BIFOCALPS Project

Boosting Innovation in Factory Of the future value Chain in the Alps

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D.T.1.1.1: FoF Manufacturing Framework

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**EXECUTIVE SUMMARY**

The aim of this document is to provide an overview of the FoF manufacturing framework in the Alpine Space regions.

The work started from the definition and identification of concepts related to the Factory of the Future as drivers, megatrends, enabling technologies and challenges affecting the sector.

Section 2 presents the national initiative for the implementation of the FoF in the five countries involved in the project: Austria, France, Italy, Germany and Slovenia.

National and regional implementation actions for the FoF represent the focus of Section 3 which particularly highlights clusters and related roadmaps, enabling technologies considered, strategic priorities and long term visions.

In Section 4 are then described the manufacturing priorities and competencies defined in each of the different Alpin Space regions according to the specific Smart Specialization Strategy defined. The specialization areas related to manufacturing have been selected and each of them has been described according to a schema which first presents an overview of the related production and research systems highlighting the main actors involved. Moreover, the priority themes of technological development and the most significant enabling technologies of the area are then detailed.
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1 FACTORY OF THE FUTURE: DEFINITION AND CONCEPTS

1.1 Definition

To understand the importance of the Factory of the Future (FoF) we have to consider that historically the manufacturing industry has gone through three main revolutions:

1. First Industrial revolution (1784): introduction of the first mechanical weaving loom;
2. Second Industrial Revolution (1923): introduction of the assembly line in the Ford Motors;
3. Third Industrial Revolution (1969): introduction of the first programmable logic controller (PLC);

And actually we are living in the commonly recognised forth industrial revolution:


Acceleration of technological progress, scarcity of resources and globalisation, force manufacturing industry to become adaptive and fully connected along value chains and life cycle phases to create value for customers and remain competitive.

“Factory of the Future” (or “Smart Factory”, or “Smart Manufacturing”) defines a variety of enabling production technologies as well as IT solutions that integrate automation with cyber-physical systems combining communications, information and communication technology (ICT), data and physical elements and the ability to connect devices. This transformation has then extended the digitalisation and automation of the production to the whole value chain and the business model, making them flexible and dynamic in matching end user requirements.

In fact, Factory of the Future solutions includes an extended set of core topics for the manufacturing environment:

- High-tech manufacturing processes, including 3D printing, nano and microscale structuring;
- Adaptive and smart manufacturing equipment and systems, including mechatronics, robotics, photonics;
- Resource-efficient factory design, and data management for increased production performance, optimised maintenance and cut of operational costs;
- Collaborative and mobile enterprises, networked factories linking dynamically supply chains to local production;
- Human-centred manufacturing: designing the workplaces of the future;
- Customer-focused manufacturing: linking products and processes to innovative services;
- Standards, regulations and legislation.

In this sense, shifting to Factory of the Future practices implies both disruptive changes and far-reaching opportunities in improving competitiveness for the manufacturing industry, especially in Europe. Starting from the Industrie 4.0 Working Group in Germany, states are then moving to promote systematic programmes and investments to support the development and enhance the evolution of the industrial production towards these new practices.

The International Electrotechnical Commission (IEC) define some concepts that characterise the Factory of the Future:
• **Open Value Chain**: value chain systems need to be more adaptable, agile and resilient and optimised with the capital expenditure.

• **Flexible Production**: the value chain has to adapt to the rapidly changing customer demand.

• **Human-Centred Manufacturing**: shifting to a more flexible relationship between human and the factory, with an open share of the knowledge and an ergonomics ensured by the robotics technology.

![Diagram of past and future factories](image)

**Figure 1**: International Electrotechnical Commission (IEC), Factory of the future, 2015

• **Business Model**: the implementation of the ICT allow the adoption of more innovative business model.
  - Crowdsourcing
  - Anything-as-a-service
  - Symbiotic Ecosystem

Infor (2015) define (FoF) as “the product of fast-changing disruptive technologies hitting manufacturing like a cyclone”. There is a drastic innovation in both information technology and operation technology. In fact, we are living the fourth industrial revolution.

Atos (2014) report that “a new generation of manufacturers” are upon us. Manufacturers whose operation are integrated end-to-end. Manufacturers with time to market that leaves competitors in the dust. Manufacturers who can accurately predict demand and alter production to suit with ease”.

KPMG (2014) define the FoF as “a future view of an interconnected manufacturing value chain, involving information and communications technology (ICT) and automation technologies: software will holistically interconnect and manage distributed factory assets. Embedded data collectors in processing centres will be linked to cross-functional enterprise systems, enabling real-time two-way data exchange and full production quality control. In the FoF, the adaption of various digital technologies will also enable the data exchange from r&d (cad, virtual simulation tools, rapid prototyping) to the factory floor (automation/robotics, control technologies, product lifecycle management (PLM), additive manufacturing) to
distribution partners (analytical applications) and back, from suppliers to OEMs to customers, and vice versa".

The transition to the factory of the future it is not only a merely technologic innovation but it also represents a completely new way to reach the market and to manage the production, it is a rethink of the business model. Deloitte (2015) suggest that the digitalization is not changing only the manufacturing landscape but the entire environment around it and propose the following framework for the Factory of the Future (see Figure 2).

![Diagram of Factory of the Future](image)

The smart factory has to interface with other smart infrastructure that creates a digitalized environment. Deloitte (2015) also report the main characteristic of the factory of the future:

- **Vertical networking of smart production system**: cyber-physical production system (CPPSs) enable plants to rapidly react to change in demands, stock or faults.
- **Horizontal integration via a new generation of global value chain network**: real-time optimised network enabling integrated transparency, high level of flexibility and global optimisation.
- **Through-engineering across the entire value chain**: development of synergies between the development of new product and the production system.
- **Acceleration through exponential technologies**: technologies that allow individualised solutions, flexibility and cost saving in the industrial process.

Along this line, every country has started to study this revolution and named in differ ways the process and the initiative used to achieve the Factory of the Future:

- Germany: Industrie 4.0
- United States: Advanced Manufacturing Partnership 2.0
- United Kingdom: Catapult Centers
• Italy: Intelligent Factories Clusters
• Belgium: Intelligent Factories Clusters
• Japan: Revitalization / Robot Strategy
• China: Made in China 2025
• France: Industrie du Futur
• South Korea: Manufacturing Innovation 3.0

1.2 Driver

KPMG (2014) identifies the main drivers of the FoF:
• Expectations of a significant boost in efficiency, safety and resource sustainability in production and logistics.
• Optimised consumption of resources through the use of energy and material efficient processes and machinery
• Increasing labour costs (e.g. china) are leading to a broader automation push.
• Reduction of design errors and “time to market”; optimisation of production processes through digital factory modelling.
• Flexible machinery and tools (adaptability/ reconfigurability), while ensuring an easy process maintainability.
• Increasing processing power of ICT and more sophisticated analytical software enables real-time performance analysis.
• Steady and stable product quality through increased process robustness and accuracy.

Furthermore, the European Factories of the Future Research Association (EFFRA) (2013) identify the main output for the shift to the FoF in:
1. Increase EU industrial competitiveness and sustainability in a global world through R & I activities for the timely development of new knowledge-based production technologies and systems:
   a. Competitive and sustainable production plants;
   b. Industrial automation, machinery and robotics;
   c. Industrial software for design and plant management;
2. Promote EU 2020 targets of a smart, green and inclusive economy:
   a. Energy- and resource-efficient manufacturing processes;
   b. Socially sustainable, safe and attractive workplaces;
   c. High-tech companies involved in innovative manufacturing;
3. Support EU industrial policy targets (EC industrial policy communication October 2012):
   a. Raising the share of manufacturing in EU GDP from 16 % to 20 % by 2020;
   b. Raising industrial investment in equipment from 6 % to 9 % by 2020;
   c. Ensuring technology transfer and training across manufacturing sectors;
4. Underpin EU trade and investment policy:
   a. EU to remain the leading trade region in the world, keeping the share of EU trade in goods between 15–20 %.

KPMG (2014) report also the main impact and consequences for the companies:
• Rapid technology innovations, cost efficiency and customer requirements push manufacturers to manage product lifecycle costs, increase product variability and continuously change production volumes.
• ICT-enabled intelligent manufacturing may require special product design; new manufacturing technologies may require new materials
• Additive manufacturing is a substitution for reductive/ subtractive processes (cnc machining like cutting or drilling, or primary shaping processes like electroforming, casting, foundry processes and powder metallurgy processes)
• Increasing cost for implementation, service and maintenance of IT systems; increasing cost for software development for special applications; new requirements for human-machine interface to handle increased complexity of systems.
• Increasing need for security of internal-external networks.
• Automation and (plant) engineering companies have to adapt components and software solutions (interfaces) to support the interconnectivity of their product portfolios.

Finally the Forschungsunion (2013) suggest how the implementation of the industry 4.0 has huge potential as:
• Meet individual customer requirements
• Flexibility
• Optimised decision-taking
• Resource productivity and efficiency
• Creating value opportunities through new services
• Responding to demographic change in the workplace
• Work-Life-Balance

1.3 Megatrends in Manufacturing Sector

Ernst & Young (2015) define megatrends as “large, transformative global forces that impact everyone on the planet”. Megatrends will have an impact on business, society, culture, economies and individuals, and they interact with each other. For example there is no doubt that digitalization (big data, sensors and social application) will underpin health management, tomorrow’s intelligent cities and so on.

Ernst & Young (2015) identify six megatrends:

1. Digital Future
   a. Digital transformation is changing business models, including revenue models
   b. Declining PC usage and increasing mobile device adoption is driving a “mobile first” world
   c. Digital transformation and a proliferation of data are fundamentally changing the relationship between businesses and their customers
   d. Digital disruption is changing the market context and competitive landscape of most industries
   e. As cyber threats continue to multiply, it is becoming harder to safeguard data, intellectual property, and personal information
   f. Workstyles and the means to engage talent are becoming more agile in the digital world
   g. Digital and robotic technologies will increasingly augment or replace workers

2. Entrepreneurship Rising
3. Global Marketplace
4. Urban World
5. Resourceful Planet
6. Health Reimmagined
By studying the manufacturing sector, we have to consider the megatrends and their impact in driving the change. The European Factories of the Future Research Association (2013) report eight main megatrends:

1. **Changing demographics** (growing world population, ageing societies, increasing urbanisation);
2. **Globalisation and future markets** (BRIC and beyond);
3. **Scarcity of resources** (energy, water, other commodities);
4. **The challenge of climate change** (increasing CO2, global warming, ecosystem at risk);
5. **Dynamic technology and innovation** (ICT and virtualisation, technology diffusion, the age of life science, ubiquitous connectivity, sensing and digitalisation);
6. **Global knowledge society** (know-how base, gender gap, war for talent, multiplication of data and information);
7. **Mass customisation** (personalised customisation);
8. **Sharing global responsibility** (shift to global cooperation, growing power of NGOs, increasing philanthropy).

Finally KPMG (2014) report ten specific megatrends for the manufacturing sector:

1. **Factory of the Future**: automation more cost effective than outsourcing, increasing industrial security risk and increase in legal provisions, regulations and industry standards.
2. **Near Shoring**: companies are shifting back to a nearshoring localisation because of raising cost labour (e.g. China) and to get a better service for the customers.
3. **Demand Shift to the East**: the power is shifting to west to east due to the growth of that economy. The presence of a rising middle class means higher demands. In fact, Asia’s economic influence are growing and companies are placing their R&D and production facilities to meet the local demands.
4. **Cluster Manufacturing**: it refers to the presence in a defined regional location of a
set of interrelated companies that gain benefit from physical proximity, core competencies, skilled workforce and specialists, activity base, specialized (physical, and knowledge) infrastructure, and industrial organisation.

5. **Energy/Resource Efficiency**: being effective in the utilization of energy and raw material lead to a cost reduction because commodity price is rising. Efficiency also depend on the environmental impact to meet legal requirements.

6. **Talent Challenge**: the complexity of the manufacturing landscape need more and more skilled people in order to use their know-how as an engine for innovation, and so, in particular emerging economies, are facing talent shortage.

7. **Nanotechnology / Nonmanufacturing**: by manipulating the structure of the matter scientist are generating new material and new capabilities for the manufacturing sector.

8. **Service-Driven Business Model**: represent the born of companies that change the business model from a product-focused to a client-centric. Manufacturers should sell service to the customer by taking a holistic view of their needs.

9. **Sourcing Governance**: Sourcing governance is the responsible management and controlling of the company’s external value chain, where the more added-value task take place.

10. **Additive Manufacturing / 3D Printing**: represent a more fast and cost effective technique for prototyping.

### 1.4 Enabling Technologies and Factors

The enabling technologies are those that are knowledge-intensive and able to allow and sustain innovation dynamic and involving products, processes, system and services. Technology lies at the base of the FoF.

- **Big Data**: this technology allow to shift from the manual and “standard defined” extraction of the data to a continued and automatized collection with the Business Intelligence (BI) system. This allow to store all the information of the process and to obtain the so called Big Data whose analysis enable real time defect identification, trend analysis, predictive maintenance and so on.

  The main scope of the use of big data are:
  - Real-time performance factory analysis
  - Real-time re-planning
  - Real-time supply chain performance analysis
  - Production quality and yield management
  - Demand pattern analysis
  - Real-time warehousing and logistic analysis
  - Real-time asset performance analysis
  - Utility and energy management
  - Decision making process

- **Simulation and Virtual Reality**: transferring the characteristic of the real world in a virtual system allow to test and simulate, for example, the engineering of a product faster and without affecting the physical plant of the facility. On the other hand, virtual reality allows seeing the plant layout in a virtual environment.

  - Modelling and simulation for the (co-)design and management of integrated product–process–production systems
  - Virtual models spanning all levels of the factory life and its life cycle
• **Internet of the Things (IoT):** it's the internet extension to physical object that has thus a sort of “intelligence”. In this way an object can receive and give information. This is allowed by sensors, whose price it is decreasing due to scale economy. This sensor stays in a sort of vertical pyramid in which they are many with a limited “intelligence” and they communicate with a central control unit. The main application area of the IoT are:

  - Production tracking and remote factory monitoring
  - Track and trace across the supply chain
  - Plant-floor automation via machine-to-machine
  - Real-time asset performance management
  - Utility and energy management
  - Warehouse management
  - Plant-floor safety and security

• **Cybersecurity:** it is the opposite side of the coin. Having such an amount of data lead to the problem of the security of this data from industrial espionage or hacker attack. In this way cybersecurity leads to the threat analysis, vulnerability identification and to the risk associated with the informatics system. Companies to avoid economic, reputational or politic damage should create a partnership with cybersecurity society.

  - Firewall
  - Security gateway
  - Honey pot
  - Cloud policies
  - Cryptographic system
  - Physically Unclonable Functions (PUF)
  - Instruction Detection/Protection System (IDS/IPS)
  - 3, 2, 1 technique (3 copies, 2 locations, 1 offline)

• **Cloud System:** company already uses the “cloud” to store, transfer and elaborate the data

  - Online cloud storage
  - Offline data stores
  - Third-party storage

• **Additive Manufacturing:** is the name of the already know 3D printing technology. This technology allows to prototype object in a way cheaper and faster that is unimaginable in the past. In the industry 4.0 3D printing is different from the traditional ways of production because it allows also the manufacturing of small batch of customised product.

• **Augmented Reality (AR):** in the industry 4.0, the augmented reality allows the operators to get real-time information about what they are doing to enhance the production and decision process. The implementation of AR (similar to the IoT sensors) with viewers allow also the continuous acquisition of data that lead to the continuous integration of the process of the industry 4.0.

• **High Value Added Manufacturing**

  - Programmable Logic Controller (PLC)
  - Computer Numerical Control (CNC)
  - Advanced Robotics
• New Material
  o Nanomaterials
  o Photo-sensible materials
  o Lightweight materials
  o Superconductors

• Human - Machine Interfaces
  o Touch screen (screens, tablet…)
  o Wearables
  o Virtual Reality
  o Identifications (retina, digital fingerprint … )

• Logistic and Transportation
  o Gps/Gprs localization system
  o Radio localization (RFID)
  o Load sensors on vehicles
  o Real-time geocoded map
  o Vehicle operative time control

• Communication Technologies for Products or Machines
  o Zig bee
  o Wireless mesh network
  o Communication over cellular network
  o Powerline communication

We can notice that the technologies of the FoF belongs to four main categories:

1. **Data, computing power and connectivity**: all the technologies that support the analysis of the data, particularly:
   a. Big Data/Open Data: collection and analysis of the data;
   b. IoT/M2M (Machine to Machine): hardware and connectivity;
   c. Cloud: centralization of all the data.

2. **Analytics and Intelligence**: the robots are not dedicated only to simple task but also to more complex one. In fact, technology is moving to:
   a. Digitalization and automatization of the intelligence;
   b. Advanced analysis: sophisticated algorithm and statistical analysis.

3. **Human-Computer Interaction**: machines are called to facilitate the human work.
   a. Touch Interface and evolved GUI;
   b. Virtual and Augmented Reality;

4. **Physical-Digital Conversion**: cost reduction, new material, progress and material obtainable thanks to:
   a. Additive Manufacturing;
   b. Advanced Robotics;
   c. Innovation in storage and collection of data.

All this cluster of technologies allows the shift to the FoF by the passage from a physical to a virtual world where data are the enabler.
1.5 Main Challenges

Obviously the main challenge of the FoF is connected with the new technology and with the renovation of the processes and business model. The German-Italian economic cooperation report some challenges connected with the FoF:

1. **Competence Development:** data scientist, developers and data manager. All the actors in all the level of the value chain should get a new know-how.
2. **Working Flexibility:** shifting to a more flexible working environment.
3. **Skills development:** new instruments, tasks and methodologies. Works less repetitive and more customer oriented.
4. **Cyber Security:** protection and assurance of the data.
5. **Legal Environment & Standard:** the creation of rules and standard for the disruption. Develop common infrastructure.

