Production harmonizEd Reconfiguration of Flexible Robots and Machinery

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I. Summary

Executive Summary

The present document is a deliverable of the PERFoRM project, funded by the European Commission's Directorate-General for Research and Innovation (DG RTD), under its Horizon 2020 Research and innovation programme (H2020).

The scope of this document is to give a picture of the market that includes market segmentation, a classification of software/hardware solutions now available as commercial components as well as an insight about some known key Research projects still in progress.

It is the result of the analysis of the market by industry segment and geographic region performed during the first 18 months of the Project. It also provides insightful analysis of key issues that will affect this market in the future.

In the second and final release, Partners will specifically identify some primary customers, the price indicators, possible competition and the related advantages of the PERFoRM products and solutions.

1. Introduction

Europe leads in many manufacturing sectors from automotive to pharmaceuticals and many European players are global leader in advanced manufacturing and strong in many innovative high-quality services. The market analysis are confirming that EU businesses, and in particular SMEs, are aware about the need of embracing the digital era to meet the new market opportunities.

Nevertheless, two of four businesses in Europe do not use any advanced digital technology. In the manufacturing sector, one business out of two has never used any advanced manufacturing technology.

Therefore, a huge potential market exists for new technologies enabling the digital transformation required for manufacturing enterprises.

In this framework, the *PERFoRM* project aims to the conceptual transformation of existing production Systems towards Plug & Produce Production Systems in order to achieve a Flexible Manufacturing environments based on rapid and seamless reconfiguration of machinery and robots as response to operational or business events.

A significant part of the research activity will be spent in the development of a suite of software tools with the objective of transforming this vision in something viable for the today's and tomorrow's industry.

PERFoRM is a complex solution that includes several components based on various technologies that will target more sectors of the manufacturing industries and will be the object of use and commercialization by the project partners. This complexity made the marketing analysis and in particular the competition analysis, very difficult. In fact, the Products that will result from the development activities is not just the sum or the composition in a single bundle of different technologies and tools; many possible combination of technologies have to be considered, targeting different typologies of customers (for size, geographic area, maturity of the processes etc.).

2. Market Analysis

2.1 Business Environment

PERFoRM aims to provide high technologies and associated services to manufacturers for improved factory efficiency. Describing the context of the manufacturing industry in Europe is a key step for setting the framework in order to perform an in-depth market analysis. Section 3.1 presents a macro level analysis of the main economic, political and technological trends affecting the marketing potential of PERFoRM's products.

In this section, "industry" refers to the manufacturing sector (i.e. industries providing benefit through the transformation of materials into products) and excludes mining, construction and energy.

Potential customers of PERFoRM products are companies with highest innovation potential, investment capacities and with needs correlated to our technologies.

2.1.1 Economic trends in the European industry

2.1.1.1 *The importance of the manufacturing industry in Europe*

In the European Union, the industrial sector is important to the EU economy and remains a driver of growth and employment. In Europe, nearly one in ten businesses are classified as manufacturing, with around 2 million manufacturing companies, accounting for 33 million jobs[1].

The manufacturing industry accounts for around 15% of EU28's GDP and for over 80% of exports. However, the EU is still far from reaching the objective to increase the share of the industry in GDP up to 20% by 2020[2].

With an increasingly competitive global economy, the economic future of the EU is intertwined with its capacity to innovate and to sustainably develop its manufacturing sector.

2.1.1.2 *The impact of the economic crisis on the manufacturing sector[3]*

As of 2014, the economy of the manufacturing sector has not fully returned to its pre-crisis level. The relative contribution of industry to the EU economy has declined from 16.5% in 2008 to 15.3% in 2014[4]. The overall EU28 manufacturing output decreased by 10% in 2014 compared to 2008[5]. The de-industrialisation process is partly due to re-location of manufacturing activities in countries with lower labour cost, notably Asia.

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[1] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, *For a European Industrial Renaissance*, January 22, 2014

[2] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, *A Stronger European Industry for Growth and Economic Recovery*, October 10, 2012

[3] EC, *European Competitiveness Report 2014, Helping firms grow*, 2014. (The data come from Eurostat and OECD reports).

[4] EC, *Monthly Note on Industrial Policy Indicators and Analysis*, n. 4/2015.

[5] EC, European Competitiveness Report 2014 (based on Eurostat and OECD's data)

The health of the manufacturing sector varies considerably across countries. During the 2008-2014 period, a few member states have seen a growth of the manufacturing production (namely Poland, Slovakia, Romania, Estonia), while others have seen a stagnation (Belgium, Austria, Czech Republic, Netherlands, Latvia, Lithuania, Germany). In a majority of countries, production has dramatically decreased (by more than 20% in Cyprus, Greece, Spain, Finland, Italy, Sweden, and Croatia).

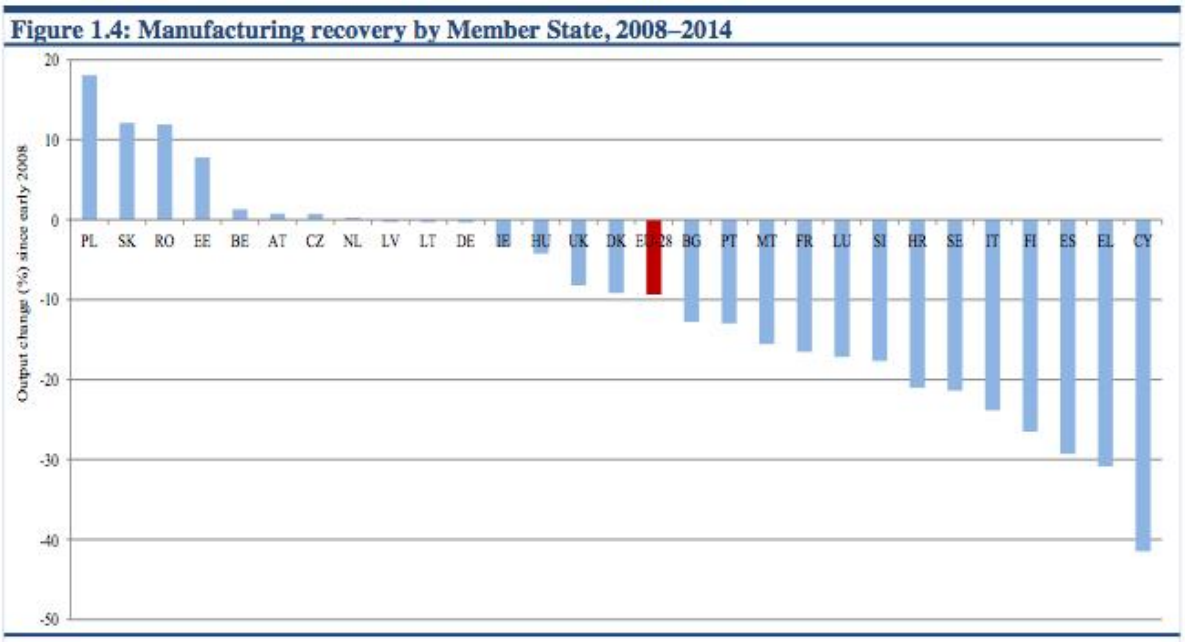

Figure Source: EC, European Competitiveness Report 2014 (based on Eurostat and OECD)

The situation varies across sectors. When comparing productions in 2014 with that of 2008, the most affected sectors are Clothing, Tobacco, Furniture (-35% to -25%); Textile, Electrical, Petroleum/Coke, Electronic, Machinery, Basic Metal, Metal Products (-25% to -15%); Motor Vehicles, Rubber/Plastics, Beverage, Chemical (-15% to 0%). In the same time, production in Food, Other transport equipment, and other manufacturing grew slightly (0% to 15%), and the Pharmaceutical sector grew significantly (more than 15%). Globally, emerging countries such as Brazil, Russia and China are not exempt from the global economic downturn, with e.g. only 3% growth expected in China in 2015.

However, it is interesting to note that the manufacturing industry has started to recover in 2014. In a majority of sectors, production in 2014 is higher than it was in 2013, as shown in the figures below.

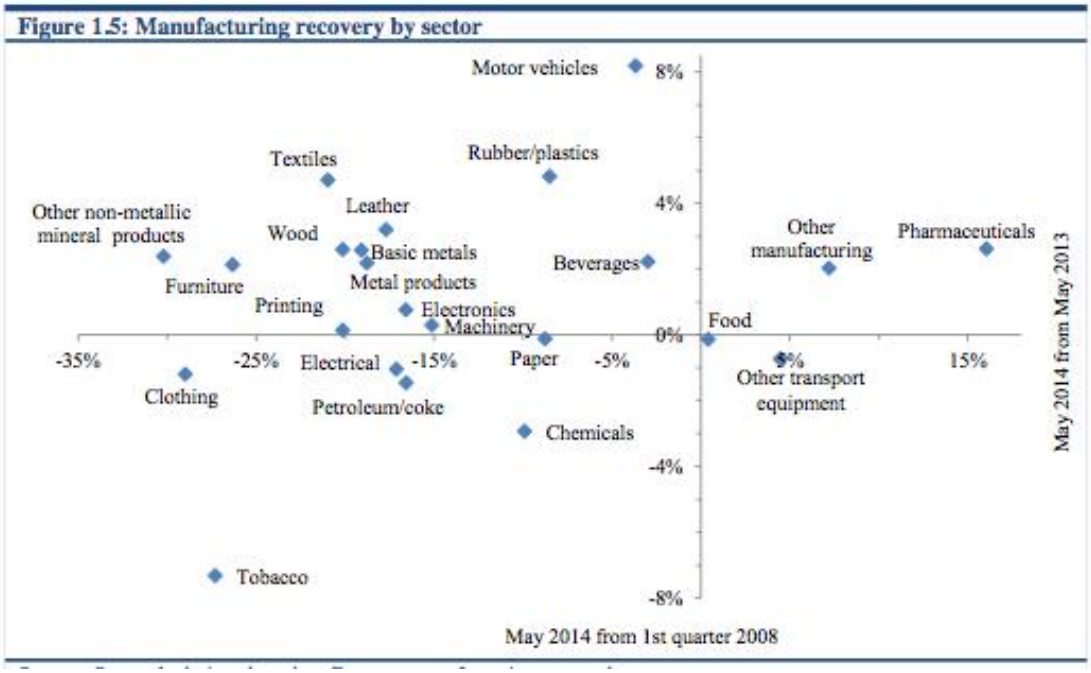

Figure Source: EC, European Competitiveness Report 2014 (based on Eurostat and OECD)

Figure Source: EC, European Competitiveness Report 2014 (based on Eurostat and OECD)

An interesting trend is that the evolutions in production seems less and less correlated with jobs creation, with employment in EU manufacturing declining steadily since 2000 (-20% between 2000 and 2014).

