments are higher than expected.

To select the priority segments, several criteria have been considered: segment attractiveness (in particular market size and ability/willingness to pay), and UPTIME's specific business strength for this market (in particular intensity of Value Creation and market accessibility). In Figure 6-5 below, we updated the segment prioritization matrix (Figure 6-2) with the bubbles representing each sector's associated market potential (identified in section 6.3 with the average market size from the two approaches).

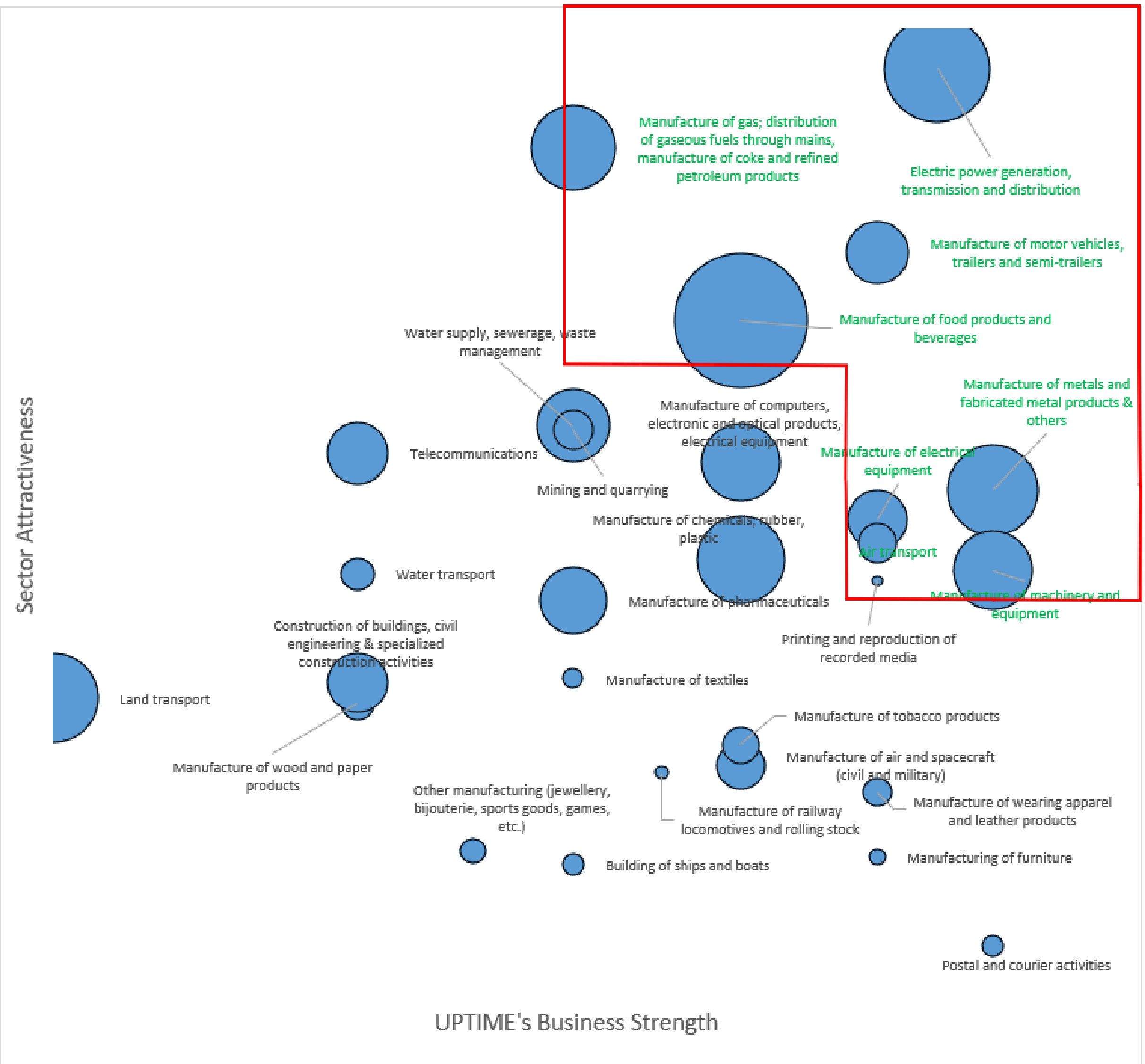


Figure 6-5 – UPTIME Attractiveness-Strength Matrix with market potential

The 8 market segments that hold the highest potential are:

Priority segments	Rationale/Comment
Electric power generation, transmission and production	High turnover with high investment capacity, this capital-intensive utility sector can use predictive maintenance to prevent expensive downtimes with continuous online monitoring (reduce overheating and loose connections, use environmental conditions, detect high dirt, dust levels and corrosive environments)
Manufacture of food product and beverages	Compared to the automotive and aerospace industries, the food and beverage manufacturing sector has always been a late adopter of digital trends. However, food processing has to overcome much more specific manufacturing and maintenance obstacles related to hygienic standards and safety, with highly complex and automated production lines. Also, the need for heightened cleanliness creates a wet environment, which can easily damage important equipment. In addition, all switches and electrical components must be reliably protected from moisture. This process requires the purchase of extra machinery and its specific maintenance.
Manufacture of gas; distribution of gaseous fuels through mains, manufacture of coke and refined petroleum products	Despite the rise in green energy, this utility sector is still one of the largest industries. Both extraction and refining involve expensive equipment that can cause health and environmental hazards in case of failure. Stakes are high to prevent such disasters with better analytics and maintenance. While many might assume a multibillion-dollar industry would be technologically savvy, the oil and gas industry is not up to par. Despite its precious cargo, most pipelines were built more than two decades ago. They still operate using old technology, which makes them expensive to run and maintain. And as the years go on, the pipelines become more susceptible to undetected leakages