Deloitte (2015) suggest that “the biggest challenge of the digital transformation is going to be guaranteeing that different systems communicate with each other”. In fact one major challenge posed by industry 4.0 will be managing the large quantities of data that are generated, for example, by analysing production data and coordinating the findings with customer information systems.

The first challenge reported are:

- Have an appropriate IT infrastructure
- Adequate Talent: skills required to identify, introduce and implement the FoF

EFFRA suggest that the main challenge to achieving the Factory of the Future are:

- Manufacturing the product of the future:
  - Sustainable mobility
  - Improved recycling (re-manufacturing)
  - Better home care for the elderly
  - Sustainable energy

- Economic sustainability of manufacturing
  - Addressing economic performance across the supply chain
  - Realising reconfigurable, adaptive and evolving factories capable of small-scale production
  - High-performance production, combining flexibility, productivity, precision and zero-defect while remaining energy- and resource-efficient
  - Resource efficiency in manufacturing — including addressing the end-of-life of products

- Social sustainability of manufacturing
  - Increase human achievements in future European manufacturing systems
  - Creating sustainable, safe and attractive workplaces for Europe 2020
  - Creating sustainable care and responsibility for employees and citizens in global supply chains

- Environmental sustainability of manufacturing
  - Reducing the consumption of energy, while increasing the usage of renewable energy
  - Reducing the consumption of water and other process resources
  - Near-to-zero emissions, including noise and vibrations, in manufacturing processes
  - Optimising the exploitation of materials in manufacturing processes
  - Co-evolution of products–processes–production systems or ‘industrial symbiosis’ with minimum need of new resources

The International Electrotechnical Commission (2015) talks about technology as a challenge:
• Connectivity and Interoperability
• Seamless factory of the future system integration
• Architecture for integrating existing system
• Modelling and simulation
• Security and Safety

Finally, the World Economic Forum (2015) report the greatest barrier that inhibits the companies from adopting industrial internet and so the FoF:

• Lack of interoperability or standard
• Security concern
• Uncertain ROI
• Legacy equipment (e.g., no connectivity or embedded sensors)
• Technology immaturity
• Privacy concern
• Lack of skilled workers (e.g., data scientist)
• Societal concerns (e.g., economic dislocation)
1.6 Bibliography


2 NATIONAL INITIATIVES FOR THE IMPLEMENTATION OF THE FOF

2.1 Italy: National plan Industria 4.0

Italy has developed the "National plan Industria 4.0 2017-2020". The Plan provides for a wide array of consistent and complementary measures promoting investment in innovation and competitiveness. All measures that have proved their effectiveness in the past have been strengthened under a "4.0" logic, and new measures have been introduced to meet new needs on the basis of three main guidelines:

- operate according to a technological neutrality logic
- apply horizontal and not vertical or sectorial actions
- act on enabling factors

The “Industria 4.0” National Plan will affect every step of the life cycle of companies that want to improve their competitiveness by supporting investments, the digitalisation of industrial processes, improvement in workers’ productivity, as well as the development of new skills, new products and new processes.

There are four main strategic guidelines summarized in Figure 4.

![Figure 4: an overview of the Industria 4.0 National plan measures](image)

In details, for what concerns innovation, main measures consist in:
HYPER AND SUPERDEPRECIATION: Supporting and offering incentives to companies that invest in new capital goods, tangible assets and intangible assets (software and IT systems) for the technological and digital transformation of their production processes.

- Hyper-depreciation: for depreciation purposes, investments in new tangible assets, devices and technologies enabling companies’ transformation to “Industria 4.0” standards will be valued at 250% of the investment value. Applies for outright purchases and lease purchase agreements.

- Super-depreciation: for depreciation purposes, investments will be valued at 140% of the investment value. Applies for outright purchases and lease purchase agreements. Those benefiting from hyper-depreciation may in the future also apply the benefits to investments in intangible assets such as software and IT systems.

CREDIT to INNOVATION: Supporting businesses requesting bank loans to invest in new capital goods, machinery, plant, factory equipment for use in production and digital technologies (hardware and software). Benefits include Contribution partially covering interest paid by business on bank loans of between 20,000 and 2,000,000 euros, granted by banks approved by the Ministry of Economic Development. This measure is targeted on all micro, small and medium enterprises in Italy in all sectors.

TAX CREDIT FOR RESEARCH AND DEVELOPMENT: Encouraging private investment in Research and Development for product and process innovation to ensure the competitiveness of enterprises in the future. The benefit consist in 50% tax credit on increases in Research and Development costs up to an annual ceiling of €20 million a year per beneficiary, calculated on the basis of the average expenditure on Research and Development in the years 2012-2014. It applies to all expenditure on basic research, industrial research and experimental development: hiring of highly qualified and technically specialised employees, research agreements with universities, research institutes, enterprises, innovative startups and SMEs, depreciation on laboratory equipment and instrumentation, technical know-how and industrial property rights

INNOVATIVE STARTUPS AND SMES: Supporting innovative enterprises at all stages of their life cycle; Sustaining the development of Italy’s startup ecosystem; Spreading a new business culture based on teamwork, innovation and openness towards international markets. Examples of initiatives include: 30% tax deduction for investments up to 1 M€ in innovative startups and SMEs, program, financing the establishment and the growth of new companies focused on I4.0 technologies, Establishment of dedicated investment funds for the industrialization of high-tech ideas and patents

The whole plan includes fiscal incentives for 13 billion euro, distributed in seven years between 2018 and 2024 to cover private investments undertaken during 2017. The private commitment related to the increase of private spending will account for 24 billion euro distributed as follow: 10 billion euro for innovation, 11,3 billion euro for research and development during the period 2017-2020 and 2,6 billion euro for private financing.

The plan is focused on the implementation of nine enabling technologies as depicted in Figure 5.

The expected benefit from this approach can be summarized in terms of:

- Higher flexibility given by small batches production with the economies of scale of mass production
- Higher speed from prototyping to mass production using innovative technologies
- Increased productivity thanks to lower set-up time and reduced downtimes
• Improved quality and scrap reduction thanks to real time production monitoring through advanced sensors
• Higher competitiveness of products thanks to additional functionalities enabled by Internet Of Things

Figure 5: Industria 4.0: nine technology drivers
2.2 Germany: Industry 4.0

With its's new Hightech-Strategy Germany wants to move forward to become a leader in innovative products and services. Part of the Hightech-Strategy is to boost the pace of innovation in industry. Therefore, the Federal Government’s funding supports all Companies – SMEs, Start-ups, larger companies – with two funding programs: a technology-specific program and a non-technology-specific program. Due to the dependence of microelectronic technologies for many sectors such as mechanical, plant engineering, automotive industry and electrical engineering, it’s necessary to strengthen microelectronics sector. Therefore, Germany is participating in the Electronic Components and Systems for European Leadership (ECSEL) research program. Another focus of the Hightech-Strategy is strengthening innovative SMEs. There are different programs to foster innovativeness of SMEs:

- The Central Innovation Program for SMEs (ZIM) promotes non-technology- specific research and innovation projects, usually projects carried out in cooperation with research institutions.

- The “Industrial Cooperative Research program for SMEs (IGF)” project, which has a pre-competitive orientation, and in which numerous companies, most of them SMEs, are participating, is aimed at closing the gap between basic research and industrial development.

- The “KMU-innovativ” program for funding cutting-edge research by SMEs is aimed at SMEs that are especially strong in research. It helps such companies enter ambitious and sophisticated specialized programs.

- The “SME-Digital” (“Mittelstand-Digital”) initiative is promoting greater use of ICT and eBusiness among SMEs, especially among crafts companies.

- The “go-Inno” initiative is supporting SMEs in improving their innovation management and enhancing their resource and material efficiency.

Besides projects, which belong to the Hightech-Strategy, there is Industry 4.0 project. This project aims to enable german industry to be prepared for the FoF. Industry 4.0 project focuses on four topics:

- SMEs: Development of profitability analysis to ensure use of sustainable technologies, foster best practices to enable adoption, strategic guidelines and recommendations to facilitate implementation of FoF.

- IT-Infrastructural and standards: Due to importance of software in industry 4.0, project “SPEDIT” offers approaches for standardization and IT-Infrastructure.

- IT-security: Many SMEs are afraid of losing their intellectual property. According to this, project “INUO” shows how to minimize cyber-attacks.
• Required competences and qualification: Industry 4.0 includes changes in job profiles. Due to this fact, it is necessary to adapt new needs of businesses for educational training.

Especially for SMEs in the manufacturing sector are several national projects located to enhance activities for FoF. There are two categories: Projects regarding to manufacturing development and preparation for FoF and projects, which connect IT with manufacturing sector and enable M2M communication.

Due to the importance of manufacturing sector in Germany the projects mainly focus on several technologies regarding this sector.

2.2.1 Microsystems technology

Microsystems technology is a key enabling technology in lots of sectors such as information and communication, automotive industry, medical engineering, biotech and photonics. Due to its importance, the Federal Ministry of Economics supports especially microsystems technology. Mainly the topics human, environment, mobility and industry are relevant for support.

2.2.2 Automotive Systems

Automotive sector is one of the biggest sectors in Germany. It is also one of the most innovative sectors. Because of the automotive systems are another key enabling technology.

To foster this sector and its competitiveness there are several research actions to enhance topics like autonomous driving, electric mobility, and smart cars.

2.2.3 Electronic engineering

Electronic systems offer different and important aspects for industry 4.0 related topics. The major requirement areas are:

- Digitalization
- Manufacturing/industry 4.0
- Smart mobility
- Cyber security

To foster this key enabling technology the Federal Ministry of Education and Research does different projects to support the sectors automotive, logistics, energy and manufacturing. Technologies related to electronical engineering in FoF are embedded systems or human-machine-interface. In Germany a lot of technologies related to this technologies are at a basic level (TRL 1-3) so that they are not ready to be used by SMEs. Technologies with TRL 7-9 are intelligent embedded systems and identification technology but not mini-embedded-systems.¹

2.2.4 Information and communication

Information and communication is one of the biggest sectors in Germany. More than 92,000 companies belong to this sector. They are an essential for innovation and growth of German economies. They provide technologies, which are the key for factory of the future.

Within communication technology the technology readiness level (TRL) is pretty high. Many SMEs already use technologies like real-time-bus-technology, it- security-systems and mobile communication. Other technologies like real-time- wireless-communication or smart communication systems are not ready to be used by SMEs. Also software-systems have a high TRL. Technologies like big data analytics, cloud computing, cloud services and mobile
communication could be used by SMEs. Others have a lower TRL like simulation, machine learning.\(^2\)

In Germany, there is a lack of TRL 7-9 technologies especially in sensor and actuator technology. In addition, human-machine-interface technologies are not ready to be used by SMEs at this time. Another issue is standardization of technologies which refers to all kinds of technology areas. \(^3\)

The following figure shows a map of FoF topics with the number of research projects.

![Map of FoF topics](image)

Figure 6: Map of FoF topics and projects in Germany


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2.3 France: Industrie du Futur

The Industry of the Future programme was launched on 18 April 2015. Its goal is to modernise France’s production tools and provide support for manufacturers as the digital changeover transforms their business models, organisations and the way they design and market their products.

The New Industrial France programme is based on 9 industrial solutions that provide realworld responses to key economic and social challenges. These solutions will position French businesses on tomorrow's markets in a world in which digital technology is erasing the boundary between industry and services. Large-scale means have been put in place to support ambitious industrial projects and step up the deployment of the goods and services of tomorrow.

These 9 industrial solutions are: Data economy, Smart objects, Digital trust, Smart food production, New resources, Sustainable cities, Eco-mobility, Medicine of the future, Transport of tomorrow.

The Industry of the Future Alliance is responsible for the operational implementation of France’s Industry of the Future project, which was launched in April 2015. The Alliance, which was founded on 20 July 2015, organises and coordinates, at national level, initiatives, projects and efforts aimed at modernising and transforming France’s industry, particularly via digital technology. To do this, it relies on dedicated working groups. The Alliance, which is now fully operational, is tasked with fostering real-world, operational partnerships (employers’ associations, clusters, sectors, chambers of commerce and industry, etc.). Its founding members, from the worlds of industry and digital technology, represent more than 33,000 businesses and 1.1 million employees (FIM, Syntec Numérique, AFDEL, Symop, Gimélec and UIMM). To support industrial SMEs on the ground, the Alliance’s actions are passed on throughout France’s regions by teams consisting of Alliance members, local authorities, the Directorates for Enterprises, Competition Policy, Consumer Affairs, Labour and Employment (DIRECCTE) and clusters.

The Industry of the Future Alliance consists of 22 members:

- Federation of Federation of Electrical, Electronics and Telecommunication Industries (FIEEC)
- Federation of Mechanical Engineering Industries (FIM)
- French Electrical Equipment, Automation and Related Services Industries Group (GIMELEC)
- Automotive Industry and Mobilities (PFA)
- French Manufacturing Technologies Association (SYMOP)
- Syntec Numérique (employers’ federation)
- TECH IN France (formerly the French Association of Software and Internet Solutions Publishers)
- Chemical Industries Union (UIC)
- Union of Metallurgy Industries (UIMM)
- Alternative Energies and Atomic Energy Commission (CEA)
- French Mechanical Engineering Industries Technical Centre (CETIM)
- Arts et Métiers ParisTech
- Centre for Higher Industrial Studies (CESI) • Institut Mines Telecom

Associate members:
2.3.1 KEY TECHNOLOGIES 2020: PAVING THE WAY FOR THE INDUSTRY OF THE FUTURE

Every five years, just as in other major industrialised countries, the Ministry for the Economy, Industry and Digital Affairs carries out a prospective technological study entitled “Key Technologies” in a bid to identify strategic technologies to help French businesses remain competitive in the medium term. This study, which has already been issued four times, has become an important source document for companies, stakeholders in French innovation ecosystems and institutional players, particularly those tasked with public policy.

The fifth edition of “Key Technologies” was drafted between autumn 2014 and early 2016, and involves the work of a large number of experts. It was led by the General Directorate for Enterprise, and was carried out by the Erdyn and Alcimed consulting firms. Atelier Iceberg provided technical expertise in the area of mapping and systemic representation. A Strategic Committee, led by Philippe Varin, and bringing together high-level individuals from both public and private bodies, met four times. The Committee provided strategic orientations for the study, validated the methodology, selected key technologies and oversaw the quality of the results. To facilitate identifying priorities in terms of R&D strategy, the Strategic Committee wanted to limit the number of technologies selected in the report.

Key Technologies 2020 thus contains 47 key technologies in nine areas – food, environment, habitat, security, healthcare and well-being, mobility, energy, digital technology, and leisure and culture.

Contents of Key Technologies

The report provides:
- A strategic vision of world markets in the medium term in nine areas of application
- A description of the 47 technologies to master in order to win these markets (one description per technology)
- An operational overview of the technologies that need to be industrialised to win market share, via the descriptions of the 47 technologies.

At each level, Key Technologies 2000 represents an operational guide for the New Industrial France solutions and provides recommendations – particularly directed at SMEs – for deploying the report’s technologies. The report is a technological forecasting tool to win market share, which identifies:
- Markets and usages in 2020 such as could be identified in 2016 using prospective analyses;
- Industrial challenges that businesses will face;
- Key success factors;
• The strengths and weaknesses of France’s industrial fabric and academic resources to help companies take advantage of the opportunities listed.

The study highlights the key stakeholders in our innovation ecosystems and offers recommendations – particularly directed at SMEs – for deploying the report’s technologies.

Of the 47 key technologies listed, more than half are cross-cutting, and seven of them have to do with at least seven of the nine areas of application, such as Big Data Intelligence, connected objects and advanced and active materials. Looking 5 to 10 years into the future, these technologies could be extremely important for French competitiveness. Each description of a key technology lists the main stakeholders, regardless of their status: businesses, academic stakeholders, technology research institutes, energy transition institutes, University Hospital centres, clusters, Carnot institutes, technical industrial centres and technology transfer and acceleration firms. Their contact details are given in a directory, under regional headings. A mapping of the key technologies was drawn up to highlight links and interdependencies between them. The most cross-cutting technologies are at the centre of the map.

The 47 Technologies:
1. Advanced and active materials
2. Sensors
3. Big Data Intelligence
4. Digital modelling, simulation and engineering
5. Internet of Things
6. Fifth-generation infrastructures
7. Safe and secure onboard and distributed systems
8. Processes related to green chemistry
9. Additive manufacturing
10. Cobotics and human enhancement
11. Artificial intelligence
12. Autonomous robotics
13. Secure communications
14. Immersive technologies
15. Processes related to oil chemistry
16. Recycling of critical metals and rare earths
17. Microfluidics
18. Meta-omics
19. Behavioural analysis
20. New hardware-application integrations
21. 2Supercomputers
22. Smart grids
23. Next-generation electrochemical batteries
24. Synthetic fuels
25. Hydrogen technologies
26. Genetic engineering
27. Innovative solutions for protecting and stimulating plants
28. Probiotic strains for bio-preservation and nutrition
29. Cellular and tissue engineering
30. New immunotherapy processes
31. Implanted devices
32. Healthcare imaging technologies
33. Exploitation of electronic health records
34. Strong authentication
35. Smart water management
36. Rapid diagnostic technologies (water, air and soil)
37. Polluted soil treatment
38. Systems for renovating existing housing stock
39. High environmental quality construction systems for new buildings
40. Integrated energy systems at building level
41. Low-temperature heat recovery technologies
42. Photovoltaic solar energy
43. Wind energy
44. Nuclear energy technologies
45. Propulsion technologies
46. Nanoelectronics
47. Technologies for designing content and experiences
2.4 Austria: Production of the Future

The Austrian funding agency has the Programm Factory of the future, where also I4.0 is addressed:

2.4.1 Materials and Manufacturing: an Overview

The manufacturing industry is a key factor in the Austrian economy: it employs around 640,000 people in some 29,000 companies, generating an annual gross value added of 50 billion euro per year. Approximately every fifth euro and over two thirds of all employees in Austria are either directly or indirectly dependant on the domestic manufacturing industry. The production of internationally competitive goods is a key factor in national prosperity. The goal is therefore to retain the manufacturing industry in Austria and make it fit for the future. Austria has excellent manufacturing companies including several world market and global technology leaders. Yet there is of course huge international competition and Austrian industry can only remain competitive with increased productivity provided by innovative technologies. There are major challenges ahead that require innovative solutions – from novel materials with special properties, reductions in manufacturing costs, shorter development cycles and greater product diversity, environmentally and resource friendly manufacturing processes through to issues related to logistics and recycling.