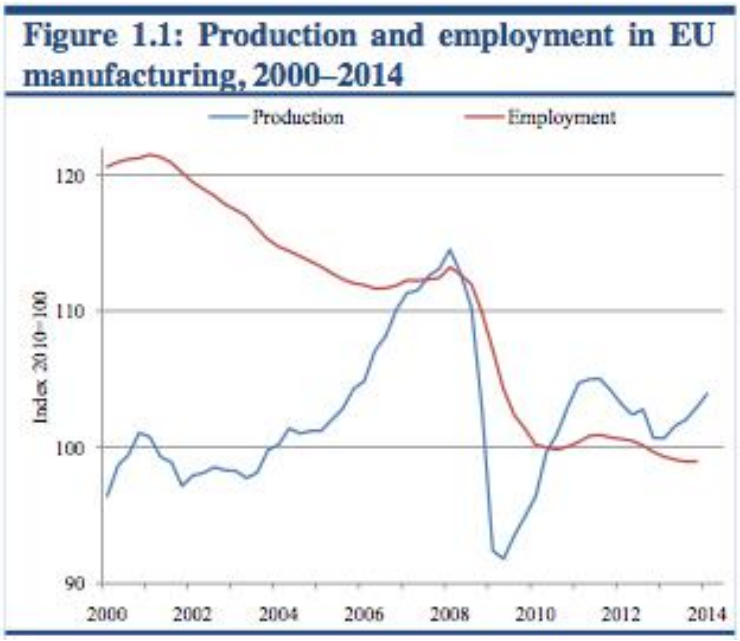

Figure Source: EC, European Competitiveness Report 2014 (based on Eurostat and OECD)

The manufacturing industry shows slight signs of economic recovery (the overall production is back to is early 2000s level). This upward trend has led to improved market sentiment and business confidence, favorable for investment and innovation.

2.1.1.3 *Investing in ICT technologies for factories will benefit the economy*

Despite this context of prolonged crisis, some companies are gaining new markets thanks to R&I investment oriented toward new products, services and emerging technologies. In particular, investing in digitalization of industrial production line will enable to improve both factory efficiency and workers' safety. The strategic development of ICT technologies for manufacturing is called "Industry 4.0", i.e. the fourth industrial revolution, mainly based on digitalization. Industry 4.0 may help to reverse the past decline in industrialization and increase manufacturing benefit.

Industry 4.0 can deliver estimated annual efficiency gains in manufacturing of between 6% and 8%[6]. The Boston Consulting Group predicts that in Germany alone, Industry 4.0 will contribute 1% per year to GDP over ten years, creating up to 390 000 jobs. Globally, one expert estimates that investment on the Industrial Internet will grow from US$20 billion in 2012 to more than US$500billion in 2020 (albeit with slower growth after that date), and that value added will surge from $US23 billion in US$1.3 trillion in 2020.
Source: EUROPEAN PARLIAMENT RESEARCH SERVICE (EPRS), Industry 4.0: Digitalisation for productivity and growth, September 2015.

[6] SMART SERVICE WELT, *Recommendations for the Strategic Initiative Web-based Services for Businesses*, March 2014.

The EC publishes yearly reports (European Competitiveness Reports)[7] highlighting internal weaknesses hampering economic growth of industry in Europe. According to the reports, too low investment in research and innovation hold back the necessary modernization of the EU industrial base and hamper future EU competitiveness. On the other hand, the EU's competitive strength has always been built on a solid and predictable institutional environment, quality infrastructure, a strong technological knowledge base and a healthy and educated labor force.

2.1.2 Policy plans supporting the factory of the future (macroeconomic governance)

The PERFoRM project will take advantage of the policy plans supporting the fourth industrial revolution (Industry 4.0) at European and national levels.

2.1.2.1 *EC industrial policies*

The EU supports industrial change through its industrial policy and through research and infrastructure funding. In 2012, in response to the decline of the relative contribution of industry to the EU economy, the European Commission set a target[8] that manufacturing should represent 20% of total value added in the EU by 2020. Whilst some observers find this goal overly ambitious[9], many believe that we are on the brink of a new industrial revolution, Industry 4.0, which could boost the productivity and value added of European industries and stimulate economic growth. As part of its new Digital Single Market Strategy, the European Commission wants to help all industrial sectors exploit new technologies and manage a transition to a smart, Industry 4.0 industrial system.
Source: EUROPEAN PARLIAMENT RESEARCH SERVICE (EPRS), Industry 4.0: *Digitalisation for productivity and growth*, September 2015.

The European Union regularly issues reports on the manufacturing industry in Europe and other publications related to ICT R&I for improving the productivity and safety of the production line, notably, Industrial Policy Communications, European Competitiveness Reports and Member States' Competitiveness Report issued in the context of the European Semester (see: section 4 on literature).

A summary of the EC industrial policy can be found on the following webpage:
http://ec.europa.eu/growth/industry/policy/index_en.htm

Fostering growth and competitiveness and achieving the goals of the Europe 2020 agenda are part of top priority for the EC and EU Member States. European industry will need to capture the potential for productivity and growth that Industry 4.0 appears to offer in order to remain competitive.

[7] EC, European Competitiveness Report 2014, *Helping firms grow*, 2014;
EC, *European Competitiveness Report 2013, For a European Industrial Renaissance*, 2013.
[8] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, *A Stronger European Industry for Growth and Economic Recovery*, October 10, 2012
[9] DEUTSCHE BANK, DB RESEARCH, *Europe's re-industrialisation The gulf between aspiration and reality*, November 26, 2013

The PERFoRM consortium is liaising with European manufacturing organizations in order to promote the project technologies and potentially to find relevant information for the market analysis and exploitation strategy. In particular, PERFoRM has established synergies with the two following organisations:

- The European Factories of the Future Research Association (EFFRA) is a non-for-profit, industry-driven association promoting the development of new and innovative production technologies. MANUFUTURE technology platform and key industrial associations established jointly the EFFRA in order to promote and support the implementation of the 'Factories of the Future' public-private partnership.
- The Intelligent Manufacturing Systems (IMS) is an industry-led, international business innovation and research and development (R&D) program established to develop the next generation of manufacturing and processing technologies through multi-lateral collaboration. It provides global services to institutions from the supporting Regions including the European Union, Mexico, and the United States of America and is a premier sponsor of the World Manufacturing Forum (WMF) event.

2.1.2.2 *National industrial policies*

EU Member States sponsor national initiatives related to digital manufacturing such as:

- Industrie 4.0 is the German strategic initiative on advanced manufacturing solutions. The term "Industry 4.0" originates from the German government's programme for creating smart factories presented at Hannover Messe (industrial fair) in 2011. The Chancellor Angela Merkel defined Industry 4.0 as "the comprehensive transformation of the whole sphere of industrial production through the merging of digital technology and the Internet with conventional industry".
- L'Alliance pour l'Industrie du Futur is a French association created by the ministry of Economy in July 2015, which brings together industry & digital companies and research centres. It was first presented at the Smart Industry event hold in Paris in September 2015. A first call for projects has been launched on technologies for the factory of the future.
- Catapult is a network of organisations set up in 2012 by the Technology Strategy Board of Innovate UK (United Kingdom's innovation agency) to promote R&D toward high value manufacturing (HVM). In December 2014, the UK government decided to invest additional £89 million in the Catapult network.

2.1.2.3 *Beyond Europe*

The market analysis covers countries beyond Europe. PERFoRM will take advantage of international networks and organisations related to smart factories.

- The U.S. National Network for Manufacturing Innovation (NNMI) is a network of U.S. research institutes launched in 2012 with a proposed US$1 billion of public funding, that focus on developing and commercializing manufacturing technologies through public-private partnerships.
- The Smart Manufacturing Leadership Coalition (SMLC) is a U.S. non-profit organization committed to overcome barriers to the development and deployment of Smart Manufacturing (SM) Systems.
- Still in the USA, the Industrial Internet Consortium (IIC) aims to accelerate the development of Industrial Internet technologies. The consortium (AT&T, Cisco, General Electric, IBM and Intel) founded the IIC in March 2014. The industrial Internet is based on various research

areas such as cloud-based manufacturing, big data, cyber-physical system and machine-to-machine communication.

According to the Application Developers Alliance (ADA)[10], companies from the Asia-Pacific area are expected to increase their manufacturing budgets from $9 billion in 2014 to $60 billion in 2020, a significant part of these R&I investments being dedicated to the Industrial Internet of Things (IIoT).

2.1.3 Technology trends

2.1.3.1 *Key technologies for a fourth industrial revolution*

Industry 4.0 (i.e. the fourth industrial revolution) is strongly related to the concept of Smart factories, Digital factories, Advanced manufacturing and the Industrial Internet of Things (IIoT). It means that everything in and around a manufacturing operation (suppliers, the plant, distributors, even the product itself) is digitally connected, providing a highly integrated value chain. Industry 4.0 is expected to enhance both productivity and working environment in factories. As is shown e.g. in the agenda of Hannover Messe 2016 (25 to 29 April 2016), Industry 4.0 is a trending topic.

Industry 4.0 depends on a number of new and innovative technological developments:

- The application of information and communication technology (ICT) to digitise information and integrate systems at all stages of product creation and use (including logistics and supply), both inside companies and across company boundaries;
- Cyber-physical systems that use ICTs to monitor and control physical processes and systems. These may involve embedded sensors, intelligent robots that can configure themselves to suit the immediate product to be created, or additive manufacturing (3D printing) devices;
- Network communications including wireless and internet technologies that serve to link machines, work products, systems and people, both within the manufacturing plant, and with suppliers and distributors;
- Simulation, modelling and virtualisation in the design of products and the establishment of manufacturing processes;
- Big data analysis: collection of vast quantities of data, and their analysis and exploitation, either immediately on the factory floor, or through big data analysis and cloud computing;
- Greater ICT-based support for human workers, including robots, augmented reality and intelligent tools.