Manufacture of motor vehicles, trailers and semi-trailers	Automotive companies operate some of the largest robot parks in the world. With the aim to reduce inventory costs, automotive companies developed just-in-time manufacturing strategies. As a result, they have tightly integrated supply chains. Though tight supply chain integration allows reduced inventory, any reduction in manufacturing efficiency results in significant disruption to the supply chain. It is no surprise that automotive companies stand to gain significantly from a technology that reduces downtime.
Manufacture of metals and fabricated metal products & others	While the industry has made continued investments in process control and optimization, it has been slow on implementing new digital technologies. PdM in these
Manufacture of electrical equipment	

Manufacture of machinery and equipment	industries can prevent downtime and associated production losses that are more frequent due to overcapacity and aging assets
Air transport	Airlines are no stranger to closely monitoring sensor data from planes. Carriers already use data for flight-monitoring, as required by regulations, and some could also be used for predictive maintenance. Today’s analytical capabilities allow them to analyze more data in order to increase airplane availability, by reducing delays/cancellations due to unplanned maintenance

7. Conclusion

Overall, the maintenance market seems to be already very dense, with a high market saturation and margins under pressure. However, the opportunities offered by innovative technologies in the recent years leave the door open to new market entrants with new maintenance types, such as software editors. Nonetheless, maintenance service providers and equipment manufacturers benefit from a strong competitive advantage as they already hold the maintenance expertise and a close relationship with industrial end-users. These stakeholders are currently shifting towards predictive maintenance solutions either by developing their own expertise or by partnering with technological providers.

On the other hand, industrial end-users that did not outsourced their maintenance have developed their own maintenance expertise with dedicated teams and may have to rely on technological providers to deploy predictive maintenance solutions.

Furthermore, our competitive analysis pointed out that there are already a lot of potential competitors that have marketed their offer around predictive maintenance, with the associated buzz words and it may be difficult for end-users to find their way in the overabundance of these solutions. In that context, it may be difficult for UPTIME to differentiate from its competitors in its marketing message.