There is also a platform for industry 4.0 which is connected to the ministry and was an initiative based on different workgroups to identify and select relevant activities in the field of I4.0 with the following content:

2.4.2 Vision: Smart Factory

The increasing use of new information, communication and manufacturing technologies triggers extensive change in the producing industry. Industry 4.0 is more than just the application of technology - it is a conceptual model of completely new developments based on available and future technologies. Companies need to integrate this model in their strategies to remain competitive.

The smart factory within a value network is a central element in the vision of Industry 4.0. What is smart production?

- Product development and manufacturing processes are physical and digital integrated. Also the integration in global value networks (horizontal integration) is accelerated.
- Products and production processes can be improved by virtualizing different factors (for example: customer requirements, time, cost, resources, energy).
- Flexible and innovative production processes enable customized products (batch size 1) at mass production costs.
- Products and production systems are self optimizing and intelligent.
- There are increased and changing opportunities in the human-machine interaction.

Mission of the Platform

The Association Industry 4.0 Austria - The Platform for Smart Production - was established to foster collaboration among all stakeholders and facilitate new technological developments and innovations in the context of digitization (’Industry 4.0’) and thereby to find sustainable solutions to challenges faced by companies, research institutions and society as a whole. The Platform facilitates the implementation of digital transformation in Austria and unifies the Industry 4.0 community. It aims to secure and create highly innovative industrial production and to boost quality employment, thus strengthening Austria’s future competitiveness.
The Platform considers Industry 4.0 a societal challenge that:

- can only be addressed by collaboration of industry, science, regional and national policy makers, associations, trade unions and NGOs
- is driven by technological innovation, new business models, knowledge transfer and its widespread socially acceptable deployment and implementation

The founding members of the Platform are:

- Bundesministerium für Verkehr, Innovation und Technologie (bmvit)
- Bundesarbeitskammer (BAK)
- Fachverband der Elektro- und Elektronikindustrie (FEEI)
- Fachverband der Maschinen-, Metallwaren und Gießereiindustrie (FMMI)
- Industriellenvereinigung (IV)
- Produktionsgewerkschaft (PRO-GE)

**Objectives and Tasks of the Platform:**

- to leverage interests between industry, science, policy makers, employers and employees associations
- to accompany the processes of change driven by digitalisation
- to provide knowledge and services on Industry 4.0 to companies, academia, RTOs and to the general public
- to define fields of action and to advise policy makers
- to develop joint strategies with high leverage on Industry 4.0
- to launch initiatives to steer regional, national and international activities
- to enable the exchange of experience, best practices, data and studies
2.5 Slovenia: (S)Industry 4.0 and S4 Strategy

Slovenian Smart Specialization Strategy (S4) represents a platform for focusing development funds on areas where Slovenia possesses a critical mass of knowledge, capacities and competences and where innovation potential for global market positioning is present. It is a strategy for:

a) Strengthening competitiveness
b) Diversification of existing industries and service activities
c) Creation of new and fast growing companies and industries

Main goals of Slovenian S4 are:

1. To raise value added of employees
2. To improve competitiveness on global markets by increasing knowledge and technology shares in Slovenian export and by increasing percentage of services with high value added in exports
3. To raise entrepreneurial activities

Strategic focus of S4 is in Sustainable technologies and services for healthy living thus positioning Slovenia as a green, creative and smart region with superb conditions for creating and innovating. This will enable Slovenia to become “co-creator” of global trends.

Slovenian S4 goals will be achieved by focusing on defined nine priority areas:

I. Digital
   • Smart cities and communities
   • Smart buildings and homes including wood

II. Circular
   • Networks towards Circular economy
   • Sustainable food production
   • Sustainable tourism

III. (S)Industry 4.0
   • Factories of the future
   • Health - medicine
   • Mobility
   • Materials as products

S4 objectives will be achieved by coordinated mechanisms and connected players - e.g. a joint strategic approach. This is initiated through so-called SRIPs – Strategic development innovative partnerships. The purpose of SRIPs is to refocus the role and objectives of individual players, bringing the economy and economic sectors to the forefront of focus.

2.5.1 INDUSTRY 4.0

Objectives of Industry 4.0 in Slovenia are to connect dominant actors or groups of strong actors with an already established cooperation with the scientific sphere, with areas where the opportunities are not fully exploited. Cooperation will be reflected in:

a. Stronger strategic links between strong private sector actors - to offer integrated solutions and consequently to have a joint appearance on the market;
b. Stronger links with research organisations in developing products with respect to the upcoming needs in the mid- and long-term periods;
c. Stronger links with small and medium-sized enterprises in terms of strengthening supplier networks as well as creating development networks;
d. Promotion of creation of new product channels by promoting establishment of new companies.
e. Modernisation and digitalisation of manufacturing process and managing the total production cycle.

Slovenia is considered a “strong innovator”\(^2\). Innovation performance has been steadily increasing with minor declines in 2013 and 2015. Slovenia’s relative performance to the EU\(^3\) has improved from 90% in 2008 to 93% in 2015 (see figure 7). Slovenia performs close to the EU average with performance in three categories being above average and being below the average in five categories. Particular relative strengths are in International scientific co-publications, New doctorate graduates, and Public-private co-publications. Strong relative weaknesses are observed for Venture capital investments, License and patent revenues from abroad, and Non-EU doctorate students. Performance in most categories and indicators has improved over the last years (see picture 2). The fastest growing dimension is Human resources\(^4\) (6.7%), followed by Open, excellent and attractive research systems (5.0%). The fastest growing indicators are License and patent revenues from abroad (20%) and New doctorate graduates (16%). A strong decline in performance is observed in Non-R&D innovation expenditures (-12%).

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\(^2\) European Innovation Scoreboard 2016

\(^3\) EU innovation performance was driven most by Innovating SMEs collaborating with others.

\(^4\) The Human resources dimension includes three indicators and measures the availability of a high-skilled and educated workforce. Human resources captures New doctorate graduates, Population aged 30-34 with completed tertiary education, and Population aged 20-24 having completed at least upper secondary education.
One of objectives of Slovenia related to Industry 4.0 is also improvement of the ranking (currently Slovenia is taking 28 place in The Digital Evolution Index (DEI) – of The Fletcher School\(^5\) by at least five spots.

Surveys show that 85% of Slovenian companies have the digitalization on their priority list as well as the fact that Slovene companies expect the biggest benefits and long term earnings of implementing digitalization activities in the fields of analytics and big data, while less is expected from the fields of IOT, artificial intelligence and robotics\(^6\).

### 2.5.2 FACTORIES OF THE FUTURE IN S4

In relation to Industry 4.0 Slovenian Smart Specialization Strategy puts a great emphasis on the critical need and high level of awareness on importance of change in corporate growth through digitalization and smart factories processes.

Smart specialization strategy of Slovenia defines Factories of the future as one of the main vertical specialization pillars. In the Factories of the future vertical pillar the following objectives are defined:

a) Comprehensive technological restructuring of Tool Making Industry by increase in the value added per employee for 25% - the value added per employee should be at least 45,000 EUR per employee.

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\(^5\) http://fletcher.tufts.edu/eBiz/Index  
b) Increase in the use of robotization and automation of the manufacturing sector. Increase in the number of robots used by 50% i.e. an increase from 48 to 72 robots used in manufacturing processes per 10,000 employees. Within demonstration pilot plants and pilot projects\(^7\), the value added on employee will increase by at least 20%.

c) Connect the knowledge and creativity of stakeholders in the field of photonics, to generate new possibilities on global markets, with the objective of increasing the value added per employee to 75,000 EUR by 2023.

d) Increase in export of automated industrial systems and equipment by the least 25% by 2023 particularly in tool industry, robotics and smart industrial mechatronic systems.

Main focuses of Factories of the future vertical pillar of S4 are: (i) Production optimisation: (distributed) production management and control, quality assurance, regulation and data processing, intralogistics, automation; (ii) Optimisation and automation of production processes: smart machines and equipment, mechatronic systems, actuators and smart sensors.

Technologies to be further developed within Factories of the future vertical S4 pillar are cross-cutting and they will be applied also in the framework of other vertical pillars as shown in the table below.

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Figure 9: A scheme of cross cutting technologies to be developed within various S4 vertical pillar.


As seen from the scheme above, S4 also defines other vertical pillars tightly connected to FOF field. Most importantly these are:

- Health and medicine\(^8\) – where the field of biopharmaceuticals in symbiosis with large, medium-sized and small companies and start-up companies also relates to FOF field.

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\(^7\) http://www.teces.si/natisni.asp?vsebina=info/obvestilo.asp&id=227&jezik=1060

Focus areas and technologies in the field of health and medicine are: Biopharmaceutical, Translational, Cancer treatment, Resistance bacteria, Natural medicines and natural cosmetic.

- **Mobility**\(^9\) – the focus is on migration from development of single components and materials to development of complex and more complex energy efficiency products, with high value added. At the forefront, the following technologies are listed: Niche components and systems for motors with injection combustion engines, Systems for e-mobility and storage energy, Systems and components for security and comfort (interior and exterior equipment), Materials for automotive industry.

- **Materials as end products**\(^{10}\) – where the focus is on strengthening cooperation between producers of finished materials and achieving higher value added as well as inclusion in international value chains. Main focus on technologies here is on Sustainable technologies in procession alloys and metals, Multi-components smart materials and coating.

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3 NATIONAL/REGIONAL IMPLEMENTATION ACTIONS FOR THE FOF

3.1 Italy

3.1.1 The Italian Technology Cluster “Intelligent Factories” (CFI)

In order to exploit the opportunities offered to the market by the fast evolutions of enabling technologies, the Italian Ministry of Education, Universities and Research has issued a Notice for the development and enhancement of National Technology Clusters, identified as boosters of the sustainable economic growth of the territories of the entire national economic system, in terms of new products, services and productive sectors.

The Italian Technology Cluster “Intelligent Factories” (CFI) is the first of the eight Clusters admitted to the facilitations, according to the evaluations of the Strategic Development Plan and the first four applied research projects proposed. The Italian Technology Cluster “Intelligent Factories” sets the target of developing and implementing a strategy based on research and innovation, able to consolidate and increment the national competitive advantages and, in the meantime, to orient the transformation of the Italian Manufacturing sector towards new product systems, processes/technologies and manufacturing systems, coherently with the strategic agendas of the European Union for research and innovation.

Besides the realization of pre-competitive research projects, intended for the development of enabling technologies for various industrial sectors, the action of the Italian Technology Cluster “Intelligent Factories” consists of other activities, such as: technological transfer, sharing of research infrastructures and mobility, support to a smart and sustainable entrepreneurship, technological foresight on a regional, national and international scale in the smart factory sector, support to the growth of the human capital.

Cluster’s expected results and impacts on industrial and research communities, and consequently on society, are strictly related to the development of the necessary enabling technologies to face the innovation challenges in the Italian manufacturing industry. The most relevant industrial and social repercussions foreseen include the dimensions of competitiveness, employment and environment, in line with the targets of the European strategy.

Since September 2012, the Italian Technology Cluster “Intelligent factories” has been set up as Non-profit Association that, currently, groups big and medium-small size enterprises (industrial members), universities and research centres (research members), entrepreneurial associations, technological districts, non-governmental organizations and other stakeholders operating in the sector of Manufacturing and of the Smart Factory (associated). A total of round 300 members adhere to the association.

MISSION

The mission of the Italian Technology Cluster “Intelligent Factories” consists in proposing, developing and implementing a strategy based on research and innovation, able to:

- orient the transformation of the Italian manufacturing sector towards new products-services, processes and technologies able to exploit and to develop successfully the unique heritage of resources offered by our Country
- create a stable and more competitive national manufacturing community in the design, execution and enhancement of research results
- connect national and regional research policies with international ones, with the aim of improving enterprises’ and Regions’ possibilities of using European research funds.
To gain a stable position inside the global competitive ranking in the productive ambit, Italy must innovate its own manufacturing sector to exploit the above-mentioned resources and to offer customers unrivalled added value in certain markets. This innovation will include, on one hand, the attainment of a higher productivity, especially through the adoption of new more efficient productive technologies, able to implement new high added-value products, and, on the other hand, the development of new strategic industries, boosting the existing successful productive tradition.

The strategic targets of the Italian Technology Cluster “Intelligent Factories” can be summarized as follows:

- enhancing the competitiveness of the Italian manufacturing industry through the design and implementation of a series of research initiatives for the development of new enabling technologies;
- preserving and cultivating in Italy advanced skills for manufacturing;
- improving Italian companies’ performance in attaining international funds;
- increasing the Return On Investment of research projects;
- supporting the entrepreneurship and the growth of companies thanks to the involvement of private investors.

**Roadmapping activities**

The roadmapping activity performed by the Italian Technology Cluster “Intelligent Factories” has led to the creation of a long-term strategic roadmap that will be periodically updated and that will constitute a strong and official positioning document about the future of the manufacturing. The definition process has been managed with the involvement of Cluster Members and presents research priorities on which they have reached a diffused consent. The roadmapping process has also considered all European roadmaps and the documents of Smart Specialization of the Regions taking part in the Cluster.
In order to define the research and innovation strategy in a shared European, national and regional context, CFI has acquired the mapping of enabling technologies proposed by the AFIL association (Associazione Fabbrica Intelligente Lombardia). AFIL (see below) has in fact analysed the main roadmap documents of the manufacturing sector and has categorised the most important related technologies.

On the basis of this map of enabling technologies, the regional programming documents of the Italian regions taking part in the Cluster and other important documentation issued by the regional clusters have been classified, in order to enable understanding how the regional strategies for research and innovation share a single vision of certain technological issues (Figure 10).

Moreover, the Strategic Action Lines along which Italian manufacturing can develop research and innovation activities for the years to come have been defined:

1. Systems for personalised production
2. Strategies, methods and tools for industrial sustainability
3. Factories for humans
4. High-efficiency production systems
5. Innovative production processes
6. Evolutive and adaptive production systems
7. Strategies and management for next-generation production systems

Each Strategic Action Line meets specific challenges and permits the best exploitation of some of the characteristics of the Italian manufacturing sector. For each Action line have been so defined a set of research and innovation priorities mapping the enabling technologies.

3.1.2 CFI regional initiatives in the Alpine Space:

AFIL – LOMBARDY INTELLIGENT FACTORY ASSOCIATION

AFIL is the Cluster dedicated to the Intelligent Factory created by the Lombardy Region. It is a private, non-profit legal entity representing a network of companies, universities, public or private research institutions and entities (including financial ones) operating in the field of the intelligent factory (Advanced Manufacturing). AFIL operates as the private part of a public-private network with Regione Lombardia dedicated to advanced manufacturing and its members are located in different territorial areas and focused on specific application fields. The cluster aims to promote and facilitate research and innovation concerning practices and enabling technologies for the manufacturing sector in order to support and develop the Lombard production system’s leadership and competitiveness.

The mission of the cluster can be summarized as follow:

• To set up a stable community by connecting companies, universities, research institutions and associations, thus favouring cooperation by promoting research and innovation projects and initiatives
• To be a reference actor for the region for the defining of research and innovation strategies in the manufacturing sector.
• To support the development of a research and innovation extra-regional network through the participation to CFI – intelligent factory national cluster and the connection with different European regions within smart specialization strategies.

AFIL realized a map of enabling technologies for the manufacturing sector derived from the analysis of the most important European roadmaps pertaining to the sector (EFFRA, European Factories of the Future Research Association for the Discrete Manufacturing, SPIRE, Sustainable Process Industry through Resource and Energy Efficiency for the continuous Manufacturing, Photonics21 – Photonics, Robotics Adsl – Robotics, etc.) and it
was used as basis for the development of regional research priorities and as a reference in the CFI roadmap.

MESAP – SMART PRODUCTS AND MANUFACTURING
It is the Innovation Cluster, created by Piedmont Region with the support of the Structural Funds 2007-2013, to promote the innovation diffusion in SME and the technological transfer among research centres and enterprises in the reference technological sectors. It is joined by enterprises of all sizes, research centres and Universities of the Piedmont territory.
3.2 Germany
To enable Germany for Factory of the Future the focus on research projects is manufacturing.

3.2.1 Allianz 4.0:
The Allianz Industrie 4.0 is a network initiated and funded by the state of Baden-Württemberg aiming to pool resources and know-how from production, information and communication technology in order to assist companies in their digital transformation process. In view of the current economic situation, we will help to foster a spirit of optimism and commitment for Industrie 4.0 technologies. A close collaboration of the key industries along the whole value-added chain paves the way for higher productivity and resource efficiency and thus creates the conditions for highly efficient and adaptive production systems and integrated service concepts. In order to gain a significant first-mover advantage, a consistent and prompt implementation of Industrie 4.0 concepts is critically important. This will enhance the competitiveness of companies and secure employment.

3.2.2 Cross Cluster:
Because industry 4.0 needs many different competences (such as production skills, process development and IT-know-how) the cross cluster aims to integrate these different competences especially for SMEs. Focuses on different technologies which are necessary to implant Industry 4.0 and FoF.