Source: EUROPEAN PARLIAMENT RESEARCH SERVICE (EPRS), Industry 4.0: *Digitalisation for productivity and growth*, September 2015.

In particular, PERFoRM's technologies will provide workers with real-time informational support via augmented reality glasses and other connected interfaces. These "body-adapted wearable electronics" has been identified by The World Economic Forum as one of the top 10 emerging technologies in 2014.

[10] THE APPLICATION DEVELOPERS ALLIANCE (ADA) EMERGING TECHNOLOGY WORKING GROUP, *Internet of Things, Manufacturing IoT From the Factory Floor*, 2014
http://www.appdevelopersalliance.org/internet-of-things/manufacturing/

2.1.3.2 *Investment in innovation in the manufacturing sector*

According to the INNOBAROMETER 2015, 15% of manufacturing companies plan to use ICT-enabled intelligent manufacturing (i.e. technologies that digitalize the production processes) in the next 12 months[11].

Investment in innovation and new technologies

Since the onset of the economic crisis, dramatically reduced levels of investment in innovation are a major concern for Europe's industrial future.

The Commission has put an increasing share of its policy, regulatory and financial levers at the disposal of Member States, regions and industry to foster investment in innovation. The Horizon 2020 Programme, in particular through its industrial leadership pillar, will provide close to EUR 80 billion for research and innovation. This includes support for key enabling technologies that will redefine global value chains, enhance resource efficiency and reshape the international division of labour. [...]

The need to speed up investment in breakthrough technologies in fast-growing areas was the main reason the Commission decided to identify in the 2012 Industrial Policy Communication the six areas in which investment should be encouraged.

These strategic, crosscutting areas are, advanced manufacturing, key enabling technologies, clean vehicles and transport, bio-based products, construction and raw materials and smart grids. The work of the six task forces that were set up a year ago has enabled the Commission to identify opportunities as well as obstacles to innovation requiring further policy action.

EUROPEAN COMMISSION, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *For a European Industrial Renaissance*, January 22, 2014

2.1.3.3 *Human-Centred Technologies; Workers' well-being*

Implementing positive psychology in the workplace means creating an environment that is relatively enjoyable and productive. The issue of happiness at work is increasingly frequent in world publications (Cf. the two following graphs) and technology research (Human-Centered Technologies).

[11] http://ec.europa.eu/growth/industry/innovation/facts-figures/innobarometer/index_en.htm

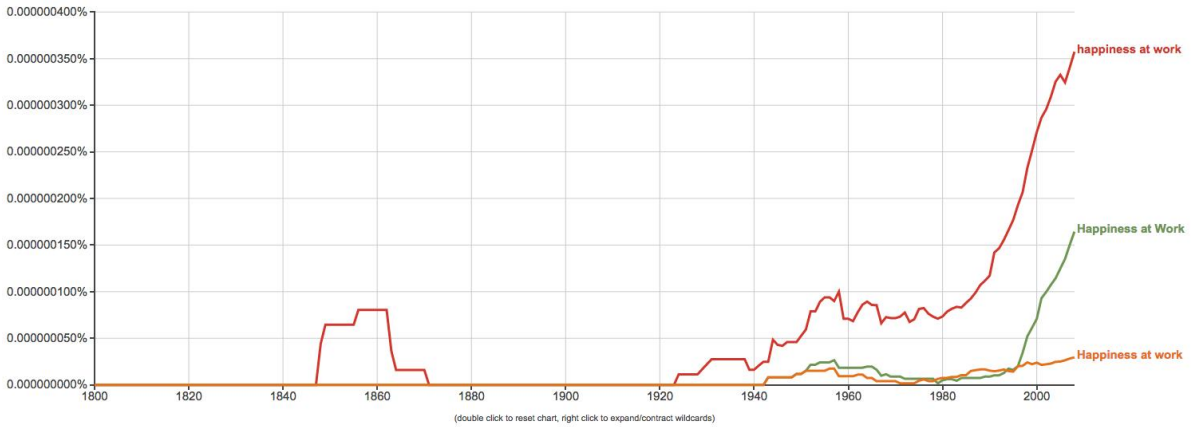

Figure 1 Frequency of the terms « happiness at work » in Google Books between 1800 and 2008 (source: Google Ngram Viewer).

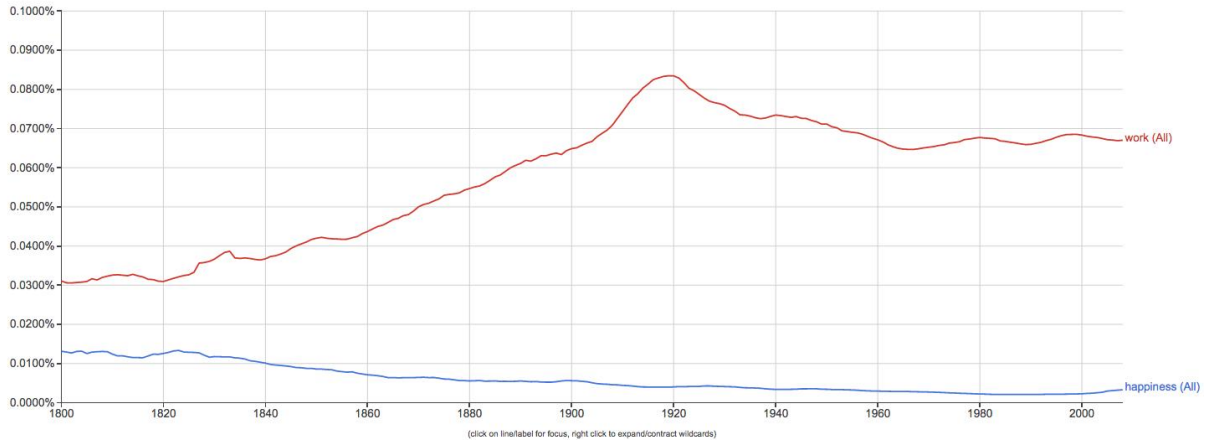

Figure 2 Frequency of the terms « happiness » and « work » in Google Books between 1800 and 2008 (source: Google Ngram Viewer).

2.2 Definition of Exploitable Products and Characteristics

This chapter contains a short description of exploitable products, resulting from the implementation of the PERFoRM project.

2.2.1 Enterprise platform for manufacturing process

PERFoRM will further develop the standard user-centered technology design methods in order to appropriately address the challenges of the shop floor environment. PERFoRM will bridge the technical advances in ubiquitous computing and the demand for attractive collaboration and interaction techniques at a factory site by involving situated embodied interaction through real-world (smart) objects and wearable devices in a way that respects such aspects of cooperation as awareness, transparency and privacy attitudes of workers. Moreover, PERFoRM will aim at lightweight solutions offering improved collaboration possibilities and robustness.

PERFoRM will offer a novel environment in order to enhance the connection between organizations, management and technology. In particular in the area of:

1. Internet of Things / Cooperating Objects
2. Agent-based CPS
3. Plug-and-Produce Devices using Service-oriented Architectures and Web Services
4. Cloud-based CPS in Industrial Automation facilitating production & energy optimization
5. Modelling and Simulation of flexible production systems

2.2.2 Internet of Things

This component of the PERFoRM architecture will deliver a set of smart cooperating devices and systems, which will be enhanced in their functionality with methods and algorithms integrated. Particularly, the dynamic creation of application functions, driven by the specific needs of a user, will be achieved by composing elementary components, integrated through standard interfaces (for machines, robots and legacy systems) by an industrial middleware, aiming the standardization of the communication protocols and data structures addressing the plug and produce philosophy.
It will be a stream engine that will be combined with other products to enhance their capabilities.

2.2.3 Agent-based CPS

Exploitation of agent-based plug-and-produce systems control architecture will be achieved through an application management service offerings tailored for every industry, skill and technical area, fan virtually for every type of customer. In particular, customizing the integrated solutions for the fast reconfigurable individual machines and robots, optimizing the changeover times and costs.
The deployment methods will allow the offering of the proposed solution and principles to system integrators, module and equipment developers and end users.

2.2.4 Plug-and-Produce Devices using Service-oriented Architectures and Web Services

The exploitation of this component will be achieved through a catalogue of industrial components enhanced with WS-interfaces which act as plug-and-produce device adapters, which aims to be standardized foundation for the subsequent further development of CPS concepts.

2.2.5 Cloud-based CPS in Industrial Automation facilitating production & energy optimization

This solution will be tailored to a lightweight application that could run on cost-efficient as a service on Cloud. The pursued goal is to implement a general-purpose development platform that enables and makes easier the development of sustainable complex systems. Thus, it will enable shop floor data aggregation, notification and control. It will facilitate and accelerate the development of heterogeneous device environments in a robust way, while offering improved usability and user experience.

2.2.6 Modelling and Simulation of flexible production systems

The exploitation of this component will be achieved through a new simulation system based on decision algorithms (criteria might be “travel time to cell”, “time till availability of production cell” etc.), enabling autonomously acting products to find their next production cell respectively and their way through the production system.

Such decision algorithms can be also applied to autonomously acting products, also in regards to optimized intralogistic distances and frequency of use (e.g. on automated guided work piece carriers being responsible for the intralogistic material and product flow).

In fact, innovative production system which will combine the flexibility and the good utilization ratio of a job-shop organization with the efficiency (esp. small stocks) of a line production through innovative decentralized control routines and reconfigurable production equipment, these highly complex production systems cannot be framed with a straight-forward simulation method available today.

2.2.7 Bundles of products

The PERFoRM project is a collaborative one and so are their products, which can be offered in total as a complete solution or combined in bundles or even as individual products. The synergies and the possibilities will be examined as the project progresses. Examples of combination in product suites are:

- Internet of Things and Plug-and-Produce Devices and Cloud-based CPS
- Modelling and Simulation with Internet of Things

In any case of cooperative work leading to joint ownership issues, a Business Agreement should be signed (cf. section 4.4).

2.2.8 Customer View of Products

The presentation of the PERFoRM products in the previous section is based on the point of view of the project and of the development of the solutions. However, for the effective exploitation it is indispensable to translate it to the customer point of view. The collaboration with key stakeholders

and potential clients will reveal that they will be more comfortable discussing the products from the technologies and solutions point of view.