Industrial end-users, though aware of the benefits that digital manufacturing technologies can deliver, struggle to effectively adopt and implement predictive maintenance strategies. Despite the barriers identified in section 5.1 that can explain this lagged adoption, analysts seem confident in the potential growth of predictive and prescriptive analytics.

In that context, UPTIME differentiates from its competitors with higher-level intelligence functions which requires high vertical customization and a more complete integration with legacy systems than most competitors. Furthermore, as the competition landscape is very dense, UPTIME value proposition (developed in section 3.4) and MVP (developed in Deliverable 1.2) will need to adjust as close as possible to industrials' needs, collected through our interviews and the community management initiatives (developed in Deliverable 7.3). Hence, as needs, concerns and investments in PM are diverse in accordance with the segmentation criteria identified in section 6.2, UPTIME will have to approach the market segments differently, with an adapted strategy.

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Appendix A – Competitive analysis methodology

We have examined 57 potential competitors (listed in Table A-1), sorted in these 5 categories. To prioritize our study, we have identified the most relevant ones and sorted out 22 solutions that were investigated in greater depth and 8 that we have interviewed, according to a list of comparison criteria (Table A-2).

Table A-1 – List of investigated potential competitors

Software AG – IoT Predictive Maintenance
IBM – IBM Predictive Maintenance & Quality (IoT Solutions)
Oracle – PeopleSoft Maintenance Management
Microsoft – Azure IoT Suite
SAP - Predictive Service
PTC - Thingworx
Bosch – Manufacturing Analytics and Predictive Maintenance
Mitsubishi Electric – Smart Condition Monitoring
General Electric – APM Strategy
SKF – SKF Aptitude Monitoring Suite
Eagle Technology - Proteus MMX
DPSI - iMaint
Amazon - Web services for Predicitve Maintenance
RapidMiner
Oracle - Oracle IoT asset monitoring
Dataiku - Data Science Studio
Riverlogic - Riverlogic Prescriptive Analytics
SPEEDD
DELL - PdM Solution
Honeywell International - PTMD
Rockwell Automation
Cisco/Tellmeplus - Predictive Objects
MPS - Maintenance Predictive Services
La Prédictive JMC
Vinci - Actemium
Parker - SensoNODE sensors
SpaceTime Insight - Warp 6
Fives
IBM - IBM Watson IoT
IBM - IBM Maximo Asset Management
SAS Institute - Asset Performance Analysis
Schneider Electric - Avantis PRiSM
eMaint (Fluke) - eMaint
MANTIS
PROASENSE
Toreador - WP12: DTA
Microsoft - Azure Machine Learning Studio
Amazon - Web services for Machine Learning
Microsoft - SQL Server R Service (RevoScaleR bundle)
Schaeffler - FAG
Qlik - QlikView
CartaSense - CartaSense IoRT
InnoLabel
ABB Ltd - LEAP
ABB Ltd - MACHsense-R
Altizon Systems - Datonis
Augury Inc. - Auguscope
C3 IOT - C3 Predictive Maintenance
Emerson - AMS Platform
Siemens AG - MindSphere
Thales - Thales Predictive Maintenance Services
Warwick Analytics - PrediCX
Intel - Intel IoT Platform
Cisco - Business Critical Services & High-Value Services
Engie Axima
Eolane Bob