3.2.3 MicroTEC Südwest (BIFOCAlps Observer)
MicroTEC Südwest is a technology cluster in southwestern Germany that unites many sectors. In the growth-oriented field of microsystem technology, microTEC Südwest with its over 360 cluster partners is one of the largest technology networks in Europe. Microtec covers the field of Smart Production, Smart Mobility, Smart Health and Smart Energy.

- Objective 1:
The cluster should be established as a leading research, development and production location for intelligent products with integrated microsystem technology.

- Objective 2:
Competence and capacities in the cluster should be expanded in accordance with the objectives and be optimally pooled in creative cooperation and innovation processes.

- Objective 3:
The appeal of the region to skilled personnel, creative minds, companies and investors should be further increased.

3.2.4 BAVARIA

BICCnet
BICCnet, the Bavarian Information and Communication Technology Cluster, aims to activate and interlink the innovation and productivity potential of the Bavarian enterprises, research
centres and universities. And to connect the cluster ecosystem to collaboration partners in Europe. BICCnet interconnects the information and communication technology sector in order to encourage and initiate new ideas, new expertise as well as to establish successful company start-ups. In doing so, BICCnet provides support for medium-sized companies in the areas of innovation and productivity. The offices of BICCnet are located near Munich, Germany. BICCnet’s thematic focal points comprise:

- Embedded systems
- Energy (Smart Grids, Virtualisation)
- Mobility („Mobile Society“, multi-modal mobility, Open & Big Data)
- Entrepreneurship
- Convergence: Apps (B2B)
- ICT services (Cloud computing)
- Safety & Security
- Catalytic effect of the cluster on co-operation between companies as well as between companies and research;
- Bringing Bavarian actors in contact with partner cluster ecosystems in Europe.

**Cluster Mechatronik & Automation**

Cluster Mechatronik & Automation is a stage and forum for defining and conducting measures concerning progress of mechatronics and it's related areas. Active communication between science and economy ensures quality and safety of developments and is thereby contributing to the economy’s advancement.

**Cluster Sensorik**

Strategische Partnerschaft Sensorik e. V. (SPS) officially manages the Bavarian cluster for the competence field of sensor technology since 2006.
3.3 France

3.3.1 THE FRENCH COMPETITIVENESS CLUSTERS

What is a “French pôle de compétitivité”? A French “pôle de compétitivité” is a partnership, based around a specific theme and a specific region. A “pôle de compétitivité” (competitiveness cluster or innovative cluster) brings together large and small firms, research bodies and educational establishments, all working together in a specific region to develop synergies and cooperative efforts around a shared theme. The goal of clusters is to build on synergies and collaborative innovation projects in order to give partner firms the chance to become first in their markets, both in France and abroad.

What objectives do “pôles de compétitivité” have? Clusters serving business and job growth. Clusters help to make the French economy more competitive. They develop growth and jobs in key markets by:

- stepping up companies’ innovation efforts and supporting mainly industrial activities with a large technological component;
- improving the attractiveness of France through greater international visibility.
- Boosting the economic benefits of the clusters’ dynamism

The core activity of the clusters is to develop collaborative innovation projects, while integrating the potential economic benefits as early as possible. Clusters meet two priorities:

- reinforcing the economic benefits of R&D projects. The clusters become factories for tomorrow’s products. They transform collaborative R&D efforts into innovative products, processes and services released onto the market;
- supporting the growth of SMEs and mid-tier companies (ETIs) by offering collective and individual services in the following areas: access to financing, international development, the forecasting of companies’ needs in terms of skills and individual assistance with the development of SMEs, including advice and tutoring.

What public support is available for “French pôles de compétitivité”? France is committed to creating a conducive environment for both firms and innovation. It helps companies to derive the economic benefits of innovation. For instance, at national and regional level, France and its regions back the development of clusters:

- Through calls for projects launched by the FUI and under the Invest for the Future Programme resulting in financial assistance for the best nation-wide collaborative publicprivate R&D projects;
- By granting loans to member SMEs or ETIs that wish to embark on the industrialisation and marketing of the results of a collaborative R&D project. This loan for the industrialisation of cluster projects (PIPO) is financed by the Invest for the Future Programme;
- By helping clusters and their member firms find the best international partners and set up technological partnerships with them focused on value creation;
- By supporting the clusters’ governance structures, alongside firms. This support enables the introduction of theme-based collective initiatives launched by the clusters, in a wide variety of fields and involving the cluster’s firms, particularly including SMEs, so as to promote innovation and improve their competitiveness;
- By involving various partners in this policy, including the French National Research Agency (Agence Nationale de la Recherche or ANR), Public investment bank (Bpifrance), the Environment Agency and the energy conservation (ADEME), the Deposits and Consignments Fund (Caisse des Dépôts et Consignations ou CDC) and Business France.

### 3.3.2 Public-sector support for R&D projects

Between 2005 and 2013, 1,313 collaborative R&D projects received public financing of €2.37 billion, including more than €1.45 billion granted by the French State through the dedicated fund (FUI). These projects, amounting to nearly €6 billion in R&D expenditure, involved close to 15,000 researchers.

**What is the French “pôles de compétitivité” profile?**

The clusters cover most sectors of activity, from emerging high-tech fields nanotechnologies, biotechnologies, ecotechnologies, and so on) to more mature sectors (automotive, aerospace, etc.).

- In 2011, each cluster had an average of 187 members (108 SME, 16 ETI, 13 major groups and 31 research and training organizations).
- Their average budget was around €1.3m (with FTE employees).
- Their leadership teams were small (8 FTE employees) and stable (more than 3 years in the job).

### 3.3.3 SME involvement in clusters

- 86% of SME: In 2011, 86% of the clusters' 7,500 member firms were SME, 12% were ETI and 2% were major companies.
- 63% of subsidies: In 2013, SME received 67% of the financial support granted to companies by the State fund dedicated to collaborative R&D projects (Fonds Unique Interministériel, FUI).
### 3.3.4 Key Technologies

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3.4 Austria

3.4.1 Definition of manufacturing priorities - Austria

Austria is one of the most innovative countries in the European Union. To keep resp. extend this position Austria put major emphasis on research, technology and innovation with the aim:

- to continue developing the potentials of science, research, technology and innovation in Austria, to make our country one of the most innovative in the EU by 2020, strengthening the competitiveness of our economy and increasing the prosperity of our society.
- to continue developing the potentials of science, research, technology and innovation in Austria, using them in a holistic manner to deal with the major societal and economic challenges of the future. (Republic of Austria et al., 2011)

As the ERA PORTAL Austria - The Knowledge-Sharing Platform, the central platform for S3 specialization in Austria highlights, Austria applies a longer term perspective in working with the Smart Specialisation concept. The federal government encourages its science and research institutions to realise their role as regional lead institutions: Universities, science and research centers are indispensable players in a process for knowledge and innovation-driven structural change, as they create regional value in both a civic and economic context. On equal terms with regional policy makers and the leading companies, they should be recognized partners in discovering and developing a region’s smart specializations. According to the EFRE homepage, funded measurements – especially for small and medium enterprises in Austria are:

**P1 – Increase of regional competitive advantage via research, technology development and innovation (Stärkung der regionalen Wettbewerbsfähigkeit durch Forschung, technologische Entwicklung und Innovation), especially:**

- M01 – Research and technology infrastructure (Forschungs- und Technologieinfrastruktur)
- M02 – Cross-organizational R&D projects, cluster projects and transfer competencies (Überbetriebliche F&E-Projekte, Verbundprojekte und Transferkompetenzen)
- M03 – Organizational R&D projects and transfer projects (Betriebliche F&E-Projekte und Technologietransferprojekte)
- M04 – Innovation consulting and funding (Innovationsberatung und -förderung)
- M05 – R&D and technology oriented investments (F&E- und technologieorientierte Investitionen)
- M06 – Clusters / networks, location management (Cluster / Netzwerke, Standortmanagement)

**P2 – Increase of the competitive advantage of small and medium enterprises in the regions (Stärkung der regionalen Wettbewerbsfähigkeit von kleineren und mittleren Unternehmen)**

- M07 – Supportive actions for entrepreneurship (Unterstützungsmaßnahmen für Gründungen)
- M08 – Supportive actions for knowledge-based entrepreneurship (Unterstützung wissensintensiver Gründungen)
- M09 – Supportive actions for growth in organizations
• M10 – Consultations for small and medium enterprises (Beratungsleistungen für KMU)

Austria launched the STRAT.AT 2020 partnership on Smart Specialization. The STRAT.AT 2020 partnership supports an engaged discussion that ultimately resulted in the document “Policy Framework for Smart Specialization in Austria” (Austrian Conference on Spatial Planning (ÖROK), 2016), which is accorded with all stakeholders and published.

General aim of the STRAT.AT 2020 strategy is to become a technology frontrunner and innovation leader to releases the potentials, increase dynamics and pro-actively create the future. An effective instrument is research and development (R&D), which Austria intends to increase to 3.76% by 2020. However, each region in Austria has its own extent to Austria’s RTI themes, which are, for example:

• Carinthia focuses on self-organizing systems and robotics
• Lower Austria focuses on priorities in agricultural and food technology
• Vorarlberg, as the former stronghold for textiles, focuses on smart textiles (within the priority of materials)
• Salzburg, Lower Austria, Burgenland, Vienna and Styria focuses on ecological and energy-efficient building and renovation
• Tyrol’s RTI scheme comprises the climate change
• Mobility technologies are in the focus of Styria and Upper Austria
• Creative industries are in the center of Tyrol, Vienna, Salzburg and Styria
• Tourism and innovation is key in Salzburg and Tyrol

3.4.2 Production skills and research priority themes – Austria

Related to the Austrian Conference on Spatial Planning (ÖROK) (2016), the following table highlights detailed information about regional thematic priorities.

<table>
<thead>
<tr>
<th>Land</th>
<th>Thematic priority</th>
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<tbody>
<tr>
<td>Burgenland</td>
<td>• <strong>Sustainable energy</strong> (e.g. renewable energy, smart grids, new construction materials, energy efficiency in buildings and transport)</td>
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<td>• <strong>Sustainable quality of life</strong> with areas from life sciences (health and wellness, pharmacy, medical technology, food and beverages, hospitality services)</td>
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<td>• <strong>Intelligent processes, technologies and products</strong>. RTI fields with a special potential for collaboration are (i) (optical-) electronics, mechatronics, (ii) materials (plastics, wood, metal) and their intelligent application</td>
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<td>Further inclusive fields of action with special significance for Burgenland are:</td>
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<td>• <strong>Production of the future</strong> (Industry 4.0: automation and IT networked production and logistics, digital production and 3D printing, product and process security, steering and control technology)</td>
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<tr>
<td></td>
<td>• <strong>Innovative (IT-supported) services</strong>, and</td>
</tr>
<tr>
<td></td>
<td>• <strong>Creative industries</strong></td>
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</tbody>
</table>

This project is co-financed by the European Regional Development Fund through the Interreg Alpine Space programme.
### Carinthia
- **ICT – Information and communication technologies** (niche: self-controlled, networked systems)
- **Sustainability technologies and materials** (renewable resources, with ICT synergy priorities to be developed: smart energy, control technology, energy efficiency)
- **Production technologies** at the interfaces between IT, control technology, module switching technology (Industry 4.0)

### Lower Austria
- **Technopole: location-related**
  - Town of Krems: **Medical biotechnology**: blood purification systems, tissue engineering, cell therapies, cell biology/physiology
  - Town of Tulln: **Agricultural and environmental technology**: bio-analysis, environmental technology, plant cultivation, use of renewable commodities, pharmacy
  - Town of Wiener Neustadt: **Medical and materials technologies**: materials, tribology (friction, wear, lubrication), medical technology, sensors and actuators, surfaces
  - Town of Wieselburg: **Bio-energy, agricultural and food technology**: bio-energy, bio-mass, energy systems, agricultural and food technologies, water management, ecological building (focus on energy-efficient building and renovation)

### Cluster: theme-related
- **Construction. Energy. Environment**: Renovation of historic buildings to low-energy standard, multi-floor
- **new buildings in passive energy quality, living comfort and healthy interior climate, energy efficiency**
- **Food**: Food quality and food safety, organic and regional products, resource efficiency
- **Plastics**: Bio-plastics, bio-packaging
- **Mechatronics**: Energy efficiency in production

### Upper Austria
- **Industrial production processes**
- **Energy**
- **Health and aging society**
- **Food and nutrition**
- **Mobility and logistics**
- **Strategic key objectives and goals for education-research-economy** were defined for each field of action

### Salzburg
- **Life sciences**
- **ICT location Salzburg**
- **Smart materials**
- **Intelligent building and settlement systems**
- **Creative industries and service innovations**

### Styria
The key themes and markets are (i) **mobility**, (ii) **green-tech**, (iii) **health-tech**. These are supported by the technological core competencies: materials technologies, production technologies, machinery and plant engineering, digital technologies and microelectronics. The creative industries are positioned as “innovation support”. Detailed strategies were defined for the key themes in an “entrepreneurial discovery process”
within the collaboration process of the actors in the clusters along the knowledge triangle.

<table>
<thead>
<tr>
<th>Region</th>
<th>Thematic Priorities</th>
</tr>
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<tbody>
<tr>
<td>Tyrol</td>
<td>Life sciences, Mechatronics, Renewable energy sources, Information technology, Timber, Wellness, Tourism</td>
</tr>
<tr>
<td>Vorarlberg</td>
<td>Smart textiles, Energy and energy efficiency, People and technology, Education and health, Intelligent production</td>
</tr>
<tr>
<td>Vienna</td>
<td>Life sciences, ICT, Creative industries, Humanities, cultural and social sciences, Certain areas of mathematics/physics</td>
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Complementary: Innovative solutions to promote the **sustainable and socially-inclusive development of the city (smart solutions)** as well as innovative production and manufacturing processes (smart production)

Figure 1: Regional thematic priorities

3.4.3 Expected impact / key enabling technologies

As the Austrian Society for Industry 4.0 highlights, expected impacts of the research into Industry 4.0, Factory of the Future and Digitalization are:

- Improvement of the organization and management of production processes
- Stronger integration of upstream- and downstream processes and activities
- Increase interdisciplinarity and acceleration of research and development
- Individualized services
- Changed responsibilities and tasks for employees
- Improved determination of education, training and knowledge
- Acceptance of new chances and challenges for work safety- and security, health and elderly employees
- Data protection
- New forms of work organization
- Development of new business models and markets
3.5 Slovenia

Currently, as explained above, the main focus of Slovenian S4 related activities is on establishing SRIPs, which are due to provide roadmaps by 9/4/2017. Thus this chapter can be further upgraded and amended once these documents are provided. The SRIPs are essentially clusters that function on the national level. On regional/semi-local level there are some clusters, however they are all included in the above mentioned SRIPs, and thus their strategic plans will be seen in the respective SRIP action plan.
4 DEFINITION OF MANUFACTURING PRIORITIES AND COMPETENCIES IN THE ALPIN SPACE REGIONS FROM S3 POLICIES

The manufacturing priorities and competencies of the regions involved in the different countries has been identified analysing the Smart Specialization Strategies defined at regional level and selecting the specialization areas related to manufacturing. For each specialization area have been described the related production and research systems highlighting the main actors involved. Moreover, the priority themes of technological development and the most significant enabling technologies of the area are then presented. In Figure 11 an example of the schema for the German regions is depicted.

4.1 Italy

4.1.1 Lombardy

Lombardy Region has identified seven specialization areas (SA) among which four are related to manufacturing:

**AEROSPACE**

The production system
The SA, well represented by the Lombardy aerospace cluster, is a regional production set-up, which - thanks to the rich and varied presence of small, medium and large enterprises - accounts alone for about one third of Italian exports by manufacturing sectors allied to aerospace. The production system consists of over 185 companies with more than 15,000 employees and an overall turnover of about 4 billion euro, 1.7 billion euro of which from exports.

The Region offers all the technologies and skills of the entire supply chain required to build fixed and mobile-wing platforms and space frames (from the mechanical components and subsystems, to satellite, helicopter and trainer aircraft integrators). Prime contractors in Lombardy are: Agusta Westland (helicopters); Alenia Aermacchi (trainer aircrafts); CGS

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11 Data from the Lombardy Aerospace Cluster (http://www.aerospacelombardia.it)
This project is co-financed by the European Regional Development Fund through the Interreg Alpine Space programme

Compagnia Generale per lo Spazio (satellites and scientific payloads); Selex Galileo (Avionics and radar); Thales Alenia Space (space).

The research system
The business and service system is supported by the research system, which has long been collaborating in synergy with production relying on scientific expertise in various technological fields: sensors, acoustics, ICT, materials, mechanical engineering, design and integration of complex systems, testing, R&D, remote sensing and earth observation, environmental monitoring, payloads and complex optical systems for satellite applications. In the sphere of Lombard universities, each specialized in its respective field, those relevant to the aerospace industry are: the Politecnico of Milan, the Bicocca University of Milan; the University of Pavia; the Carlo Cattaneo LIUC University. The many research centres situated in the Region include: INAF - the Astronomical Observatory of Brera; CNR-IREA, AWPARC (a cooperation agreement between the Politecnico of Milan and Agusta Westland). In the aerospace industry, private research amounts to an average 12% of turnover. In terms of patenting activity, since 2005 more than 255 requests of patent registration have been filed by 13 companies from the Lombardy aerospace cluster, to protect technologies that can be applied in other sectors such as automotive, electronics, simulation and smart maintenance systems and ICT.

The priority themes of technological development in this SA are: space integrated systems and space systems, fixed and mobile wing integrated aeronautical systems, electromechanical systems and avionics, new technologies for production and infrastructures. The most significant enabling technologies for the area are the ones related to advanced materials, advanced manufacturing technologies, micro and nano electronics and photonics.