Additionally, the value of the Use Cases and the tests that will be conducted at the pilots is immense. Their description is valuable to the partners involved in the project who want to forward the products they will develop to the market for two reasons. Firstly, the description is being translated in a series of steps during the implementation phase and it can help solve technical issues related but not limited to: software development methodology, data transfer, compatibility, integration etc.

The contacts we are having with key stakeholders has shown that a solution suitable for a specific shop floor may need the combination and coordination of multiple PERFoRM products, thus making imperative the solution of any resulting IPR issues on the foreground, as well as the establishment of a Business Agreement between the partners collaborating for the provision of a more complete solution.

2.3 Competition and SWOT Analysis

2.3.1 Competition

The outcome of the PERFoRM project will be a set of products. A part of them will be the results of the efforts of the technological partners who operate as for-profit entities in the form of SMEs. However, there are partners developing technologies and solutions who operate as non-for profit. As it has been discussed in previous sections, the solution offered to the potential customers may require the provision and collaboration of multiple components. Thus, it was necessary to analyse the competitive to the PERFoRM available solutions and technologies, in order to gather information that must be incorporated to our unique selling position and to our value proposition. In this first iteration the analysis has been focused on

1. Internet of Things/Cooperating Objects
2. Agent-based CPS
3. Cloud-based CPS in Industrial Automation facilitating production & energy optimization

2.3.1.1 *Internet of Things/Cooperating Objects*

Overview: Collaboration is essential in any manufacturing working environment. In the Factories of the Future the required level of skills and the value of experience and technical knowledge is rising, collaboration and exchange of information between the sensors and machine is even more critical. Smart Sensors are widely available. Coordinating and integrating them in a Network that can operate and transmit data at real time is a tedious task. Large companies offer costly solutions that integrate their products, while our approach is non-for profit.

Competitor/ Product [*Competitor name*] [*Product*]	Value to customers [*Unique value to customers, e.g. convenience, quality, price or service?*]	Strengths [*What are your competitor's main strengths?*]	Weaknesses [*What are your competitor's main weaknesses?*]
Thingsquare http://www.thingsquare.com/	- easy to operate and monitor devices through mobile applications for home automation - complete stack and compatibility with IPv6 systems	- self healing networks - based on popular open source Contiki-OS - compatibility and interoperability with different open source systems	- Not designed for industrial environments - Not reliable in high interference areas operating on 2.4Ghz - No multi-radio support

Competitor / Product [*Competitor name*] [*Product*]	Value to customers [*Unique value to customers, e.g. convenience, quality, price or service?*]	Strengths [*What are your competitor's main strengths?*]	Weaknesses [*What are your competitor's main weaknesses?*]
Linear - SmartMesh IP - SmartMesh WirelessHART http://www.linear.com/	- Developed for industrial monitoring - Industry leaders in wireless sensor network provider.	- Developed for industrial monitoring providing high reliability and solid rugged devices - Supports both compatible IP (6LoWPAN) and industry mesh (WirelessHART) standards	- No multi-radio support - No self-healing support - No end-to-end security or mobile application support

2.3.1.2 *Agent-based CPS*

Overview: Changes in production lines, failures and malfunctions require a dynamic re-adaptation of production facilities. An overview of the shop floor as a conceptual wireframe contains information on machinery and personnel status and availability. Thus, the supervisor or production line responsible person can easily and efficiently re-adapt while achieving a human resources workload balancing.

Competitor / Product [*Competitor name*] [*Product*]	Value to customers [*Unique value to customers, e.g. convenience, quality, price or service?*]	Strengths [*What are your competitor's main strengths?*]	Weaknesses [*What are your competitor's main weaknesses?*]
Impact 360® Enterprise Workforce ManagementTM Forecasting, Scheduling, and More to Balance Your Workforce with Workload http://www.verint.com/solutions/customer-engagement-optimization/enterprise-workforce-optimization/products/workforce-management/	Quality	Integrated solution on workforce management Web-based	Cost
SAP Workforce Management (WFM) to plan, create, and maintain employee schedules http://help.sap.com/saphelp_wfm31/helpdata/en/93/9ac13ec9a14670bc108dcd86542033/frameset.htm	Reliability	Forecasting function for optimisation of HR Supports multiple locations Tailored UIs according to access rights Size and experience in enterprise software	Cost

Competitor / Product [*Competitor name*] [*Product*]	Value to customers [*Unique value to customers, e.g. convenience, quality, price or service?*]	Strengths [*What are your competitor's main strengths?*]	Weaknesses [*What are your competitor's main weaknesses?*]
IFS Dynamic Scheduling Engine (IFS DSE http://www.ifsworld.com/uk/solutions/enterprise-service-management/mobile-workforce-management/dynamic-scheduling-software/	Truly dynamic scheduling	Optimisation engine satisfies complex workforce scheduling needs for mobile resources The DSE is truly dynamic, allowing it to respond to urgent new jobs more quickly, saving time which is precious with demanding Service Level Agreements (SLAs)	Focus on medium-sized to large organisations
Improve Workforce Efficiency and the End-to-End Experience Through Enterprise Workload Management http://www.genesys.com/solutions/enterprise-workload-management	Quality (performance)	Optimisation of back-office operations	Focuses on the service sector
JAMS Job Scheduler: an enterprise job scheduling and workload automation solution http://www.jamsscheduler.com/what-is-jams/ /	User friendly and easy to use Relatively low cost	Simple software solution Cross-platform	Focus on IT sector Relatively new company (1985) Lack of strong dynamic scheduling functionalities
Control-M Workload Automation: Helps you schedule and monitor complex business processes solution http://www.bmc.com/it-solutions/control-m-self-service.html	Value for money	Allow for real time decision making Simple interface and mobile app	No focus on the manufacturing sector
Automic Workload Automation http://automic.com/scheduler-migration	Holistic approach to scheduling offering convenience	Offers a single solution for scheduling Integration with other enterprise software	
Schedulix: The all-round, carefree package for automating your IT processes http://www.schedulix.org/en	Increased efficiency	Integrated solution providing a wide range of features (http://www.schedulix.org/en/features)	Focusing on IT processes

Competitor / Product [*Competitor name*] [*Product*]	Value to customers [*Unique value to customers, e.g. convenience, quality, price or service?*]	Strengths [*What are your competitor's main strengths?*]	Weaknesses [*What are your competitor's main weaknesses?*]
ProActive Workflows & Scheduling: easily execute all company jobs and business application, monitor activity and quickly access job results http://www.activeeon.com/workflows-scheduling	Value for money	Simplicity and flexibility of the solution Open sources solution	Better fits to project-related processes IT-focused

http://www.capterra.com/sem/human-resource-software?gclid=CLCP1IO52MgCFdQaGwodQfQPyA

2.3.1.3 *Cloud-based CPS in Industrial Automation facilitating production & energy optimization*

Overview: There are a number of competitive solutions for our Cloud-based CPS, nevertheless, they are either the products of companies resulting from the need to coordinate their products either the result of small-customized projects which are difficult and costly to scale up and are out of focus for this analysis. There are also open source solution and there are other solutions of this type available too. The main competitors listed below have resulted after the analysis of Cloud-based CPS with similar or comparative features to the solution proposed by PERFoRM.

Competitor / Product [*Competitor name*] [*Product*]	Value to customers [*Unique value to customers, e.g. convenience, quality, price or service?*]	Strengths [*What are your competitor's main strengths?*]	Weaknesses [*What are your competitor's main weaknesses?*]
Amazon Web Services (AWS)	These platforms segment consists of amounts earned from sales of compute, storage, database, and other PaaS service offerings for start-ups, enterprises, government agencies, and academic institutions.	There are fully managed service that makes them easy for any developer to use historical data to build predictive models that can be used for a broad array of purposes, including detecting problematic transactions, preventing customer churn, and improving customer support.	Public cloud vendors are establishing unique characteristics that indicate the market will support multiple players. The most notable area of competitive weakness is in quality of IT support and non-proprietary open stack.
Microsoft Azure			
IBM BlueMix			
Pivotal's Cloud Foundry			
Google Cloud Platform			
VMware			
Apache Foundation			

The main competition comes from the big players who can offer unified integrated solutions. Nevertheless, their focus for the decision support systems is on asset efficiency and on analyzing massive data from similar machinery, which is do not address the issues that our product will tackle.

Competitor/Product [*Competitor name*] [*Product*]	Value to customers [*Unique value to customers, e.g. convenience, quality, price or service?*]	Strengths [*What are your competitor's main strengths?*]	Weaknesses [*What are your competitor's main weaknesses?*]
IBM – Advanced Analytics	Brand name, compatibility with other IBM products	Major contributor in the field, Optimisation and customisation capabilities	High price, not compatible with all systems, requires consulting and considerable effort to customise
Intel - Intel® Decision Support	Brand name, compatibility with other Intel products, high quality	Management of mission-critical assets, cloud-based application, Sensor data is automatically collected and transmitted to Intel	High price, not compatible with all systems, main focus on transportation and aerospace industry
GE - Decision Support Studio	Brand name, compatibility with other GE products, suite of products	Ability optimise business operations, giving early detection of mechanical, operational, instrument, or business events.	Compatibility with RuleDesk Pro, high price, requires effort in development

2.4 Products/services SWOT analysis

The SWOT analysis for the PERFoRM products is tabulated below

1. Internet of Things/Cooperating Objects
2. Agent-based CPS
3. Cloud-based CPS in Industrial Automation facilitating production & energy optimization

2.4.1 Internet of Things/Cooperating Objects

Strengths	Weaknesses
- Integration of physical sensors to monitor the factory environment - Reliable transport of data in harsh industrial environments using the designed multi-radio technology approach - Easy and fast deployment of wireless sensor network - Safe transport of data using secure communication channel ensuring high level of data integrity	- Lacks of standard protocols for the integration with middleware technologies - The component is an outcome of several research projects, thus it lacks of comprehensive testing and support resources compared to commercial products - Multi-radio nodes consume more energy than single radio low-power sensor nodes - Lacks tamper proof hardware technology - Lacks flexible firmware updates
Opportunities	**Threats**
- Adoption of the reliable IEEE802.15.4e MAC layer for the 6LoWPAN interface - Increased need for factories to adopt a reliable communication	- Privacy issues - Insider attacks by device tampering - Emerging competitors in the same field