Table A-2 – List of comparison criteria

		Category
		Expertise
		Relevance
Equipment	Sensors	Hardware provided?
	Edge processing	Hardware provided?
		Configurable edge diagnosis?
Software	Data acquisition & manipulation	Feature provided?
	Diagnostics	Feature provided?
		Health assessment? (trends & pattern?)
	Prognosis Assessment	Feature provided?
		Existing configurable algorithm repository?
		Is compatible with several types of analytics techniques? (ML, Deep Learning, AI, etc.)
	Advisory Generation	Feature provided?
		Schedule/Cost optimization?
		Continuous improvement of recommendations through collection of maintenance action impact/effectiveness?
		Maintenance scenarios simulation?
	IS interfacing module	Feature provided (passive dialog)?
		Maintenance ticket action generation? Resource allocation and scheduling?
Attributes	Deployment model	
	Configuration level necessary	
	Is the competitor willing to let third parties access to the data collected/generated?	
Services provided	Software Implementation	
	Hardware Implementation	
	Maintenance Action/Intervention Services	

Appendix B – Market analysis methodology

Out of the 4344 professionals that have been reached by e-mail, 899 (21% out of 4344) opened it, 413 (46% out of 899) followed the link of the UPTIME technical brief, 41 (10% out of 413) replied using the online survey tool. The Figure B-1 below shows the breakdown of participants per country. A second wave will be launched soon with an adjusted value proposition.

Below is the technical brief used:

Unified Predictive Maintenance System

A fully adaptable, modular and integrable end-to-end predictive maintenance framework for industrial & manufacturing assets and high-value products, from sensor data collection to optimal maintenance planning. Through advanced prognostic algorithms, it predicts upcoming failures or losses in productivity. Then, decision algorithms recommend the best action to be performed at the best time to optimize total maintenance and production costs and improve OEE.

Market benefits

- Acquisition and analysis of sensor-generated and historical data in an Industry 4.0 environment
- Advanced diagnostic and prognostic capabilities for detecting the current health state and the future behaviour of equipment based on streaming data and FMECA outcomes
- Continuously improved proactive decision-making capabilities for mitigating the impact of future failures and for planning appropriate actions

Issue

Traditional maintenance approaches are often under optimized as regular scheduled maintenance inspections/actions are not cost-effective. Improvements in maintenance productivity can enable 10 to 20% savings on total maintenance costs depending on plants' cost structure and also improve Overall Equipment Effectiveness (OEE).

With the emergence of the Internet of Things (IoT), industrials are progressively shifting to strategies based on the monitoring of assets' condition through sensors. However, these strategies based on sensor-collected data may be difficult to deploy within existing processes and legacy systems. The lack of standardization due to this emerging trend coupled with the scarcity of adequate competencies make it difficult to reach the opportunities offered by IoT.

While some predictive maintenance solutions try to address these challenges, they present some limitations. Most of them only offer analytics capabilities to predict failures and estimate assets' remaining lifetime. Relying on these indicators, operators have to assert themselves the maintenance action to implement, based on their experience. They also have to manually balance between multiple variables to decide on the optimal implementation time in the production schedule to minimize consequences.

Solution

Our vision is built upon the predictive maintenance concept and our technological pillars (i.e. Industry 4.0, IoT and Big Data, Proactive Computing) in order to result in a unified information system for predictive maintenance. Our open, modular and end-to-end architecture aims to enable the predictive maintenance implementation in manufacturing firms with the aim to maximize the expected utility and to exploit the full potential of predictive maintenance management, sensor-generated big data processing, e-maintenance, proactive computing and industrial data analytics. Our solution can be applied in the context of the production process of any manufacturing company regardless of their processes, products and physical models used.

Key features:

- Sense:
  - Data aggregation from heterogeneous sources with universal connectivity gateways
  - Configurable diagnosis capabilities on the edge
- Detect:
  - Configurable Asset Diagnosis & Health Assessment
- Predict:
  - Configurable predictive algorithms to detect trends and estimate the asset's remaining useful life (RUL) and upcoming conditions
- Decide:
  - Proactive maintenance action/timing recommendations
  - Trade-offs of scenarios to consider alternative actions and impacts on costs
  - Continuously improved recommendations over time
- Act:
  - Action implementation management handled natively or through CMMS interface

Figure B-1 – Breakdown of the participants per country