AGRI-FOOD

The production system
The Lombard agri-food production system is the most important at Italian level and one of the most important in the European context. The value of the Region’s agro-industrial production exceeds 12.3 billion euro, or 15.6% of the national total. This figure represents approximately 3.7% of the Region’s GDP, or as much as 11.5% considering the trade and transport margins. Agricultural production and food processing activities take place in approximately 70,000 production sites, involving about 245,000 workers, more than 175,000 of whom are part of the permanent workforce (4.2% of the Lombard workforce). Considering the macroeconomic data of the Lombard agri-food system components (meaning the sum of: intermediate consumption in agriculture, added value of agriculture, added value of the food industry, of catering, and of trade and distribution), the estimated value amounts to about 38 billion euro, corresponding to 16.4% of the national agri-food system. Most of the final value of the regional agri-food system is provided by distribution and catering, those added value accounts for 41.5% and 18.6% respectively. Lombardy proves to be one of the leading entrepreneurial realities of the Italian modern distribution: the density of modern retail outlets (hypermarkets, supermarkets, mini-markets and discounts) exceeds 290 m2 per 1,000 inhabitants.

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12 Sources: Lombardy Agri-Food High Technology Cluster; Lombard agriculture counts-2012, Regione Lombardia, VI General Agriculture Census-2010, Istat, Agriculture and Livestock, istat.it, Data & Trends of the European Food and Drink Industry 2012, Food drink Europe. Data provided by the Directorate-General for Agriculture and by the Lombardy Agri-Food High Technology Cluster.
The research system
In the innovation and research system, worthy of note is the Parco Tecnologico Padano (PTP), established thanks to financial aid from Regione Lombardia and local authorities, which is a research centre for agri-food biotechnology. The Technology Pole also houses the Experimental Animal Disease Prevention Institute, the “Lazzaro Spallanzani” Institute, the CNR - IBBA and ITB, CRA - Vercelli, the Faculty of Agriculture (6 departments) - University of Milan, Faculty of Agriculture (1 department) - Catholic University of Milan, ISU - Institute for University Services, the Large Animals Hospital - University of Milan, and the Experimental Livestock Teaching Centre. Further scientific expertise in the agri-food field is contributed by the University of Pavia, the Politecnico of Milan, the Bicocca University of Milan and the University of Brescia.

The main research priority themes are sustainable and competitive agri-food supply chain, individual well-being (for instance new solutions for healthy ageing through systems, food, supplements and nutriceuticals), food safety and security to ensure food security, availability, and protection. The most significant enabling technologies are biotechnologies, advanced materials and systems of advanced production, photonics, and micro and nano electronics.

ADVANCED MANUFACTURING

The production system
The manufacturing industry is a fundamental pillar of every developed region. In Europe, the manufacturing industry is the first sector of the non-financial economy in terms of added value and number of employees. Moreover, this sector is complementary to the service industry, as it produces goods required to produce services, thus generating a demand for services (it is estimated that a new job in the manufacturing sector generates two jobs in the service sector). The production system includes approximately 100,000 enterprises counting a number of employees in the region of 1 million units and generating a turnover of 250 billion euro, with an added value of 60 billion euro (Istat, 2010). The percentage of R&D investments in the sector referred to the GDP of the region is 1.38% compared to the national level which is 1.26% (COTEC, Annual Innovation Report, 2012). On the other hand, private R&D investments amounts to 3 billion euro (Eurostat, 2010). Regione Lombardia is the first manufacturing region in Italy in terms of turnover and added value and the third in Europe concerning the number of employees, after Bayern and Baden-Württemberg. Lombardy is the leading manufacturing region in Europe regarding some sub-industries such as: manufacturing of metal products, excluding machinery and equipment; textile industries; production of base metals; manufacture of wearing apparel; printing and reproduction of recorded media; wood and products of wood and cork, except furniture. Lombardy is the first Italian region by number of patents registered at the European Patent Office (EPO) concerning manufacturing technologies (industrial technologies, metallurgy, mechanical engineering, chemicals, textiles).

The research system
The public research system consists of the CNR (ITIA - Institute of Industrial Technologies and Automation), Politecnico of Milan, University of Milan, Bicocca University of Milan, University of Brescia, University of Bergamo, University of Pavia, Insubria University.

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13 Source: Lombardy Agri-Food High Technology Cluster
14 European Commission 2009, European Parliament 2010
15 Data provided by the Lombardy Smart Factory Cluster
There are 2,946 researchers, professors, research fellows and PhD students involved in the study of manufacturing topics\(^\text{16}\). Since 2003, 50 university spin-offs have been created (Netval, 2003-2013). The research and technology transfer system in the manufacturing industry is composed of 160 research and technology transfer centres\(^\text{17}\). Lombard Industry and research are present in numerous platforms/initiatives at European level such as, for instance: Manufacture, EFFRA-European Factory of the Future Research Association, EuRobotics aisbl.

Thanks to the complementarity of the skills in Lombardy, the priority themes of technological development are connected to the development of the key enabling technologies such as, for example: advanced manufacturing processes; mechatronics for advanced manufacturing systems; modelling, simulation, forecasting methods and tools; ICT; sustainable manufacturing technology; advanced materials; strategy definition and management methodologies.

**SUSTAINABLE MOBILITY**

**The production system**
The Lombard mobility industry is a comprehensive field that encompasses rubber, rail and water mobility, and logistics. The automotive manufacturing industry (products and processes) and the boat manufacturing industry are particularly important in this area. The Lombard automotive sector\(^\text{18}\) counts over 43,000 employees. It consists of more than 100 Lombard enterprises of medium-large dimensions that operate in different automotive sectors; these are complemented by a multitude of micro, small and medium enterprises working for them on a subcontracting basis providing components, moulds and equipments. The overall turnover is estimated at around 12 billion euro, representing 30% of the total Italian turnover generated by components. The system includes manufacturers of motorcycles, agricultural vehicles, commercial vehicles and caravans, manufacturers of machinery, plants and equipment (moulds, assembly equipment, industrial automation systems), design, construction and marketing of vehicle components. The automotive supply chain in Brescia alone is Italy’s second largest automotive pole after Turin, in terms of employees and local production units. Lombardy boasts an extremely vigorous supply chain for the building of pleasure boats, which involves leading design firms, shipyards engaged in the building of sailboats and/or motorboats, businesses specialized in fit-outs and furniture, sail makers, businesses providing maintenance, repair and refit services and logistical assistance, mooring and storage. The production system\(^\text{19}\) counts approximately 19,000 employees, 2,889 of whom working in refitting-repair and storage, 9,630 working in shipbuilding, 5,804 working in accessories and components and 708 in engines. Lombardy is the first Italian region as regards the number of pleasure boating companies situated in the territory and second in terms of employees working for them.

**The research system**
The research system is composed of the following universities and research centres: University of Brescia, Politecnico of Milan, Bicocca University of Milan, University of Milan, Bocconi University, Catholic University, University of Bergamo, University of Pavia, CNR. The private research system includes the Brembo Research Center housed in the Kilometro Rosso Science Park, active in mechatronics and sensortronics (a joint-venture with the

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\(^{16}\) MIUR – National Committee for the Evaluation of the University System “Nuclei 2012”, CNR  
\(^{17}\) Eupolis Lombardia (www.questio.it)  
\(^{18}\) www.clusterobservatory.eu  
\(^{19}\) Source: “La nautica in cifre”, yearbook by the UCI NA Research Office in association with the Economics Department of the University of Genoa - 2012

This project is co-financed by the European Regional Development Fund through the Interreg Alpine Space programme
DaimlerChrysler Laboratory, that involves ceramic composites and base materials) and Pirelli Labs, which represents the centre of technological excellence of the Pirelli Group.

The priority themes of technological development include: structural weight reduction; reduction of CO2 signature through alternative transmissions and fuels; development and dissemination of innovative and efficient urban goods logistical systems through sustainable means; related vehicles (control systems); vehicle safety systems; advanced materials. The most strategic enabling technologies for this area are advanced materials, micro and nano electronics, systems for advanced manufacturing and nanotechnologies.

4.1.2 Piemonte

AEROSPACE

The production system

Piedmont's aerospace industry has a strong local presence and a significant role in the development of programs for high technology innovation to both commercial and military scope. It has an international supply network and sales market.

Concerning the area of aerospace innovation, the production system consists of 140 local businesses with about 8,000 employees, representing 12.7% of total Italian employees in the sector: 90% of these companies operate in the manufacturing sector, while the others relates to support service activities specialized in aircraft and spacecraft repairing and maintaining, and air transport. The overall Piedmont aerospace industry employs about 15,000 people and contributes to the overall turnover for about 2.5 billion euro.

There are several areas of activity of the Piedmont companies operating in the aerospace sector: construction of special machines and tools for precision machining; design and construction of plants; production of special vehicles; support for services to the design and prototyping, integrated engineering services and advanced IT services are included also.

Piedmontese companies operating in international markets are: A380, B787 Dreamliner, Typhoon, the new JSF fighter, the space station, the Crew Exploration Vehicle, the GOCE satellite and Ariane 5, the Europe's largest rocket launcher.

The research system

Those involved in research, development and innovation are the Universities (led by Politecnico di Torino), followed by the Piedmont Aerospace District Committee, a Technology Platform and incubators as Enne3 and I3P. They play a key rule to support the engineer training, design and research and development.

A strong integration between the system of scientific research and a large industrial sector led to the birth and growth of the current 200+ SMEs and 9 large-sized companies operating in international market: Alenia Aermacchi, Avio, Aviospace, Icarus, Intecs, Mecaer, Microtecnica, Selex ES, Thales Alenia Space.

Priority themes of technological development

Application opportunities for Research, Development and Innovation are: remotely piloted aerial systems; eco-friendly engine tuning solutions; more electric aircraft; clean sky; space exploration; management systems in orbit; engineering services, logistics and control; innovative platforms for missions (except “payload”)

This project is co-financed by the European Regional Development Fund through the Interreg Alpine Space programme
The industry's strengths are: a long tradition on production and research; the presence of specialization areas with global leadership; high technology and strong tendency to export; regionally and nationwide structured partnerships network and collaborations.

KETS are: industrial biotechnology, advanced materials, micro and nanoelectronics, nanotechnology and advanced manufacturing systems.

AUTOMOTIVE

The production system

Piedmont is the leading Italian region across the automotive sector and is known as one of the top five European cluster for “intense automotive”. In 2012, the Automotive Innovation area involved 2,673 businesses and 82,033 employees, which constitutes a 16.5% nationwide share within this sectoe.

There are a large number of companies providing accessories and components, machinery, equipment and services, especially in the styling and engineering areas: first of all, the FCA. In addition, Piedmont offers a complete IT sector, which guarantees the excellence in integrated circuits, design and software development, as well as strong skills in different fields related to the automotive sector: Electronics and Microsystems, hydrogen, nanotechnologies, wireless and mechatronics. Automotive companies of Piedmont exporting abroad are 74%, compared to 56% in the rest of Italy; 40% of the sector's companies are engaged in R&D, with an average investment of around 3% of turnover.

The 73.5% of Piedmontese automotive companies produce vehicles and their components; the remainder is mostly specialized in service activities linked to mobility and logistics. To complete the picture, almost 50% of the regional European patents comes from companies operating in the automotive industry.

The research system

The Politecnico di Torino offers a unique concentration of expertise in the automotive sector and is characterized by offering: a five-year degree course in Automotive Engineering, some postgraduate Masters and long-term training courses.

A staff of over 900 engineers works for the Centro Ricerche Fiat (CRF) which develops and transfers innovative products and processes: this is the place where the “ABS braking system” and the “Common Rail diesel engine” were invented and created. The Center offers workshops and high-level machineries, operating across different sectors: environment, energy, safety, materials and technologies.

In the new “Cittadella Policlinica” of the Politecnico di Torino, GM Powertrain Europe has created its own research center for new generation low emission engines.

Priority themes of technological development

Thanks to a national framework agreement, the overall chain of Piedmontese enterprises - car makers, hammers, breakers, crushers, steel industries and waste treatment - have been committed for several years to developing innovative technologies and solutions on the topic of vehicle's components and materials reuse or recycling. This commitment closely follows the instructions set out in Directive 2000/53 / EC, which at least requires a 85% recovery in weight of the vehicle.

Application opportunities for Research, Development and Innovation are: control and power systems and technologies; alternative drive systems; power and energy storage; high
security mechanical components and subsystems, performance and energy efficiency; board systems for driver assistance and emergency management; Car-to-Car Communication (C2C) and Car-to-Infrastructure (C2I) technologies; non-traditional materials (composites, nanostructured etc) with high performances and low environmental impact.

KETS are: industrial biotechnology, advanced materials, micro- and nano-electronics, nanotechnologies, advanced manufacturing systems.

**MECHATRONICS**

**The production system**

Mechatronics is one of the main sectors of the Piedmont industry and includes two major segments: the Mechanics and Electronics, which are integrated with the automation and ICT. It is a crucial industry for the development of local economy, as it produces specialization and innovation that contributes to several other sectors too. The area of Mechatronics consists of 35,000 local economic activities and employs 170,000 people, representing 12.4% of regional and 9.8% nationwide employment. Half of employees work in electronics and mechanical engineering industries; concerning the other half, it refers to the service activities engaged in design and research, telecommunications, maintenance, and installation of plant and machinery.

The companies have developed interesting innovation projects, which are: intelligent systems for the reduction of automotive fuel; Micro robotic factories for biomedical components processing and assembly; the extensive sensors development for functional parameters control for automotive, aerospace and railway applications; development and control of high power solid state laser sources for the reduction of energy consumption in sheets cutting and welding.

**The research system**

Twelve Innovation Poles created by the Piedmont Region has greatly contributed to the local enterprises development. This network brings together various entities: Politecnico di Torino and other Universities, research centers and companies. Two CNR institutes and incubators as I3P are involved in research, development and innovation as well.

MESAP (Polo Mechatronics and Advanced Production Systems) stands out over others. It consistently has funded the relaunch and research in mechatronics industry for more than three years. Nevertheless, MESAP is a member of the Network Cluster Collaboration.eu; it also actively cooperate on the “InToMech”, “Mechatronics European Intercluster”, Clustercoop and SAGE projects. Finally, MESAP adheres to Enterprise Europe Network (EEN) Alps North West Italy.

**Priority themes of technological development**

Technological development is mainly spread on two major areas: the smart products (for consumer and industrial products), the flex processes (for the flexibility and adaptability of the production processes) and green processes (for eco-efficiency and eco-friendliness of production processes)

Similar developments affect both product and process trajectories, such as: Virtual Performance Simulation, Mechatronics Automation, Micro - Nano technologies and Manufacturing Transformation.
The theme of "smart specialization" is becoming more and more important in terms of: 1) technology transfer from research centers and universities to enterprises, and 2) technology transfer between sectors, which leads to hybridization of technologies and resulting in applications on different industries.

KETS are: Photonics; Advanced Materials; Micro and Nanoelectronics; and Advanced Manufacturing Systems.

MADE IN PIEMONTE

The production system

This sector contains all the Piedmontese highly specialized centers and chains. This sector is made up of food and textiles, which represent the core of economic activities with approximately 37,000 local units and 172,000 employees representing 12.5% of the Piedmontese workforce. Despite the reduction of enterprises and volume of production due to the 3-years economic crisis, the transformation of the Italian productive specialization, registered a growing presence in foreign markets; it's worth to underline that companies focusing on conservative productions and domestic market, have become the worst performing across these sectors. The competitive power of local enterprises is linked with the ability to pursue radical innovations of products meaning (also called “innovation driven”).

Made-in-food is an international root to date, considering both production and innovative delivery. The textile and clothing sector is geared to quality products (not only the "luxury" ones) and has achieved an excellent global positioning by maintaining and preserving the chain integrity, as well as the growing willingness to new industrial and technological solutions.

The Piedmontese production system is highly broad and it provides fertile ground to innovative applications in manufacturing companies. Unique factors enabling these dynamic are: the strong degree of sustainability, the product and production ethics, the traditional products transformation trend, the integration with service contents and public health, and the innovation in the use and reuse of new materials and raw materials.

The research system

In order to protect the peculiarities of the local production sites, some entities support the research and development of the made-in-Piemonte: among others, there are Universities, a technological platform, two Innovation Hubs, 7 CNR institutes, some incubators (Enne3, I3P) and CSP, an institute who studies innovation in the ICT sector.

Priority themes of technological development

The key factors of the made-in production mainly can be divided into specific factors. On the one side, the companies should struggle to defend their leadership and to deploy their innovative capacity in order to face up the growing complexity in the organizational contexts, the higher competition in the non-domestic markets, and the changing customers’ preferences that are becoming more and more unstable and sophisticated. On the other side, there is a need for integration of style, product and technology, especially with regard to ICMT (information, communication and media technologies) in order to accelerate response to market needs.

Application opportunities for Research, Development and Innovation are: track-chain; food-core; go-to-market; food-sustainability; farm-of-the-future; material for selective crop protection; probiotics and nutraceuticals; weareable technologies/smart textiles; technical
protective clothing; functionalized textiles for medical applications; furniture items and structural textiles for buildings and transportation.

KETS are: industrial biotechnology, advanced materials, nanotechnology, advanced manufacturing systems.

4.1.3 Friuli Venezia Giulia

Friuli Venezia Giulia region has identified five specialization areas. For what concerns the “Smart manufacturing and related services” area, “Manufacturing&Industry” and “Furniture” are the two most relevant capabilities.

MANUFACTURING & INDUSTRY

The production system

One of the most important manufacturing segments of the of Friuli Venezia Giulia is the engineering sector coinciding with the segment of the metallurgy, the manufacture of metal products and machinery and equipment.