2.4.2 Agent-based CPS

Strengths	Weaknesses
Business strengths - Offering measurable improvements in the efficient use of resources especially in emergency/ unexpected events (e.g. machinery breakdown) Technology strengths - Dynamic rescheduling - Dynamic reallocation of equipment and personnel workload	- Rather challenging interoperability / integration issues (with existing scheduling modules)
Opportunities	**Threats**
- Most solution providers offer rather simplistic or no features on dynamic rescheduling / reallocation of equipment and personnel workload	- Major enterprise information vendors / dealers may add such module in their solution offerings - Competition from startup companies offering solutions on time scheduling

2.4.3 Cloud-based CPS in Industrial Automation facilitating production & energy optimization

Strengths	Weaknesses
- Integration of real world devices in management platforms - Enabling interoperability of heterogeneous devices and components - Facilitation of development and deployment process - Integration of event brokerage - Matured in many different projects	- As research project, PERFoRM lacks of comprehensive testing and support resources compared to a commercial product - Just an underlying technology. Applications and services must be developed on top of it
Opportunities	**Threats**
- Addressed topics are currently in demand (CPS, Industrie 4.0…) - Increased need for factories to better connect their heterogeneous systems - Transformation in industries demand also inter-company connections - There is no widely accepted middleware standard	- Risk to reveal protected data - Privacy issues - Complex topic can make it harder to get started with the technology

2.5 Customer Description / Segmentation

The intent of this initial study was to gather an approach regarding the Market but also that of creating and validating an efficient methodology for this activity to be applied in next months in the other target territories for sales.

Main issues are:

1) Identifying manufacturing industry potentially interested to the PERFoRM products and services (key customers).

2) Collecting requests and expectations from industry decision-makers through empirical methods (e.g. interviews). Identifying the purchase incentives regarding new technologies and services in the various market segments, and their evolution.

3) Making a market segmentation depending to customers' needs.

Sources considered for analyzing trending topics in the manufacturing sector are:

- Interviews of manufacturing industry decision-makers.
- Reports from public and private organizations
- Articles on key journals
- Topics discussed during mainstream conferences
- Hashtags used on Twitter
- Statistics from EUROSTAT and national institutes for statistics

The proposed approach is that each partner will contribute to the data collection. Key questions to answer are: Is your area experiencing growth? Are there industries/services established in the area? Is the region's economy stable? Are there specific provisions or limitations?

What is the size of the market? What recent trends have emerged in the market? What growth potential is available and where do you fit in? How will the market/customers change when you enter the market? What external factors will affect your customers?

2.5.1 Identify

2.5.1.1 *Customer demographics*

Each partner will define who its target customers are and how they behave. It can include age, gender, social status, education and attitudes. What are their production methods, activities, values, needs, interests or opinions? Where are they located?

2.5.1.2 *Key customers*

Each partner will identify its key customers. (These can be factories that will use its products/services or consultants offering services employing its products/services, whose satisfaction is key to the

success of its business.) How will you target your products/services to them? How will you deliver its products/services to them?]

2.5.1.3 *Customer management*

Main questions each partner is asked to answer are: *How will you maintain a good relationship with your customers? What techniques will you use? How will you keep your customers coming back? Have you introduced customer service standards? Do you follow any particular code of practice?*

2.5.2 Market research

An important point to consider in order to consolidate a unique, standard approach to the market research, is the way the market analysis has been performed by each involved partner. Questions are: *What research have you completed to help you analyse your market? Did you use a survey/questionnaire?*

2.5.3 Market targets

Market targets that each partner considered in its business context are valuable information that should be shared. Questions that each partner have to answer are: *Outline your planned sales targets. What market areas do you plan to reach with your products/services in a planned timeframe? What is the market share we expect to gain?*

3. Exploitation Analysis

3.1 Exploitation strategy

In this section the exploitation objectives and plans for the PERFoRM project are presented. These objectives and plans correspond to the updating and detailing of the initial objectives – as drafted in the initial PERFoRM "Description of Work" – according to the progress of the project, the evolution of the partners strategic and business interests, and the evolution of the markets potentially addressed by PERFoRM outcomes. Despite the fact that these plans and objectives may be pivoted over time, through updated and revised models and strategies adjusted to changes in project outcomes and external factors, they already offer a steady basis for preparing the future exploitation of the PERFoRM outcomes, from different perspectives: technical, business and societal.

3.1.1 Key Points

There is a general willingness of all stakeholders in new manufacturing and industrial approaches to exploit cutting edge promising technologies. But there is also the fact that exploitation of this technology requires substantial investments that need to be justified by an adequate return.

Depending on the stakeholder, this return on investment may be either monetary, in terms of a permanent revenue stream that pays back for the investment on the longer run, or non-monetary. Examples of non-monetary benefits are the enhancement of the manufacturing approaches through introducing human-centred technologies and ensuring workers' well-being, better use of resources in industries, through the provision of new, cutting edge technologies in ways that are both productive and appealing to employees and contribution in the international scientific community and society.

Considering the impact on European society and the market potential, it is important for European ICT industries to take the leadership in new emerging technologies applied for Industrial Management and the Modernization of the Industrial Workplace.

The PERFoRM outcomes could be either exploited as a holistic system or as a variety of individual components in the form of separate commercial products. For this reason, the main objective is to form a spin-off company which will fully exploit the PERFoRM outcomes through transforming them into integrated commercial products and introducing them into the market. Alternatively, there is the potential for each partner of the consortium to individually exploit the components of the PERFoRM outcomes, for the development of which they mostly contributed or even cede the control of the commercial exploitation rights to an external company (resellers).

3.1.2 Exploiting PERFoRM as a whole

The PERFoRM project will have as a result a set of toolkits, software and hardware, concepts and models that will form the "PERFoRM Platform". It will be the outcome of combined efforts of individual partners that collaborate since the proposal submission phase and beyond to formulate

the concept and approach and to develop the desired solutions. It is the consortium's desire to exploit and commercialise the overall solution as a complete product and/or service. The exploitable products and characteristics have been presented in Section 2.2. In this section we discuss the possibilities for the commercialisation of the overall PERFoRM framework.

3.1.3 Unique Selling Position

What is new in PERFoRM, more than the technologies and the features of each of its single components, is the way that such a complex environment can be used to address the objective of a healthy and pleasant working experience to all employees. That's really challenging.

In the PERFoRM approach, an initial consultancy activity is necessary in order to identify the needs of each user and to propose a customized path for the introduction of new technologies. This introduction can be progressive, respective of the business objectives and aligned with upper management commitment. The experience of each user is capitalized and become part of the knowledge base of PERFoRM, that is shared by the partners and can be considered as well part of the Product. This unique approach allows a high reuse of previous experiences and an efficient process of customer tailored offer proposition that result in lowest prices for the customers.

As far as the pricing range is concerned, the partners have agreed on following a "pay for what you use" policy. This enables the solution to be promoted at different markets with different needs and financial abilities, thus allowing the PERFoRM platform to penetrate various types of business activities and areas.

The complete, detailed Business Model will be provided in the 2nd iteration. Overall, the framework as a whole is targeting but not limiting to industrial manufacturing companies and smart factories. Individual products can have a broader appeal, as it will be described also in the exploitation plans for each partner.

The products being developed are taking into account client's needs, offering also unique futures to already available similar solutions will be summarised in the table below.

Product	Unique Selling Point

3.1.4 Exploitation plan during the project

The exploitation of such a complex infrastructure like PERFoRM is going to be, usually starts at the end or near the end of the project, when the products have reached a mature development phase. However, there is a unique potential offered by the synergies formed and the ongoing product building. Additionally, the fact that this is an EU funded project involving such athematic area with partners who are among the leaders in their field of expertise is serving as a seal of excellence for

exploitation purposes. Thus, partners have found the opportunity to pursue activities towards engaging stakeholders even this early in the project.

Just because we are at the starting point with no actual products already developed, we needed a Lean approach. We have capitalised on the Lean methodology and on the consortium's skills in exploitation, commercialisation and internationalisation of products similar to those of the PERFoRM ecosystem.

Figure: Traditional Sales & Marketing

The Exploitation Methodology that has been proposed and accepted by the partners is based on four steps: Segment, Identify, Analyse, Plan. A similar approach has been previously used by partners of the consortium. We called it Lean-Champion approach and it can be applied for the promotion of the whole solution, bundles of products or individual products of PERFoRM.

1) Segment. A preliminary market analysis reveals where the most promising likely customers are. They are then classified according to traditionally used parameters such as size, business area, market position, geographic area, and then, complimentarily, according to exploitation potential criteria such as their influence, number and quality of local links. Main channels and sources of information for this activity are: participation to specialized exhibitions and events, networking activities, capitalising on the consortium members' networks, cross

dissemination with the cooperating partners and customers; articles and internet media (YouTube, websites, social networks etc.)

2) Identify. It is the identification of at least one significant representative for each class of possible customer (we call it the *Champion);* A Champion inside a Production Chain or an Industrial District is a well-known company with high reputation within its eco-system of suppliers, customers and partners and other stakeholders. In this way, we identify a key player in the market which can be translated into a key stakeholder for us. The key element for the successful application of this step is to identify the Champion that has high potential impact in the business area and/or geographic vicinity.
3) Analyse. It is the phase of tools/technologies identification. It is mostly based on direct interaction and discussion with the selected prospect, necessary for better understanding user needs. It is imperative to understand the demands to be met and the PERFoRM setup promotes just this, but going a step further from the traditional analysis, allowing for consideration of needs from different levels of the company hierarchy. The analysis then allows for our partners to offer a view of the product and to explain how we can meet the customers' requirements and needs with our technologies.
4) Plan. An Agreement containing a Plan is proposed to the prospect as basis for a discussion, to initiate discrete exploitation activities. The main steps considered in the Plan are:
    - A significant possible "use case" will be analysed by a team of experts. For economy of resources reasons and to capitalise on the outputs o the project, use cases similar to the already available Business Scenarios are proposed.
    - A minimum set of that use case is developed at no cost for the customer (pilot). This is a tempting offer to the prospects, because they just invest minimum time for collaboration with the team members to record their needs and to monitor the evolution of their use case. It has proven to be an irresistible one, because of the value it will add to the *Champion*.
    - The results of the pilot are made public and disseminated with the help of the customer. This is the only thing that the PERFoRM team asks for; to share the knowledge on the outcome achieved for the minimum set of the use case that has been offered to be implemented for free. It is accepted because it can also serve as an advertisement for the *Champion* to have their company involved in a big EU funded project.