The production system consist in 2,705 active companies (2014), representing 28.4% of the manufacturing and characterized by different sizes (biggest companies in metallurgy and steel industry, SMEs in the manufacturing of metal products and machinery). In 2011 the sector employed more than 39,000 workers, mostly in the province of Udine (49.0%) and Pordenone (35.0%).

Considering the entire sector chain, it would count, at the end of 2013 6,438 operational units in Friuli Venezia Giulia able to employ almost 73,000 employees, 50,791 of which located in the production (figures refer to 2011).

The research system

The business and service system is supported by the research system, which has long been collaborating in synergy with production. In this sense, strategic resources are:

- the University system with the faculties of Engineering of Udine and Trieste and their relevant departments (eg. Electrical, Management and Mechanical Engineering and research interdepartmental centers);
- the scientific and technology parks, including for instance Area Science Park, Friuli, Pordenone technology park, Innova FVG;
- innovative start-ups focused on the implementation / commercialization of products of mechanical engineering;
- Districts and consortia, that are mostly business combinations operating in the engineering sector (Cluster COMET for instance).

Companies active in the sector constantly invest in innovation and research (both process and product). Innovations usually come from the production phase and designed to solve execution problems. In some cases they are transformed into patents.

The priority themes of technological development

Starting from the "entrepreneurial discovery" process and the thematic groups of stakeholders promoted by the FVG Region has defined three important scientific and technological trajectories: technology of numerical modeling of process and product; methods and technologies for integrated design; smart machine.
Enabling technologies
The most significant enabling technologies for the area are the ones related to processing modes; new programming and simulation techniques; Integration between mechanics and electronics

FURNITURE

The production system
Furniture is a productive sector that play a major role in Friuli Venezia Giulia. It includes all the activities for the production of goods that are placed in the domestic environment, whose most important components are represented by the wood industry and products and by companies operating in the manufacture of furniture.
The production system consists of over 2,890 active companies (2014), which account for about 30% of the manufacturing sector. In 2011, Furniture (limited to the wood industry and furniture manufacturing) employed just over 22,500 employees, or about 20% of workers employed in the manufacturing of Friuli Venezia Giulia.
According to data from MISE (year 2012), the total turnover of the sector amounted to more than 4,329,443 euro.
Inside the Region operate several realities of excellence that have consolidated significant market shares thanks to the constant focus on research and innovation. The list includes – mentioning the really major -: Friul Intagli Industries SpA, SpA Calligaris, Snaidero Rino SpA, Valcucine SpA, Moroso SpA.

The research system
The business and service system is supported by the research system, which has long been collaborating in synergy with production. In this sense the strategic resources are:
- the Universities of Trieste and Udine, with the faculties of engineering and the related departments of physics and architecture;
- Science and technology parks (eg. Area Science Park, Friuli innovation, Pordenone Technological Center, INNOVA FVG) with innovative start-ups focused on the implementation/commercialization of innovative products related to the home system, in particular in the study and analysis of the design;
- Districts and consortia, aggregations of firms operating in the home system (eg. the chair district and furniture, now under revision).

Companies active in the sector constantly invest in research and innovation (both process and product).
The process innovations are incremental. Among these are counted:
- those aimed at acquiring a higher level of environmental sustainability by replacing harmful substances (resins, adhesives, paints and solvents especially), promoting innovative forms of energy recycling of waste materials and experiencing environmental management systems according to the standard EMAS or proposing a new environmental quality mark.
- those designed to recover productivity and, in this way, lower unit production costs.
Product innovations regard the rethinking of the concept (deconstruction of the environment, modularity, integration or combination of user functions), the design of products for functions previously not widely imagined by regional producers (outdoor furniture) and use of new materials, not only in the chair, and the testing of new mix of materials (with the most use of plastic and composite materials) or in the introduction in the manufacture of furniture and / or appliances of electromechanical and electronic components (eg . home automation, use of wifi systems).
Product innovations, in the "house system and technologies for living environments," often are accomplished through the use of computer-aided design and / or three-dimensional modeling with the help of specialized software (CAD / CAM, in particular).

**The priority themes of technological development**
Starting from the results of the process of "entrepreneurial discovery" and thematic groups of stakeholders, the Region has defined a set of four important scientific and technological trajectories for the territory and for immediate implementation:

- technology related materials;
- methods and technologies for the rapid design;
- technologies for energy efficiency in buildings;
- cloud computing technologies;

**Enabling technologies**
The most significant enabling technologies for the trajectories are:

- Nanotechnologies, intelligent materials for the trajectory "technologies related to materials";
- CAD / CAM systems and 3D printers for the trajectory "Methods and technologies for the rapid design";
- for the trajectory "technologies for energy efficiency in buildings": technologies systems / plants for the production of solar and photovoltaic energy, particularly insulating materials able to reduce the use of energy in order for substantial cooling and heating of the environments;
- Smart Grid technologies for the trajectory "cloud computing".

*Source: Regione Friuli Venezia Giulia, “Strategia Regionale di Ricerca e Innovazione per la specializzazione Intelligente del Friuli Venezia Giulia”, Marzo 2015*

**4.1.4 Veneto**

**SMART AGRIFOOD**

The production system
The agribusiness supply chain is a sector with great potential, several peaks of excellence, and the ability to combine research and innovation with the traditional quality of the famous Venetian food products. The three strengths of the Venetian Smart Agrifood sector are high quality product diversification, the promotion of traditional products, and the strong ties with the region.

In this sector, there are some leader companies in the Verona area, along with a multitude of small and medium-size businesses scattered over the whole region, with some important nexus points in the Prosecco wine region of Conegliano and Valdobbiadene, in the Verona area for wine and fresh produce, and in the fishing district of Polesine and the south of the Venice province. Veneto can claim several more peaks of excellence in the food industry, which employs 34,000 workers in 3,650 regularly registered companies.
The flagship product of the industry is wine. Veneto is the biggest producer of wine in Italy, and Venetian wine is being appreciated more and more on a global scale. As of today, Veneto has 35 PDO (Protected Designation of Origin) and PGI (Protected Geographical Indication) wines, 14 DOCG (Controlled and Guaranteed Designation of Origin) wines, and 28 DOC (Controlled Designation of Origin) ones, as well as 370 traditional food products. However, the system has its weaknesses, such as the prevalence of small companies, their inability to coordinate and, finally, their issues in taking the opportunities offered by innovation.

The research system

Veneto is well-known for its universities and research centres, an advanced food safety and certification system, a consolidated supply chain (from harvesting and picking, to processing and cooking, to packaging), and for its defence of the quality of the products. There are four universities in the region: the University of Padova, the University of Verona, and Ca' Foscari University and the IUAV institute in Venice. The four universities organised consortia and inter-university research centres. The region also hosts branches of other research organisations and CNR (National Research Council) research units, mostly in the Padua and Venice areas.

The lack of collaboration between research and the industrial sector, the absence of large distribution companies, and the low availability of capital for innovations are factors that limit growth and create a negative spiral which further discourages research and capital sources.

The priority themes of technological development in this SA are: the development of policies on research and innovation and their transfer to the business world, ecologically sustainable distribution, improvements in product conservation, the strength of the brand recognition of typical products, smart packaging, the use of sensors, and business networking.

The traditional sectors (farming, breeding, fishing, and the food industries) are being influenced by cross-cutting sectors such as packaging, energy, logistics, catering, the chemical industry, farm and food processing machinery, and the biomedical sector. Inter-sector collaborations are mostly concerned with mechanics, chemistry, transportation, or innovative materials.

Future developments are mostly directed towards nutrition, health and food safety, sustainable agrifood, a smart management of natural and energetic resources, innovative and sustainable processing, and traceability and protection of the supply chain. Energy efficiency and environmental sustainability are two fundamental drivers of innovation, partly because of the growing issues caused by climate change.

The most significant enabling technologies for the area are the ones related to trademarks and certifications, industrial biotech, logistics, ICT, and nanotech.

SMART MANUFACTURING

The production system

Smart Manufacturing is a term that represents the processes, activities, and knowledge that derive from the introduction of “smart tech” in the industrial design and production process. These innovations are causing a fast change in the workflow on a global scale; their advantages in terms of production efficiency, working conditions, and product quality are significant. Companies are increasingly exposed to global competition, and they have to work on developing efficient production processes, combining traditional know-how and its high quality, with the new IT and automation systems, energy efficient plants, and organisational tools.
The number of local units in Veneto, as of the 2011 census, is 16,754, employing about 219,550 workers. The mechanical manufacturing sector also has 556 “best companies”, large and high quality companies which maintain a high profitability and capital strength, low debts, and steady or growing production value and size. The leather tanning hub in Vicenza is the biggest in Italy and one of the most important in the world; it represents 50% of the national production and it employs 40% of the local workers. The mechatronics and mechanical component and instrument industries are strongly interdependent, as the products they create are used across several industries of different sectors. The link between technical disciplines, such as IT and bioengineering, with human-centric scientific research, e.g., neuroscience and social science, is providing innovative results in industrial automation, robotics, and machine-human interaction. There are several excellence sectors, such as automotive, mechatronics, precision work, thermotechnics, and component production. The main weaknesses of the system are the small size of companies, the lack of networking between businesses, logistics and mobility, and the technological backwardness of several companies.

The research system

Veneto is classified as an “Advanced Manufacturing and Clustering Region with no specialisation in knowledge activities”, and it presents a high degree of specialisation in manufacture, with a good presence of KIBS. It has little R&D activity compared to the most advanced European regions, but its dense network of informal relations allows companies to exploit external knowledge for innovation. Smart Manufacturing research aims at introducing new technologies and cross-sector systems in the regional production base. Collaborations between companies and research centres, although still few, are helping make applicative innovation more usable.

The priority themes of technological development are sustainable production and industrial processes, cognitive and automation systems, innovative and inclusive workplaces, new organisation and production models, and the design and production of high-tech production systems. Energy efficiency, active ageing and design are the main drivers of technological innovation in the sector. The most significant enabling technologies for the area are the ones related to ICT, prototyping, photonics, and nanotech and its applications in materials.

CREATIVE INDUSTRIES

The production system

The fashion industry is arguably the one that most expresses the Italian style. Vento has the shoemaking district of the “Riviera del Brenta” area, the “sport system” area of Asolo and Montebelluna, the Belluno eyewear district, and the Vicenza goldsmith district, which are among the most famous in the country. In general, the fashion industry is composed of companies of various sizes, from world-class players to a multitude of small and medium-sized businesses, winned by global competition. The companies on the market have developed a strong distribution capability with international brands, a high product quality, and excellent design, thanks to the creativity of the design teams. In 2013, the fashion industry of the region generated a surplus of 6.3 billion Euros on the trade balance, thanks to the integrated “made in Italy” supply chain and to the knowledge base of the local suppliers. The traditional sectors are shoemaking and clothing, leather
tanning, goldsmithing, eyewear, artistic ceramics and glass, tourism, culture, and mobile. The 2013 data show that production of clothes is growing (+4.8%), along with leather products (+11.4%), eyewear (+5.6%), and shoes (+4.1%).

The creative industry is one of the most dynamic productive sectors in Veneto, generating welfare and unique peaks of excellence. This sector is characterised by the continuous need of restructuring and modernisation to keep up to date with the changing tastes of consumers, rapid technological changes, materials innovation, commercial competitors, and changing production costs due to global competition.

It is also exposed to issues such as forgery, legal and illegal competition, its dependency on foreign production, and the problems of having price as the main competition parameter.

The research system

Research on new cloth materials, such as special fibres and composite, “bio-based materials”, and functionalised materials, is fundamental to the sector. Product design, materials, the production process, supply chain management, and advertising and branding are the steps in the production chain which the synergy with research, innovation, and creativity can improve to generate new and competitive products. The Venetian universities, which were already mentioned above, are among the best in terms of both the quality and the breadth of their teaching; they also have a high intra muros investment rate in R&D (7% of the national level), growing faster than other regions in the Italian north.

Priority themes of technological development

In the creative sector, the ideation and design process is extremely important and diverse, exploiting the ingenuity of graphic designers, artists, architects, and designers in general. Incentivizing and improving these ideation processes, as well as facilitating collaboration between different sectors’ know-how, is necessary to improve the success of Venetian creative companies on the market.

New environments to show products, 3D visualisation, virtual and augmented reality, new tools for online marketing, multimodal and creative interaction, and shared digital spaces are all becoming important for the sector.

The main drivers of innovation are research on fibres and innovative and sustainable materials (which has the fastest growth), innovative marketing and product virtualisation, Made in Italy, and business model restructuring.

The most significant enabling technologies for the area are the ones related to plasma cloth processing, rapid prototyping, and nanotech.
4.2 Germany

4.2.1 BADEN-WÜRTTEMBERG

MACHINE CONSTRUCTION

The production system
Baden-Württemberg is the center of German machine and plant construction. One third of the 30 largest machine-builders in Germany are situated in the South-West of the country. A large number of small and medium-sized companies, which are world-market leaders in this sector, have their headquarters in Baden-Württemberg. With 304,000 employees, the mechanical engineering sector is the largest industrial supplier in Baden-Württemberg. More than 55,000 engineers are employed in this sector in Baden-Württemberg.
The sector generated sales of 70.7 billion euros in 2014 - almost one third of the total turnover of German mechanical engineering sector. The export rate is almost 70 per cent and the export volume has reached 181.4 billion euros in 2014. As one of the most innovative regions in Europe, Baden-Württemberg promotes the digitalization of the industry (Industry 4.0) and of the economy as a whole (Economy 4.0). Baden-Württemberg’s companies invest 6% of their turnover in innovation and development. According to the statistics disseminated by Baden-Württemberg International, during the last three years almost 76% of mechanical engineering companies have successfully completed at least one innovation project.

The research system
With more than 70 universities and almost 100 research institutes, Baden-Württemberg is one of the top scientific areas in Germany. Many universities of the federal state (Karlsruhe University of applied sciences, University of Stuttgart, Karlsruhe Institute of Technology, University of Ulm, Aalen University of Applied Sciences etc.) offer degree courses in the field of mechanical engineering, such as material and manufacturing technology, mechatronics, thermodynamics and robotics.

In addition, almost 60 research institutes in the country deal with the future development of machine and plant engineering and contribute to the innovation leadership of the industry. Among the other, are the Fraunhofer Institute for Manufacturing Engineering and Automation IPA and the Fraunhofer Institut for Systems and Innovation Research ISI particularly active in this field. The Allianz Industrie 4.0 is a network initiated and funded by the state of Baden-Württemberg aiming to connect all the innovative industrial departments in order to assist companies in their digital transformation process.

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The priority themes of technological development in this field are the automation technology, mechatronics, microsystem technology, network and communication technology, including IT security and software for manufacturing companies. The most significant enabling technologies are advanced manufacturing processes, mechatronics for advanced manufacturing systems, Cyber-Physical Systems (CPS) and Internet of things systems.

AUTOMOTIVE INDUSTRY

The production system
Baden-Württemberg is the most important area in Germany for the production of motor vehicles and motor vehicle parts: approximately 17% of the population of the region is employed in this sector. With more than 219,000 employees in 2015 the sector is not only the second largest employer in the federal state, but at the same time - with 113 billion euros (2015) - it is also the one which generates the highest turnover22. The automotive industry is the most export-oriented sector of the region: the export of cars and machines in 2012 amount to 44% of the total exports. In 2015 the export volume has reached 195 billion euros.

The automotive industry sector is one of the most innovative in the state and is investing almost 8 billion euros annually in research and development (R & D) of new technologies. As center of the German automobile industry, Baden-Württemberg is also the home of more than 1,000 suppliers. The Automobilland Baden-Württemberg is characterized by a close network of vehicle manufacturers, a powerful supplier industry with predominantly medium-sized companies, as well as specialized manufacturers, service providers, universities and research institutions.

In Baden-Wuerttemberg there are more than 20 networks and clusters that actively promote innovation and synergies between the companies, strengthening the international competitiveness of the automotive sector. The Stuttgart region with global players such as Daimler, Porsche and Bosch is so far the most important automotive cluster within Europe.

The research system
Automotive Industry is also one of the leading investors in research and development: over half of all R&D expenditures in Baden-Württemberg's industry are invested by the automotive industry (about € 6 billion).

Many universities of the federal state offer degree courses in the field of automotive industry such as process engineering, vehicle technology or automotive information technology (University of Stuttgart, Karlsruhe Institute of Technology (KIT), various universities for applied sciences).

In addition, a large number of excellent research institutes in the federal state deal with topics concerning motor vehicle construction, sustainable mobility and transport, such as the Max Planck institutes, the Fraunhofer institutes and the Innovation Alliance BW23.

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22 www.bw-i.de/fileadmin/user_upload/redbw-i/informationsmaterialien/brancheninformationen/Branchenuebersichten/Branchenuebersicht_Automobilwirtschaft_Nov2016_DE.pdf
The DLR Institute of Vehicle Concepts in Stuttgart works on and coordinates transport relevant research issues developing new vehicle concepts and vehicle technologies²⁴.

The priority themes of technological development in this field are electro mobility and autonomous driving, including all therefore needed software and technologies, car sharing and other new traffic solutions by modern generations, carbon emission reduction, smart traffic management, internal combustion engine energy efficiency, development of alternative drive technologies adaption of lightweight materials and electronics²⁵.

The most significant enabling technologies are automotive electronic, engine electronic and advanced software.

ELECTRICAL ENGINEERING AND ELECTRICAL INDUSTRY

The production system
Baden-Württemberg is one of the most important locations for the German electrical industry. With around 160,000 employees and sales of 36 billion euros, the Baden-Württemberg electrical engineering and electrical industry is one of the federal state’s three largest industrial branches together with the mechanical engineering and vehicle construction. Baden-Württemberg has a share of a quarter of the turnover of the entire German electrical engineering and electronics industry. In terms of R&D expenditure and R&D personnel, the companies in the electrical industry sector in the south-west are amongst the top rated in Germany²⁶.