There only risk involved in the proposed Lean-Champion approach is in case of bad or insufficient results for the *Champions*. Otherwise, the time and effort invested can be translated into customers ready to adopt the products being developed. This risk has been accounted for and the mitigation measure lies within the user-centric iterative planning and development approach of PERFoRM. Any mishandling, inconsistencies or deficiencies will be handled using the experience acquired during the Industrial Lab Test and Pilot trials and they will be addressed via the iterative process.

The results of this approach are very promising and are the following:

- A better understanding of the user needs is achieved, growing outside of the consortium's end users and taking advantage of the experience gained within the project implementation.
- It has come to our attention that potential customers feel overwhelmed with the plethora of information going around. They want to use what they view as the new technologies (AR, remote tools, DSS, depth cameras etc.) but there are so many, they don't know how to choose, how to make an informed decision. They need someone to match their needs to products. They feel that these technologies are only usable now from the really big players.

- Networking and presenting information for PERFoRM, even if it does not result to getting *Champions* involved, it is translated into stakeholders wanting to know more. They are interested to learn about the results from the pilot test before getting more involved and they invite us to revisit them with updates, because they want to be among the first to adopt the solutions when they are ready.
- Engaging *Champions* in product development allows for a more wide view of the problems to be addressed.
- Having *Champions* on board in this phase of the project will produce strong bonds and involvement and they have great potential of becoming what we call Clients Ready2Go.
- Moreover, this approach enables the word about PERFoRM to get further around. It has been found that other companies want to get involved as Champions, they want to get into the game and not miss on the opportunity to collaborate with us.
- The offer of free services for the development phase has proven to be so successful, that the *Champions* usually ask for their full use case to be analysed or even to include more use cases, at cost. This means that partners have already started exploiting PERFoRM.
- The information from the pilot tests will be enriched with the results from the use cases of the *Champions* and they will be further disseminated with the aid of all involved members, reaching out to a larger audience than initially targeted and anticipated.

The application of the Lean-Champion approach can be of course prolonged and employed after the end of the duration of the PERFoRM project.

3.1.5 Exploitation plan for PERFoRM

Direct Commercialisation

Within the strategy/plan the option primarily investigated was the *direct commercialisation* of the PERFoRM framework, led by the project consortium. This type of exploitation is anticipated after the end of the project when the products will be available. The plan involves:

- The definition of a more detailed consortium agreement, focused on joint investment in the exploitation of PERFoRM. It will define investments necessary to transform the results of the project to ready-to-market products (refining existing software, packaging, user documentation, more detailed testing, higher integration with other frameworks etc.) as well as the corresponding marketing activities.
- The investments necessary to enlarge the portfolio of models and covered domains, in order to offer an attractive product to the market. Further actions should be also included, such as the creation of a supporting infrastructure to provide adequate customer care services – training, consulting, helpdesk, etc.

Considering this approach, the consortium composition itself presents the first barrier in the commercialisation efforts, despite the fact that required technical skills and competences are present. It includes several research institutions (FHG-IPA, HSEL, IPB, Lboro, MTC, PoliMI, SmartFactory, TUBS); some of them are even forbidden, due to statutory regulations, to pursue commercial activities. Technology providing partners (SIEMENS, COMAU, Loccioni, XETICS, GKN, WHR, IFV-eD, POL-eD, Paro) are enterprise focused on different business activities, in particular, some of them with no strong potential and interest in leading this process in a market where they still have no direct presence and they cannot support with their own resources alone. The aforementioned obstacles suggest that an alternative scenario would be more viable, for instance to create a start-up company specifically for this purpose, as discussed in the next section.

Creating the start-up PERFoRM Company

The partners forming the consortium of the PERFoRM project are committed to explore collaborations after the completion of the research project. It has been discussed that it would be preferable and more effective to form a start-up company promoting the complete suite of the products that are being developed in the project framework. The exact legal form of the company and its base, as well as its business model is yet to be decided. However, at this stage a preliminary business agreement has not yey drafted. Moreover, certain partners are cooperating closely in the development of tolls and components.

Creating a start-up company to pursue commercialisation of the PERFoRM results potentially overcomes some of the problems related with direct exploitation. Primarily, even research institutions are usually allowed to participate in start-ups (with direct shares, share options, revenue share agreements or IPR licensing). Additionally, creating an independent company to transform PERFoRM into products and services would overcome some of the internal coordination hurdles and facilitate organisation and operation. Of course, the level of participation and revenue share still need to be negotiated among partners. However, tasks like hiring additional staff to develop software or to reinforce the sales force become easier once an independent start-up is established. From the customers' point of view, it will be simpler to address them as one company, targeting specific needs and market segments. From the collaboration's point of view, it is more efficient to address as one legal entity attract additional partners, such as companies with complementing expertise in the market take up phase. Furthermore, it will be also easier for an independent start-up to capture external funding (public funding, private investors, BAs, VCs etc.).

Possible structure and funding of the PERFoRM Company

Based on the composition of our consortium, it is plausible to say that some of the partners, for example some end users and/or research institutes might not be involved at all in the start-up. A likely alternative for some of the research/academic partners is to keep indirect involvement through licensing or provisioning of services. Other research partners are likely interested in participating in the start-up, since these institutions explicitly value and encourage such knowledge transfer operations. Participation may assume multiple models, including direct shares or profit sharing.

As it has been previously noted, additional companies can be brought in, when creating the start-up or later on, in order to complement the consortium's technical and commercial expertise. The costs accompanying the commencement of such an endeavor may require venture capital participation, unless the alternative to capture enough public funding for entrepreneurial initiatives is met, which is rather difficult to happen.

In general PERFoRM partners are not expected to bring capital to the start-up company. Instead, they may contribute with the algorithms, models, applications and IPR they developed in the course of PERFoRM, as well as with they own resources. SME's may be willing to bring in additional capital, in order to increase their share in the start-up company, but it is unlikely they are available to provide the full amount of necessary capital.

This leads to the need of external funding, which can be obtained by loans (unlikely for a start-up with few tangible assets), venture capital and/or public funding for start-ups. Anyway, while the required upfront investment is critical for the success of the start-up, it should be noted that necessary investment is expected to be well within typical venture capital investments in small SME's.

Portfolio of Products and Services

The exact and detailed identification of the products and services to be commercialized by the start-up company obviously requires more work, however we can discuss at this point the main alternative potentials for revenue:

- Commercialization of the PERFoRM framework as a software pack, with individual licenses and enterprise licenses for larger companies. A rough estimate of the amount per user will be produced in the cost–benefit analysis in the second iteration of this deliverable. It is assumed required hardware will be purchased from third parties.
- Commercialization of the PERFoRM framework as a service, based on a SaaS model. On average regular users are expected to pay around 20% of the cost of the matching software pack per year, while a layered pricing model could be examined in the process for tailoring costs to the actual needs and domains of interest of the end users.
- Training services for the two packs (collaboration, training).
- Consultancy services for the two packs (collaboration, training).

Licensing the PERFoRM Framework to a 3rd Party

In the rapidly and continuously changing market new competitive solutions may rise, for instance by an already established company with a strong brand of related products offering prices comparable to the ones provided by our start-up, leading to higher acceptance by the market. PERFoRM has a few leading advantages (acquired know-how, shorter time-to-market, competences of the involved partners, integrate solutions) but for a faster market penetration those advantages may not be enough.

Licensing the PERFoRM framework (or its key components) to such a company or another 3rd party with strong presence in industrial manufacturing solutions could be an interesting, less risky solution to foster adoption of the framework and some return to involved PERFoRM partners. Possible licensing alternatives and specific components to include should be individually and extensively analysed in direct communications. After the considerations of sales projections, a licensing fee for the software sales and the SaaS services need to be estimated.

Releasing PERFoRM as Open Source or Freely Available

A final alternative for the exploitation of PERFoRM results as a whole is the release of the platform as open source (or at least a freely available product), offering the possibility to the research and development community starts using and further developing it.

There are several possible reasons for such an approach, considering also the fact that a major contribution comes from research/academic partners. It would allow us to attract a large user community with a free product, enabling revenues for related products and services in an indirect way (e.g. advanced paid versions, consulting, training, cross-selling of other products). Moreover, it would accelerate the process of enlarging the portfolio of open models. Finally, in what we see as one of the worst case scenarios, in case of failure of commercial exploitation of the PERFoRM results, offering the outputs to the open community would make sure that the results get to be exploited and further developed.

Considering the aforementioned approach, a professional model offering the outputs freely, while complementing with sales of related services and products is difficult to succeed, since the market may not be large enough to support this solution. The maintenance of the open source release would mostly be based on a voluntary work from the consortium partners, which is not so probable to succeed. Moreover, the functional prototypes that will be delivered by the end of the project, after being tested in the pilots, will need to be further elaborated. The question rises as to if the open source community will be able to carry out this process.

The remaining option to donate the solution without direct return is still interesting enough to be considered on its own, in the case of failure of the commercialization alternatives discussed before. Several PERFoRM components can be released as open source in this context, and remaining components could probably be released as free components (still allowing involved partners to keep its source code undisclosed), but this is not applicable for all components and further examination is necessary in order not to compromise the individual exploitation plan of the partners of the consortium (cf. Section 3.1.3).

3.1.6 Exploitation strategy per partner

In case that the option of each partner of the consortium individually exploiting separate components of the PERFoRM is selected, as the most suitable and profitable prospect, the determined policy that will be followed, demonstrating each partner's strong engagement to exploit the project results to support their own business or activities, is described below.

3.1.6.1 *Exploitation objectives and plan for each Partner*

Goals and Objectives <Partner>

Goal 1	Goal 2	Goal 3	Goal 4
Relative Objectives	Relative Objectives	Relative Objectives	Relative Objectives
	-	-	-

Exploitable products and other benefits <Partner>

Product 1	Product 2	Product 3	Product 4

Exploitation Methodology and Channels <Partner>

Fully detailed financial planning and cost-benefit analysis will be provided in the second iteration where the whole business model of the PERFoRM outcomes as commercial products is analysed.