This field is with the automotive industry strictly connected, as the electro mobility is one of the keys to achieving sustainable mobility for the future Components for electric vehicles like electric hub motors can bring suppliers of the automotive industry new business.

The research system
A total of 33 institutes/specialist areas and centers at the universities as well as six specialist universities with their outstanding research performance help Baden-Württemberg achieve its top international ranking in research and development in the field of electronics and electrical engineering.²⁴ The Institute for Microelectronics (IMS CHIP) in Stuttgart carries out research closely allied to commercial applications in the areas of silicon technology, user-specific circuits (ASIC), photolithography and image sensor technology, and also engages sustainably in continuing professional development. Seven Fraunhofer Institutes and one Max-Planck Institute in Baden-Württemberg are focusing their research on electronics and electrical engineering.²⁴ Together with the major research facility of the Karlsruhe Institute for Technology (KIT), a total of 48 institutes/specialist areas and centres support businesses in the electrical industry with innovative research and development work.²⁴ VDE Association for Electrical, Electronic & Information

²⁶http://www.bw-jobs.de/tr/isveren-dizini/branslar/ulasim/elektronik-elektroteknik/forschung.html
Technologies - an international expert platform for science, standardization and product testing - is one of the largest European associations for branches of electrical engineering and information technology.

One of the most important priority themes of the electrical engineering sector is to find new ways to make a sustainable energy future possible. The Robert Bosch Center for Power Electronics (rbz) is a newly established research and teaching network in which the Bosch Group, Reutlingen University and the University of Stuttgart have joined forces, doing research together in the fields of Power Electronic System, Microelectronic Systems, Power Semiconductor Components etc. The most significant enabling technologies are electric heat, high-voltage engineering, power supply and performance electronics, the use of renewable energies (sun, wind, and biomass) and advanced communications technology.

MEDICAL TECHNOLOGY

The production system
With a share of more than 25 percent of the total production Germany is the most important medical technology manufacturer in Europe. Baden-Württemberg is the leading medical technology state in Germany, as it generates more than 20 percent of the field’s national turnover27.

In 2015 more than 46,000 people were working in Baden-Württemberg’s medical companies generating sales of 11.7 billion euros. Small and very small enterprises are the majority: half of the companies have less than 10 employees. In addition to the numerous small and medium enterprises in the region there are also world conglomerates such as Roche, Boehringer Ingelheim and Aesculap.

The strength of Baden-Württemberg medical technology industry is its great innovative power. More than 50 percent of sales are generated with products that haven't been on market for 3 years yet.

The research system
In addition to successful companies, numerous institutes and centers contribute to developing the research in the field of medical technology. Examples are the Karlsruhe Institute of Technology, several Fraunhofer Institutes, Max Planck Institutes and research facilities at universities. Baden-Württemberg is furthermore characterized by a large number of clusters, which give innovative impulses to the sector’s economy28. The Mannheim Medical Technology Cluster provides access to both, domestic hidden champions and mature world market leaders across a large variety of disease states and medical technologies29.

The priority themes of technological development in this field in Baden-Württemberg are High-tech and innovative robotics, imaging, diagnostics and life-support systems.

27 https://wm.baden-wuerttemberg.de/de/innovation/ausgewaehlte-branchen/medizintechnik/
29 www.medtech-mannheim.de/en/medical-technology-industry
The most important **enabling technologies** are advanced clinic services, IT-related telemedicine, homecare and eHealth systems.

**AEROSPACE**

**The production system**
The aerospace industry is an important economic sector for the federal state of Baden-Wuerttemberg.

Besides a large number of small and medium-sized enterprises, there are also leading global companies - such as **EADS** with its subsidiaries **Astrium**, **Cassidian** and **Tesat Spacecom**, **Recaro Aircraft Seating** or **Diehl Aerospace** and **Diehl Aircabin** - having established their headquarters in the southwest of the state. The sector’s strength lies in its mix of tradition and innovation. Baden-Wuerttemberg produces avionics and cockpit systems, products used for cabins like passenger seats, panels, air-conditioning and lighting as well as radar technology and guided missiles.

Aerospace stands out through its intensive collaboration with other sectors. Due to the particularly high level of investment in research and development and its multidisciplinary approach, it is one of the country’s leading sectors

In recent years, the aerospace industry of Baden-Wuerttemberg has shown a strong employment growth. According to a survey of the industry carried out by the network organisation Aerospace Forum Baden-Wuerttemberg (LR BW), the aerospace industry accounts for more than **15,000 employees** and generate a turnover of **4.5 billion Euros**.

**The research system**
Numerous institutes and centers situated in the state contribute to developing the aerospace research.

Besides the institutes of the **German Aerospace Centre (DLR)** in Stuttgart and **Lampoldshausen**, noteworthy research activities are carried out by the **Fraunhofer Society**, the **University of Karlsruhe** and the **University of Stuttgart’s Faculty of Aerospace and Geodesy**. These institutions are supported by the **Aerospace Forum Baden-Wuerttemberg e.V**., which stimulate network activities between local companies and research institutes as well as between the major institutions themselves.

Concerning the **priority themes of technological development** particularly important in Baden-Württemberg is the space sector, for example with regard to satellites for scientific missions and earth observation systems, payloads for communication satellites and satellite thrusters. The future prospects of Baden Wuerttemberg's aerospace industry are bright. Besides the expansion of the civil aviation market, current trends - such as the need for new propulsion technologies - will have a positive impact on the sector's development.

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32 http://www.wfgheilbronn.de/ximages/1448850_kompetenza.pdf
The most important enabling technologies are advanced communication and navigation systems, communication and information technologies, advanced materials, advanced manufacturing technologies, micro and nano electronics.

4.2.2 BAVARIA

AUTOMOTIVE INDUSTRY

The production system
With 197,460 employees (2015) and a turnover of 102 billion euros, the automotive sector is one of the most important of the region. 25% of the cars produced in Germany come from Bayern.

Important companies of Bavaria's automotive sector include global players such as BMW, Audi and MAN (commercial vehicles), as well as over 1,100 companies including well-known suppliers such as Bosch Rexroth AG, Brose, Continental, Dräxlmaier Group, Schaeffler, Webasto and ZF Sachs. All significant international automotive suppliers have branches in Bavaria, providing the ideal conditions for automotive production.

In Bavaria excellent materials research meets innovative design and the production of high-performance on-board electronics: all the components for modern automotive production.

Efficient driving dynamics, vehicle safety and comfort, and efficiency and flexibility in production are some of the topics dealt with by the Automotive cluster.

The research system
Eleven universities and 17 universities of applied sciences in Bavaria provide the perfect basis for excellent university-based research and education, including in the automotive sector. Many universities teach and generate automotive-specific expertise, for example Automotive Computer Science at the University of Applied Sciences Landshut, Automotive Technology and Management at Coburg University and Vehicle Technology and Mechatronics at Munich University of Applied Sciences. The research undertaken by the universities is complemented by the work of institutions such as multiple Fraunhofer Institutes, the iwb Anwenderzentrum Augsburg and the Neue Materialien Nordbayern competence centre.

Multiple networks in Bavaria bring the key players in the automotive sector together. One of these is the Bavaria-wide Automotive cluster, whose aims include increasing transparency in the existing competences in business and science with relevance for the automotive industry.

The priority themes of technological development in this field in Bavaria are connectivity, sustainable mobility, E-Mobility, robotisation. The most significant enabling technologies are automotive electronic, engine electronic and advanced software.

34 https://www.invest-in-bavaria.com/branchenvielfalt/automobilindustrie.html
CRAFT INDUSTRY

The production system
The craft industry is a fundamental sector of the bavarian economy. The federal state has always been economically successful thanks to its medium-sized economic structure, which is strong characterized by the craft industry. In 2016 there were 107,140 craft enterprises in Bavaria. The companies of the Bavarian craft sector produce a share of 9% of the GDP. With a share of 13% of all employees in Bavaria, the craft industry sector contributes significantly to the federal state’s employment. According to official statistics, about 920,000 people are employed in this field in Bayern (2016).

Crafts companies are active in many high-innovative technology fields. They implement technological innovations into concrete, competitive products and services providing professional maintenance. Nowadays production and business processes are increasingly dominated by new information and communication technologies, which are used by almost all companies in the craft sector.

The research system
With its wide range of different professions, the craft industry offers good opportunities and development perspectives, as well as secure employment for professionals of all schools and for young people with different inclinations and skills. The focus of the Bavarian craft industry promotion (around 85% of the total subsidies) lies on the vocational training (investments in construction and equipment in vocational training centers, courses for the inter-company apprenticeship training). Many of sector’s innovation priority, especially robotisation/automatization and the transition to electro mobility are challenging the regional employment rate as they require less manufactural work steps and consequently less stuff. Especially SMEs are often overburdened by the complexity and the financial effort required by this innovation´s process.

The priority themes of technological development in this field in Bavaria are craft sector 4.0, automatization, robotisation of production. In the future the challenge of the sector will be to make products "intelligent" through the integration of hardware and software in order to individualize and perfect the production´s system.

IT-SECTOR

The production system
According to the Technical University of Munich the federal state is the most important IT location in Germany. A study by the EU Commission saw the Munich region as the leading IT

36 http://www.dasbayerischehandwerk.de/artikel/daten-zahlen-fakten-74,1687,4757.html
location across Europe\textsuperscript{38}. According to official statistics roughly **260 000 people** were employed in this sector by the end of 2010\textsuperscript{39}

In Amberg, **Siemens** has one of the most modern production facilities in the world. Numerous medium-sized "hidden champions" are world market leaders in the field of digital automation, e.g. **KUKA** or the **Maschinenfabrik Reinhausen GmbH**. Siemens products organize their further processing themselves - reflecting the idea of IoT - using programmable logic controller of the type Simatic, a part of Totally Integrated Automation, which is also produced by Siemens. KUKA is the world’s leading producer of robotics and production systems. Siemens and KUKA in turn are suppliers to the regional car industry.

**The research system**

Among the Bavarian universities those relevant to the IT sector are: **TU (Technical University) Munich** (German observer in Project BIFOCAlps), **University of Bamberg**, centre for telematics of Würzburg, Automation Valley of the metropolitan area Nürnberg.

There are several institutions and projects aiming to implement the needed technologies for renewal and innovation, for example the initiative **Bayern Digital**, which brings together representatives of policy, science and economics (e.g. the Bavarian ministry of economics, Technical University Munich, KUKA).

The **priority themes of technological development** are the Internet of Things, new apps, embedded systems, software platforms (IaaS, PaaS, SaaS), mobile applications and collaboration models, high performance computing, Big Data, Intelligent devices\textsuperscript{40}. Some of the most significant **enabling technologies** are for example the Cyberphysical systems (CPS) - the technical basis for the intelligent factory (SmartFactory), which can independently solve problems and control and adapt processes and the programmable logic controller, and industrial digital computers.

Additive manufacturing processes such as 3D printing enable individualized production and pave the way for so-called mass customization. With Augmented Reality, virtual tests can be carried out during the development process, as well as complex and labor-intensive maintenance and repair work.

**MECHATRONICS**

**The product system**

Mechatronics is an interdisciplinary field of knowledge that characterizes modern mechanical engineering and is the basis for most ideas of the industry 4.0. Mechatronic innovations in technology fields such as automation, robotics and efficient production systems are especially important for production in Bavaria, as the sector employed around 50% of all

\textsuperscript{38}https://www.heise.de/newsticker/meldung/EU-Studie-Muenchen-ist-europaeischer-IT-Leuchtturm-2169850.html
\textsuperscript{39}http://www.zdnet.de/41556463/it-standort-muenchen-blicke-hinter-die-kulissen/
\textsuperscript{40}https://www.stmwi.bayern.de/digitalisierung/bayern-digital/ausgangssituation/
industrial workers\(^{41}\). The industrial groups particularly affected by the mechatronics (automotive industry, electrical and electronics industry), employ more than **550,000 people** in Bavaria and generate sales of around **190 billion euros** annually\(^{42}\).

The **Bavarian mechatronics cluster** offers to economy and science stakeholders a platform to cooperate actively, promoting innovations in the mechatronic sector. The cluster’s business activities include information and consulting services, research and transfer activities as well as qualified staff.

**The research system**

Leading research institutes such as the **German Aerospace Center (DLR)**, several **Fraunhofer institutes** as well as a number of specialized universities contribute to innovative industrial applications in mechatronics\(^{43}\). The **Cluster Mechatronik & Automation e.V.** (German observer in Project BIFOCAlps) with headquarters in Augsburg connects knowledge originating from the disciplines mechanics, electronics and computer sciences. The Cluster Mechatronik & Automation supports and accompanies projects in every technology sector which is relevant for mechatronics such as industry or service robotics, semiconductor industry, industrial automation, engineering, automotive, environmental and medical engineering as well as drive technology and electro mobility.

The **priority themes of technological development** are Micro-mechatronics, Adaptronics, Mechatronic Organizational Development, Open source software in mechatronic systems, Diagnosis and quality assurance, robotics. Some of the **enabling technologies** are control systems, Smart Diagnostic systems, Innovative materials, Nanotechnologies for mechatronics, advanced communication and information systems.

**AEROSPACE**

**The production system**

The State of Bavaria is not only the home to global players such as **Airbus** or **MTU**, it is also the home to the headquarters of the **Deutsche Zentrum für Luft- und Raumfahrt (DLR) / German Aerospace Center** (the national aeronautics and space research centre of the Federal Republic of Germany), numerous research institutions and many SMEs. Bavaria is one of just a few regions worldwide with the entire value added chain from basic research, industrial research and development, via prototyping and manufacturing to maintenance, repair and overhaul\(^{44}\).

The small and medium-sized enterprises constitute the majority of the nearly 550 Bavarian aerospace companies, which cover virtually the entire real net output ratio – from basic research to marketing. Annually around **7 billion Euros** in revenues are generated in the

\(^{41}\) [http://standortportal.bayern/de/standortinfos/standortberatung/cluster/mechatronik-automation.jsp](http://standortportal.bayern/de/standortinfos/standortberatung/cluster/mechatronik-automation.jsp)

\(^{42}\) [https://www.stmwi.bayern.de/innovation-technologie/schwerpunkte/mechatronik/](https://www.stmwi.bayern.de/innovation-technologie/schwerpunkte/mechatronik/)

\(^{43}\) [https://www.cluster-bayern.de/cluster/mechatronik-und-automation/](https://www.cluster-bayern.de/cluster/mechatronik-und-automation/)

manufacturing aerospace sector. Overall, more than 60,000 employees are working in this field in Bavaria – including airlines and airports.

The research system
Bavaria is home to numerous universities, universities of applied science and major research institutions such as the Deutsche Zentrum für Luft- und Raumfahrt (DLR) or institutes from the Fraunhofer Gesellschaft and Max Planck Society which are active in aerospace research and teaching. The Ludwig Bölkow-Campus in Ottobrunn was founded in 2013 to promote synergies between science and industry, initiate projects and bring products to market. The campus, whose stakeholders include Bauhaus Luftfahrt, DLR, TU München, University of Applied Sciences Munich, Universität der Bundeswehr München as well as Airbus, IABG and Siemens, explicitly sees itself as an innovation platform and starting point for interdisciplinary cooperation. The non-profit association Bauhaus Luftfahrt deals with the future of mobility in general and with the future of air travel in particular.

The association bavAIRia e.V. was commissioned by the Bavarian government with the management of the Aerospace Cluster. The aim of bavAIRia is to identify Bavarian core competencies in aerospace and space applications, and to link the competencies with each other in order to increase the global competitiveness of the sector.

Some of the most important priority themes of technological development are new wing configurations in order to increase the aerodynamic efficiency, development of unmanned aerial vehicles, advanced control systems for drives, complete aerodynamic integration of wings and cabin (Blended Wing Body BWB).

The most important enabling technologies are: three-dimensional modeling of urban environments, advanced communication and navigation systems, nano electronics and photonics.

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46 http://www.bauhaus-luftfahrt.net/
47 http://www.bavaria.net/bavaria-ev/
4.3 France

4.3.1 Rhône-Alpes Region S3

Since January 2016, the Auvergne Region and the Rhône-Alpes Region have merged into a new great Region: Auvergne-Rhône-Alpes. A new Regional pattern of economic development has been voted in December 16, 2016. A new S3 is in going but not still operational, in particular the mapping of economic stakeholders and research systems (universities, laboratories) related to the main 8 areas of excellence as defined in the Regional pattern of economic development (http://www.auvergnerhonealpes.fr/actualite/393/le-srdeii-de-la-region-auvergne-rhone-alpes-adopte.htm). This document is the only official document so far.

Here are some information about the new areas of excellence related to FoF activities. The Regional economy is made up of several structuring sectoral pillars. One of the characteristic traits of the new Region is the ever-present industry, as well as the commercial tertiary sector. Auvergne-Rhône-Alpes is the first French Region by its volume of industrial jobs and one of the first in relative value added. This industrial and tertiary base is structured around employment zones where industry remains very present (Arve Valley, Oyonnax, Mauriac, Saint-Flour, etc.) and in the urban centers attracting tertiary functions. This industrial and tertiary base is also home to future-oriented sectors of excellence with good international visibility (biotechnology, pharmaceutical industry, micro and nanotechnology, chemistry, nutrition-food-health, fundamental biology, plastics…). These channels form the eight areas of excellence that will be a major component of the SRDEII strategy.

**Eight areas of excellence to ensure the attractiveness and competitiveness of the Region**

The numerous exchanges carried out with all the Regional innovation actors during the SRDEII and SRESRI consultations revealed 8 major areas of excellence for Auvergne-Rhône-Alpes:

1. Industry of the future and industrial production
2. Buildings and Public Works
3. Digital
4. Health
5. Agriculture, Agroalimentary, Forest
6. Energy
7. Mobility, Intelligent Transport Systems
8. Sport, mountain and tourism

**There are three areas of excellence related to Factory of the future:** 1) Industry of the future and industrial production; 3) Digital; 7) Mobility, Intelligent transport system.