<Partner> Exploitation Plan					
		Exploitable Results			
		Product 1	*Product 2*	*Product 3*	*Product 4*
Type of exploitable result	Product				
	Service				
	Other				
	Comments:				
Target Market	Industry				
	Public & Commercial Organisations (hospitals, water/power providers, etc.)				
	Consulting Companies / Intermediate users				
	Pilot Owners/Administrators and Facility Managers				
	Comments/ Further Info:				
Sales Strategy	Free				
	Academic version				
	Licensed version				
	Add-on to existing product/service				
	Other				
	Comments:				
Additional Services	Consulting services				
	Implementation services				
	Extension services				
	Training services				
	Support services				
	Other				
	Comments:				

Time To Market	In Months after project completion	12 Months (minimum time)			12 months (minimum time)

Table: <Partner> Exploitation Plans (per outcome)

The pricing and sales strategy will be defined and proposed at months 24 and will be presented in the final deliverableRe-evaluation and updates will be conducted at regular intervals with the final analysis having been planned when the products will be closer to the market.

The average pricing strategy for the exploitable outcomes will bepresented on the following Table. As mentioned before, fully detailed financial planning and cost-benefit analysis will be provided in the second iteration where the whole business model of the PERFoRM outcomes as commercial products will be proposed.

Pricing Policy				
Exploitable Results	Product 1	Product 2	Product 3	Product 4
Type	Cost / €	Cost / €	Cost / €	Cost / €
Stand-alone application (Academic version)				
Stand-alone application (Licenced version)				
Add-on to existing product/service				

Table: <Partner> Pricing Policy

3.1.7 Conclusions

In this section we identified and discussed four alternative approaches for exploiting the PERFoRM results as a whole.

The direct commercialization driven by the consortium is the least attractive solution because of the composition of the consortium and the potential administrative and managerial obstacles implied. The partners at this stage agree that similar results can be more easily achieved creating a start-up company.

A first analysis of the start-up option shows it is an interesting and valuable solution, although its economic viability needs to be further examined in the second iteration, considering the need for external funding, the break-even point for the initial investment and several risks related with market acceptance and competition. The possibility of bringing additional partners to the start-up needs to be also further examined, in order to address financing needs and to involve companies with more expertise and presence in the target markets.

This idea of collaborating with a company already established in the market with similar products is the basis for the third alternative: licensing the PERFoRM framework to an existing company willing

and capable of turning it into a successful product. This option may result to financial return, but with lesser risks. The drawback in this case is that the potential exploitation of future follow-up applications and outcomes will not be controlled anymore by the PERFoRM consortium.

Finally, we presented the possibility of releasing a large part of the PERFoRM framework as open source – with some of the remaining components made freely available but not open source. No significant advantages are evident in what relates with financial return or fastest adoption of framework. The open source release should be seen more as a donation to the community – still attractive for a number of reasons – rather than an investment with direct, tangible return.

The comparison of the four alternatives leads to the following preliminary observations:

- Commercialisation directly driven by the consortium is not interesting enough and will most likely not be pursued.
- Releasing PERFoRM as open source (or freely available) does not guarantee return to the consortium partners. Also, it is difficult for the open source community to invest the necessary resources, in order to achieve considerable adoption of the PERFoRM platform as a whole. However, it should be seen as a backup solution if the other alternatives do not succeed, so that the results do not get lost.
- Deciding between the start-up and licensing models depends on additional factors that require further examination, in the willingness of the partners to continue to be directly involved in the exploitation of the project results as a whole, as well as in the support from venture capital. At the moment, the start-up option looks slightly more attractive on the long term, but it also presents higher risks.

3.2 IPR Issues

In this section the legal and IPR issues associated with the PERFoRM products are addressed, including pre-existing IPR (within the consortium partners), IPR handling of the outcomes of the project, and possible constraints imposed by external IPR (for instance licensing terms of third-party software used in the development of the PERFoRM platform).

3.2.1 Internal Competition (at Consortium Level)

Direct competition at internal level within the PERFoRM consortium is not a key issue, because of the structure of the consortium. The competencies, interests, priorities and strategies of each involved partner are mostly complementary, rather than competitive. Thus, cooperation is anticipated between partners, rather than direct competition. The group of partners involved are not facing overlapping of competencies nor technologies. The development of the solutions are made with the integration of every single contribution thanks to the design of architecture of the project and the development plan that did not highlight any issue under this perspective.

However, in the unlikely case that internal conflicts and competition occur, they can be arbitrated by the PERFoRM Consortium & Grant Agreements and, if deemed necessary, further analysed by specific IPR agreements on the exploitable outcomes, setting the rules and rights over outcomes (e.g. geographical regions or business domains).

3.2.2 Pre-existing know-how (Background)

All partners are prepared to provide their pre-existing know-how in order to contribute to the success of the project. The partners will respect each other's IPR on all pre-existing items that are owned by one of the partners and that are used in the context of the project. A partner that is the holder of patents, copyright protected material or other intellectual property items that are needed for the execution of the PERFoRM project will provide those items to other Partners at fair licensing conditions.

Partners will only use the products, information, source code or other protected items owned by another partner in the context of the PERFoRM project when the licensing conditions for exploitation of these items in the context of the project have been clearly communicated by the partner that holds the IPR of these items.

The input IPR assets to PERFoRM are strongly related with specific competencies and innovative solutions that affect mostly singularly the partners. This situation eases the consideration of addressing IPR issues between partners, because it will most likely result to individual initiatives for entrepreneurial decisions regarding IPR protection, considering complexity in terms of investment, strategic decisions etc.

3.2.3 IPR outcomes of the PERFoRM project

During the PERFoRM project results will be produced that will need to be protected and the partners have agreed on the principle that for every result in the form of know-how, report, computer programme or any other form eligible for intellectual property protection, the right holder or right holders will be accurately identified (according to the effective contributions of involved partners). The partners also have agreed on the principle that they will respect each other's rights on the exploitation of the results.

During the implementation of PERFoRM, partners will be required to use the knowledge owned by other parties, in order to successfully complete the tasks within the project. The rules and obligations regarding pre-existing know-how (background) and know-how developed during the project (foreground) has been agreed upon in the Consortium Agreement. Additionally, the member of the consortium will consider a Business Agreement.

The easier to acquire of these rights is probably copyright as affirmed: any document (including a computer program) authored by a partner will "belong" (under copyright law) to that partner. However, having copyrighted it will not necessarily excuse a partner from acquiring other rights (e.g. to apply for a patent). The wish and responsibility to publish research results and carry out technology transfer will be carefully weighed against the necessity to keep specific foreground within the consortium and not to endanger future exploitation. All partners provide information about planned publications to the consortium and to the Management Team. Thus, if any partner may be affected, they can raise the issue and request to delay publications until the IP has been protected.

The very nature of the consortium dictates that the foreground produced by parties will be considered for protection depending on the type of the legal entities involved. For example, academic/research partners will publish their work, or even offer their results to the scientific community, requesting however for the acknowledgment of the source of information (e.g. Open License). Moreover, they could make direct industrial use and technology transfer internally or to customers and further development to R&D projects.

3.2.3.1 *IPR belonging to 3rd parties*

In addition to the IPR belonging to the consortium partners, the exploitation of the project results might be also affected by possible IPR and/or licensing restrictions imposed by third parties. The use of software components developed in previous European Projects and commercially available tools is subjected to licensing restrictions for commercial use. Partners incorporating third party components in PERFoRM modules shall be responsible for identifying possible licensing and IPR conflicts and for informing the other consortium members of such conflicts. As the project progresses, the IPR belonging to third parties will be considered and continuously updated.

3.2.4 IPR analysis according to activity

A more detailed overlook of the market context and PERFoRM group will be presented using three main categories that organize the development areas under the conceptual field of activity: knowledge information management, software and procedures, hardware devices. Under these groups the consortium sets the corresponding IPR strategy approach.

3.2.5 Conclusions

At this point IPR protection potential remains to be deliberated, once tangible results will be available. Although patenting possibilities may not look so strong, the know-how to be produced within PERFoRM seems to be the greater and more exploitable value, because of the diversity of the partners and the specific competencies they have. The patrimony of PERFoRM appears in this stage to be the architecture of the whole IT infrastructure, the knowledge and the contents as a whole. Being highly complex and complete to satisfy a wide number of needs, all partners aim to focus in exploitation activities.

The complementarity of the partners' competencies will allow for the formation of a platform of functions and tools, resources and technology that can be adapted to specific needs. The AR element has strong potential for IPR protection. Moreover, each partner will examine possibilities for the components under development. Under this perspective, there is good chances of competitiveness using also the open source approach that will be used to build some of the elements of the infrastructure. For example, the Apache License could be applied retaining preservation of the copyright notice and disclaimer.

In conclusion the uniqueness and the potential of the consortium to address a value in the market environment is based on the mix of competences and technologies that suit a wide number of use

cases, being also flexible, scalable and cost effective. The consideration regarding the time of protection initiatives and areas will be revisited after the first business scenarios have been implemented, when each partner will be able to assess the level of innovation of their foreground.

3.3 Risk Analysis

The following section the risk analysis conducted until M18. This is a continuously updated procedure that will be revisited in the next version of the deliverable.

3.3.1 Introduction to risk analysis in the PERFoRM exploitation plan

Exploitation risks can be classified in different categories:

- Framework conditions risks are those related to the unforeseeable evolutions of the macro-level business environment, including macro-economic trends, perspectives for the European manufacturing sector, and legal risks.
- Market risks relate to competition and offer-demand dynamics, and include a product or service ill-matched to the consumers needs, competitors entering the market with stronger value propositions, and unsustainable business model.
- Internal risks include those directly related to the proper execution of the exploitation activities by the project partners themselves. They include shortcomings or delays in developing the technologies, failure to reach consensus on the exploitation strategy, or insufficient commitment of resources.

Framework conditions risks are completely outside the consortium control. Therefore, the main mitigation measures are analysis and anticipation. Macro-economic risks and the general trends in the manufacturing sector have been analysed in this report. This analysis will be updated in the next version of the exploitation plan.

Legal risks include those related to IPR (e.g. patents, licences) and those linked to higher-level regulations at the national and European levels. ICT businesses operate in a particularly moving legal environment. The new regulation on personal data protection[12], the Safe Harbour ruling by the European Court of Justice[13], and EC works on the Digital Single Market[14] are just examples of the fast-moving legal framework. This environment will be further analysed in the next steps of the exploitation activities. In particular, Freedom To Operate (FTO) analysis will be carried out for each product and service that the project will consider exploiting.

Market risks are at the interface between the project consortium and its environment. Mitigating the market risks is the main purpose of this document and the market analysis work carried out by the PERFoRM team. Of course, this requires a continuous effort to update the project knowledge of its environment, closely monitor the trends in its customer base, and radar the emergence of new technologies or competitors. A preliminary analysis has been presented, and will be updated.

[12] www.politico.eu/article/deal-data-protection-laws-parliament-privacy-tech-digital/
[13] http://curia.europa.eu/jcms/upload/docs/application/pdf/2015-10/cp150117en.pdf
[14] http://ec.europa.eu/priorities/digital-single-market/

Internal risks originate from the PERFoRM consortium itself. Mitigation measures thus include strong management of exploitation activities as well as the organisation of a regular debate between partners on exploitation issues – during consortium meetings, teleconferences and through emails. Moreover, in the next period, the project will develop a business model that will comprise the identification of the resources that each project partner is ready to commit, beyond the end of the EC Grant Agreement, to put PERFoRM solutions onto the market. The goal is that, at the end of the project, interested partner sign an Exploitation Agreement that is legally binding in terms of each partners contributions and rights.

3.3.2 Detailed risk analysis of PERFoRM KERs

For this report, the PERFoRM consortium adopted an approach around 6 main risks:

1. Partnership risk factors
2. Technological risk factors
3. Market risk factors
4. IPR/legal risk factors
5. Financial/management risk factors
6. Environmental risk factors

Those 6 risks will be assessed for each of the project KER (Key Exploitable Res), they will be presented in the following proposed tables. For each risk factor, the following dimensions have been quantified:

(1) Degree of importance of the risk related to the final achievement of this Key Exploitable Result. Rating from 1 to 10 (1 low- 10 high)

(2) Probability of risk happening. Rating from 1 to 10 (1 low - 10 high)

(3) Scope and type of potential intervention for mitigation

(4) Feasibility/Success of Intervention. Rating from 1 to 10 (1 low- 10 high)

3.3.2.1 *<Company> / <Product & Solution>*

Risk analysis of KER 1 – <Partner> / <Product & Solution>						
Risks	Importance of the risk / achievement of this KER (1)	Probability of risk happening (2)	Risk Grade	Potential intervention (3)	Feasibility/ Success of Intervention (4)	Priority Level
Partnership Factors						
Technological Factors						
Market Factors						
IPR/legal Factors						
Financial/ management Factors						
Environmental /regulatory Factors						

3.3.3 Conclusion

This preliminary risk analysis method will highlights the major risk factor for most of the PERFoRM KER. The second most prominent risk factors will be the market, and this confirms the need for a well thought-out, context-aware, objective-oriented exploitation plan in PERFoRM. This is what will be carried out during the second year of the project, and with the publication of the second iteration of the deliverable D11.3.

3.4 Marketing strategy

This section presents the marketing strategy of PERFoRM with regards to product advertising and public relations. In particular, it explains the activities that will be undertaken by the consortium to achieve the objectives in terms of product visibility and customer engagement. The methodology for market penetration and for building synergies with related organisations will be further detailed.

Definitions:

- *Public relations* is a strategic communication process that builds mutually beneficial relationships between organizations and their target groups;
- *Advertising* is the activity of producing information for promoting the sale of commercial products or services.

The PERFoRM product marketing, advertising and public relation strategy will be carefully designed to address the identified target groups in the most effective way. The expected outcomes of these marketing activities include:

- A large number of industrial & research stakeholders being more aware of the ideas and technologies proposed by PERFoRM for building the industrial future of Europe;
- And above all, a broad interest from industrial decision-markers in PERFoRM solutions for the enhancement of both work life and manufacturing productivity.

PROMOTION: PRODUCT MARKETING, ADVERTISING AND PUBLIC RELATIONS		
Chronological order	Channels, materials and activities	Rough estimate of cost (indicative)
1 - Preliminary steps	The technology potential and the technology readiness are clearly assessed	
	Target customers have been identified for each partner and as a whole.	
	One or several technology packages are proposed to customers depending on their needs. B2B contracts are proposed.	
	Price strategy has been determined. The options could be: • Market skimming pricing (to begin with high prices);	

	• Market penetration pricing (to begin with low prices). The project could use a loss leader, that is to say, an item sold below cost in an effort to stimulate other profitable sales; • Neutral pricing.	
2 - Product branding & strategy	A "Funnel analysis" is performed in order to choose the right communication channels for B2B marketing and to allocate the optimal budgets/efforts to them (e-Commerce)	
	Creating visual identity & advertising slogan, allowing the transition from project communication to business advertising	< 500€
3 - Promoting PERFoRM's products	Print advertising: flyer / brochure / poster / catalogue of products and services	< 500€
	Page dedicated to PERFoRM products on the project website	0€
	News on social media (Twitter, LinkedIn).	0€
	Press release/publication published on external media.	0€
	e-Newsletter	0€
	Video on YouTube	< 500€ (voice-over, illustrations)
	Events: organising workshops, conference, etc.	Varies depending on the event
	Public relations: by contacting and engaging directly the target audience (emails, invitations to meetings, etc.)	Travels costs

Performance measurements (e.g. by measuring Key Performance Indicators - KPIs) will be done in order to assess the quality and success of the marketing efforts, and to readjust actions whenever required.

3.5 Conclusions

In the previous sections we have discussed the business environment, the target market and the possible paths for exploiting the "PERFoRM framework" as a whole. This analysis showed that such exploitation is viable (either via a start-up company created by selected partners specifically to undertake this mission or via licensing to a third-party company already established in this market domain), despite the risks and the level of economic results.

We have also discussed the alternative of exploitation by the partners individually or in collaborative schemes, supporting the customer point of view of the PERFoRM products. The collaborative platform for instance could be coupled with the DSS and the HR workload management toolkit, offering a more interactive environment within the smart factory. Another example is the

combination of the real-time localisation with the incident feedback engine and the smart sensor network to provide for a complete solution for safety and ergonomics.

This second strategy can have faster exploitation results – when compared with exploiting PERFoRM as a whole – reaching to the markets in most cases, using less resources and facing fewer risks. It should be mentioned that it can be pursued with lighter structures, having a few partners collaborating, making it easier to reach to an agreement, capitalising on their market presence, brand name and expertise.

This situation further justifies the following decision:

- The distributed approach will be the primary strategy to be followed towards exploitation, allowing different clusters of partners (or even individual partners) to independently exploit different components of the project, possibly in different time frames and in different market domains. Allowing the coexistence of multiple and not necessarily strictly aligned exploitation activities is expected to result in faster, larger and less risky tangible exploitation results.
- The exploitation of the PERFoRM results as a whole will be further considered, complementing the distributed approach. Partners will continue to evaluate until the end of the project especially the formation of a start-up company or licensing to a third party, considering the evolution of the market, the economy in general (market evolution, access to external financing) and their own interests.

In order to plan and support exploitation, the following roadmap is being considered for the duration of the project:

- To identify and analyse possible exploitation paths for the PERFoRM framework as a whole.
- To identify the key exploitable components and the core partners involved with them, followed by a preliminary SWOT analysis.
- To analyse potential competition and opportunities and to address any legal and IPR constraints for the exploitation of the outcomes of the project.
- To collect, refine and update individual exploitation objectives and plans from each partner, in order to map exploitation interests per partner and per exploitable component. This information can also help defining the expected role of each partner for the exploitable component(s) they are involved in.
- To draft the PERFoRM Business Agreement (cf. Annex II), a commonly agreed guideline and understanding on the exploitation roles, rights and responsibilities, per partner and per exploitable component.

Exploitation plans will be continuously update throughout the duration of the project and more work is foreseen to be done on the definition of clusters of partners interested in collaborating for the exploitation of bundles of products. Even if each cluster may have different needs and time schedule, depending also on its time-to-market, the following activities are foreseeable:

- More detailed definition of exploitable components, within each cluster, revising and detailing the already provided SWOT analysis of market and technological trends.
- Elaboration on exploitation models in line with the individual partners' plans.

- Updates or extensions to the Business Agreement, reflecting the results of the previous activities.

Considering the specific path of exploiting the PERFoRM framework as a whole, the following activities are foreseeable:

- A SWOT analysis for the complete solution based on a more detailed study of the market and possible sales strategies.
- Analysis of possible strategies for establishing the start-up (involved partners, selection of country to host the company, legal framework, access to venture capital, management structure).
- Further discussion for the selection of strategy among PERFoRM partners, leading to a final decision at the end of the project.

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Annexe I: Template – Questionnaire for collecting recent Market Analysis and input for the Exploitation Analysis

- Product
- Proposed Selling Model (in case of direct sale to an end-user customers)
  - ✓ Software Licence ?
  - ✓ Pay-per-use ?
  - ✓ Limited-time trial licence ?

- Proposed Selling Model (in case of sale trough distributor or V.A.R.)
  - ✓ Consultancy plus limited-time trial licence ?
  - ✓ Consultancy plus Saas (software as a service) ?

- Advantages (in comparison with competitors)
- Data Interoperability Standards Compliance
- Appeling of the Solution (wow effect: 1 to 10)
- Manufacturing Sector (Process Industry, Mechanical,..)
- Automated work intensity
- Manual work intensity
- Destination market (mass market, low-end vs high-end price position,)
- Average added product value (cost of the product/cost of manwork)
- Geographic Localization Area
- Size (turnover, number of employees)
- Investment capacity
- Average Decision Time for new technology adoption
- Multiregional vs. Local Market positioning
- Multiregional vs. Local Production facilities
- Average age of workers
- Average scolarity level of workers (%Primary school, %Secondary, %University degree)
- Worker's turn-over
- Average new products learning time/product commercialization life
- Esplicit interest for adopting PERFoRM

2.3 Competitors

- Product Name
- Developer
- Age of Installations
- Technology Area
- Target Addressed
- Commercial Organization and Networks
- Commercial Capacity Investments
- Product Development Capacity (Average Time Between Main Releases)
- Market Knowledge
- Multinational vs Local Development