**1 - Industry of the future and industrial production**

The first industrial Region in France, Auvergne-Rhône-Alpes is based on a wide range of sectors whose activities are particularly innovative. The Region has undeniable assets on certain targeted and complementary themes:

- Environment chemistry, industrial processes and eco-efficient plant;
- Construction of industrial equipment, intelligent machines, internet of objects, simulation chains;
- Mechanical, precision machining, high precision machining, additive manufacturing;
- Robotics, mechatronics, digital technologies;
- Composite and bio-sourced materials, technical textiles, plastic parts, etc.

Many key players in the field of innovation who act as drivers of growth and jobs accompany this dense industrial fabric on the territory. This territory has a triptych probably unique in France, namely:

- **8 competitiveness clusters** ("pôles de compétitivité") : Axelera, Minalogic, Mont-Blanc Industries, Plastipolis, Techtera, ViaMéca, Tenerdis and Imaginove, which have combined their potential and the services offered by their members in the field Industry of the future;

- **an advanced technological transfer capacity** through a strong concentration of technological platforms associated with the most important Regional network of Industrial Technological Centers (grouped within ACTRA) and several Carnot Institutes (CEA, Cetim, etc.);

- **a strong academic force** that also contributes to the dynamism of this sector (Mines, ENISE, INP Grenoble, Institut Pascal, ...).

Other players such as the Trimatec cluster, the Aerospace Auvergne-Rhône-Alpes cluster, the industrial efficiency cluster, Coboteam and JCEP, also contribute to forging the dynamism of the Regional ecosystem in this area.

While Auvergne-Rhône-Alpes can rely on the strengths represented by the strong dynamics undertaken by public and private actors offering innovative industrial solutions, it must also be part of a dynamic that transcends Regional boundaries. The various European initiatives, including the “Four motors” network (Auvergne-Rhône-Alpes, Catalonia, Baden-Württemberg, Lombardy), as well as the national plan “Industrie du Futur”, with substantial financial resources within the framework of the PIA (national funding), are part of it.

The conditions are now in place for the Auvergne-Rhône-Alpes Region to be able to launch an ambitious industrial reconquest plan to assert its leadership. The aim is to offer the SMEs in its territory the means to obtain competitive advantages enabling them to integrate into an increasingly competitive globalized economy.

One of the Regional priorities is to focus on strengthening skills, integration and engineering capabilities in intelligent machines and efficient production systems, to improve the competitiveness of the Regional industrial fabric and put people at the heart of these Changes.

In particular, several Regional structuring and innovative equipment are emerging in the area of additive manufacturing and new manufacturing processes. The aeronautics sector, in particular, has a real potential for innovation in the Region, which needs to be strengthened.

At the same time, the challenge will be to support the SMEs in the appropriation of the new technologies and processes stemming from these innovation players. This, along with the new organizational methods and digital tools that form the foundation of the industry of tomorrow.

### 3 – Digital

The Auvergne-Rhône-Alpes Region aims to become a world reference in the field of digital excellence and friendly systems. Digital is an essential sector of the economy, as it represents many skilled jobs, and is also a strong lever for business transformation, creating
jobs and wealth (nearly 90,000 jobs in total in the Region), Auvergne-Rhône-Alpes has many skills on digital:

- Advanced production and industrial robotics: photonics, sensors, nanotechnologies, embedded software, augmented reality, control control, single crystals and the machine to machine (M2M), cobotics, but also Design and advances in human and social sciences;
- Service robotics and ambient intelligence: applications in health and well-being, efficient buildings, mobility, complex data processing and cybersecurity;
- Digital content industries: cultural and creative industries (ICC), education and e-learning, digital works, and immersive environments (virtual reality ...).

The dynamic of the Auvergne-Rhône-Alpes Region is based on an ecosystem of public and private actors, rich and dense:
- **French leaders in the digital economy**, robotics and digital security (eg CGI, SOPRA, CGI, ATOS, Cap Gemini, etc.), a tightly knit fabric of startups, small businesses and creative and innovative SMEs;
- **Professional networks in the sector**, bringing together digital players with several clusters and clusters: Minalogic, Imaginove, Digital Cluster, Coboteam, Numelink, E-Cluster;
- **A network throughout the territory** of "facilitating" structures such as incubators, accelerators, themed entrepreneurial centers, French Tech networks and metropolises and funders (venture capital, business angels, etc.), serving startups;
- **A network of laboratories and universities** with international reach around research centers, as well as structures disseminating digital uses and contributing to the acceleration of the digital transition of the economy and society.

With the ambition of positioning Auvergne-Rhône-Alpes as the Silicon Valley of Europe, one of the challenges for the Region is to develop its attractiveness to keep its talents and promote international development. The merger of the Numelink cluster and the Digital Cluster will contribute to this visibility.

The other major challenge for the Region is to stimulate and accelerate the penetration of digital and robotics in other sectors such as industrial production, health, transport, culture, education, agriculture, Tourism ... by creating bridges between designers and upstream users. This could be translated into a transversal networking of digital actors through the coordination of the different "totem" sites to acquire a critical size. The emergence of structuring innovation projects and the development of new forms of innovation (uses, business models ...), the stimulation of cross-fertilization will be the preferred tools to establish these connections between sectors.

Given the rapid and permanent evolution of digital technologies, the Region is very concerned about having enough qualified employees. Thus, the Region is carrying out a major project on the digital professions, combining initial training, continuing education and business services, through the creation of a European digital jobs campus. Aimed at increasing employability throughout the life of employees, and the competitiveness of companies.

Finally, this Regional ambition for the development of the domain of digital excellence is backed by a priority for the coverage of the whole territory in Very High Speed.
7 - Mobility, Intelligent Transport Systems

This area of excellence raises the stakes of mobility through a systemic approach to transport, in order to optimize its efficiency in the innovation market. The Region relies on the presence of all the industrial and academic skills necessary for this systemic vision on its territory. Its ambition is to strengthen its development and to ensure its national and international visibility on the following fields:

- Management of mobility and networks of people and goods: technologies, and associated services;
- Automated industrial vehicle: safe, clean, efficient, interactive and cooperative;
- Mobility infrastructures: advanced materials and systems, connection between infrastructures and transport systems, development of urban spaces;
- Modeling and regulation: decision support for new transport services, approval and certification process (security), integration of constraints related to the energy transition law;
- Uses: development of innovation around human intelligence and uses, multidisciplinary approach in the design of transport systems, to target market applications;
- Sectors of application: heavy vehicles, public transport (bus, coaches, tramways, shuttles ...), automobile, railway, river transport, cable transport.

The priority given to mobility is based on a triple observation of the constant increase in travel flows, changes in use, the strong Regional presence of an industry ecosystem: Michelin, Renault Trucks, IVECO, and research: IFSTTAR, Labex ImobS3, LAET ..., and technologies: CEA, INRIA, IRT Nanoelec, etc. The many actors in the academic sector have identified Mobility as a major challenge in their projects. This ecosystem is complemented by a network of ETI, SMEs and start-ups that have seized the opportunity to innovate in this area of excellence.

The Region will have an offensive action to support collaborative research and innovation projects on these themes, in particular through the action of clusters and competitiveness clusters concerned (LUTB-RAAC, INDURA, Viaméca, Minalogic), so that Avergne-Rhône-Alpes is recognized and recognized worldwide as one of the main ecosystems of innovation on this subject.

One of the priorities in this field of excellence is to ensure the full range of experimental platforms in Auvergne-Rhône-Alpes unique in France, including Transpolis, which will materialize from 2018 onwards, PAVIN and PTL platforms, already existing. This is to promote the possibility for manufacturers to test their innovations in various situations and to develop new partnerships (companies, laboratories, research centers, etc.) by working on scenarios of use.

The Region also has four major urban areas, which largely focus on issues related to travel and associated new uses. These metropolises, together with the players present, make the Auvergne-Rhône-Alpes Region a key area to capitalize on innovative experiments in the field of passenger transport and logistics.

Auvergne-Rhône-Alpes also offers a variety of rural and mountainous areas, embodying strong transport and constraint challenges in complex environments where the Region aims to be a representative experimental territory on a European scale.
The Region therefore faces a challenge in order to assert itself as a pioneer in the experimentation of innovative vehicles and transport systems, up to the approval and their placing on the market.
4.4 Austria

4.4.1 Vorarlberg

Definition of manufacturing priorities and competencies
Vorarlberg is one of nine federal states in Austria. Vorarlberg has an area of 2,601 km², with approximately 387,634 people living in 96 districts. The state is divided into four counties (Bregenz, Dornbirn, Feldkirch, Bludenz). The state capital is Bregenz with approximately 30,000 citizens. (Land Vorarlberg, 2016). It is one of the most strongly growing regions in Europe. (Austrian Conference on Spatial Planning (ÖROK), 2016)

Main actors and players form production and research
Vorarlberg economic environment is determine by small and medium enterprises (SME’s) and family owned businesses. SME’s and family businesses in Vorarlberg have been successful over generations, but this is however also true for the many newcomers to the area. As a predominantly entrepreneurial country, the majority of co-workers work in medium sized firms in the commercial market. Only a few of these companies employ 500 or more workers. Following on from this tendency for a small company size is that Vorarlberg experienced a large upturn in economic activity as a result of exportation. Vorarlberg has developed into a place with many small and medium sized companies, in which the manager plays an active role within the business, a very business friendly environment, this has meant that today – also with a small number of sick days- this has resulted in the lowest strike rate in Europe. (Land Vorarlberg, 2016)

As the Wirtschaftskammer Vorarlberg (2016) highlights, the region of Vorarlberg locates 21,212 companies whereas 1,247 of these are start-up companies. Vorarlberg maintains 156,506 workplaces and provides a regional Gross Domestic Product (GDP) of 15.2 billions Euro. With an export quota of 60 %, Vorarlberg is an export-oriented region.

The main product groups produced in Vorarlberg are machinery-metal (51.2 %), electronic (17.1 %), food and agriculture (12.1 %), wood, chemistry, paper (10.5 %), textile (7.8 %). The overall amount of export amounts 9.510 Mio Euro whereas the product groups machinery-metal lasts electro 29,15 % (2.772 Mio Euro), 26,34 % (2.505 Mio Euro), wood, chemistry, paper 11,52 % (1.096 Mio Euro), food and agriculture 9,42 % (896 Mio Euro) and textile 8,54 % (812 Mio Euro). Remaining product groups comprises, for example, furniture, game and others and contribute 15,03 % (1.429 Mio Euro). Important companies are, for example, Carcoustics (100 % export ratio), Liebherr Nenzing (99 %), Hirschmann Automotive (99 %), Erne Gruppe (99 %), Ömicon Electronics (98 %), Bachmann Holding (98 %), Baur GmbH (98 %), Blum Gruppe (97 %), IMA Schelling (97 %).

The collaboration of research and industry is an important pillar in the Vorarlberg’s strategy. Vorarlberg maintains the Vorarlberg University of Applied Sciences (FHV) (incl. the research centers: Microtechnology, User Centred Technologies, Process- & Product Engineering, Social & Economic Science and Energy). FHV is the main player in Vorarlberg’s research strategy and is well-known for its industry-related research. Furthermore, V-Research GmbH is located in Vorarlberg. V-Research GmbH is a competence center industrial research and acts in close relations to regional industry and research and beyond. Additional, Vorarlberg locates the research institute for textile chemistry and textile physics. It is a spin off of the University of Innsbruck (Tyrol) and collaborates with lead organizations in the branch of textile as Schoeller, Wolford, Getzner, Lenzing and Benning.
In 2016, 196 patent applications are successfully submitted from the region of Vorarlberg.

**Research priority themes Vorarlberg**

Smart specialization is an essential pillar of the State’s science and research strategy. As highlighted in table 1 Regional thematic priorities, Vorarlberg’s smart specialization strategy focuses on

- Smart textiles
- Energy and energy efficiency
- People and technology
- Education and health
- Intelligent production

Further, the European Regional Funds (EFRE) supports Vorarlberg with the following measurements:

- M01 – Research and technology infrastructure (Forschungs- und Technologieinfrastruktur)
- M02 – Cross-organizational R&D projects, cluster projects, and transfer competencies (Überbetriebliche F&E-Projekte, Verbundprojekte, und Transferkompetenzen)
- M03 – Organizational R&D projects and transfer projects (Betriebliche F&E-Projekte, Technologietransferprojekte)
- M05 – R&D and technology oriented investments (F&E- und technologieorientierte Investitionen)
- M09 – Supportive actions for growth in organizations (Unterstützung für Wachstum in Unternehmen)
- M11 – Organizational investments into renewable energy and energy efficiency (Betriebliche Investitionen in erneuerbare Energien und Energieeffizienz)
Figure 12: Data base EFRE Austria
4.5 Slovenia

Relevant manufacturing sectors: manufacturing of machinery and equipment, manufacturing of pharmaceutical raw materials and preparations, mobility, Materials as end products.

In this framework the focus areas with the highest complementarity rate as well as with the highest market potential were identified.

Factories of the Future - Manufacturing of machinery and equipment
Slovenia has revealed comparative advantages on the field “Manufacturing of machinery and equipment”, including “Manufacturing of other special-purpose machinery” in both segments: intermediate and final products (see Burger and Kotnik 2014).

According to FIDEA Long term dynamics, demonstrates continued strengthening of comparative advantages from 2004 onwards, however it also identifies huge untapped export potential (FIDEA 2014). The area in Slovenia also has great research and development potential. For example, in the field of photonics Slovenia has the highest number of diode-pumped solid-state medical lasers per capita according to S4.

In terms of the number of toolmakers per million inhabitants, Slovenia takes the second place just after Japan in the world. In terms of excellence of services Slovenia is second in Europe, preceded only by Portugal.

Smart factories area is identified as an extremely collaborative and horizontal field where both users and providers have shown strong interest and displayed commitment.

The research system
University of Ljubljana - Faculty of Engineering, University of Ljubljana - Faculty of Electrical Engineering, IJS - Institut “Jožef Stefan”, TECOS - Industrial Association of Toolmakers, LAHA - Laser and Health Academy, Chamber of Commerce of Slovenia, TECES – Machinery and equipment cluster, ICT Network, various companies and associations with their own research capacities.

The priority themes of technological development and research include:
Priority themes of technological development are focus on: Optimization of production including the development of management and control system, quality assurance, regulation and processing data, internal logistic, digital automatization and robotization, optimization and automatization of manufacturing process. Smart machines and equipment, mechatronic systems, batterie and smart sensors

In this area has already established international partnerships, particularly through active participation in platforms such as. EFFRA, ISTMA, EMVA, CEEPUS, MATERA-ERANET – Bonaco, MATERA- ERA-NET- Multifuncoat, Photonics 21, PPP platformo euRobotics

Health - Manufacturing of pharmaceutical raw materials and preparations
The area of Manufacturing of pharmaceutical raw materials and preparations is one of most competitive, both in terms of revealed export and technological comparative advantages (see Burger and Kotnik 2014). This economic activity consumes 25% of total gross expenditure for research and development. At the same time the it ranks on the top considering advanced cooperation between public research organizations and the economy.
Slovenia, in addition to pharmaceutics shows comparative advantages also in the area of medical instruments and equipment. This area is dominated by small and medium-sized enterprises, which are also very active in international cooperation. In the period 2009-2012 growth of value added per employee remained at 13.6% and the growth in exports also remained at 25.8% (Burger and Kotnik 2014). Another area showing promising comparative advantages and being identified as a highly dynamic area is natural medicines and cosmetics. This is especially evident in increased value added per employee and increased export.

The research system
University of Ljubljana, Faculty of Medicine, University of Ljubljana - Faculty of Electrical Engineering, Oncology Institute, University Medical Center—Ljubljana IJS, University Rehabilitation Institute, Republic of Slovenia – Soča, Center of Excellence for Biosensors, Instrumentation and Process Control (CO BIK), NMR Center of Excellence for research in biotechnology, physics substances (CO EN-FIST), Lek Development Center - one of the key global development centers in Sandoz, LAHA Academy - Laser and Health Academy, Competence Center Biomedical Engineering (BME KC), IJS - Institut “Jožef Stefan”, University of Ljubljana - Faculty of Pharmacy, Center of excellence for translational medicine

In the consortium of Biomedical Technology more than 120 researchers developed 17 new products, 15 patents and 50 innovation.

The strategic development innovation partnership targets the following value chains; ICT in support of remote assistance, monitoring and ehealth sectors, big data analytics, nano medicine, alternative medicine (holistic approaches, stem cell sector).

The priority themes of technological development and research include:
Manufacture of basic pharmaceutical products and pharmaceutical preparations, biomedical devices and techniques, production of medical instruments and devices in the segment of optical, measuring, medical and surgical instruments and apparatus, sensors and sensor systems. New methods of biopharmaceuticals, methods of cancer treatment and the use of translation systems and scanners using new imaging techniques in nuclear medicine. In application of lasers in medicine, the development of new laser sources and the development of minimally invasive medical devices.

In this area are distinctly strong international stakeholders linked through a range of organizations and platforms among which mention only a few: EATRIS,ERIC, EFPIA (European Federation of Pharmaceutical Industries and Associations, International Probiotics Association, IPA, AACR American Association for Cancer Research, The European ESTRO Society for Therapeutic Radiology and Oncology, European Technology Platform for Advanced Engineering Materials and Technologies - EuMaT, EUFEPS European Federation for Pharmaceutical Sciences, ECHA Alliance.

Mobility
Another key area of Slovenian economy is Mobility. It creates around 10% of GDP with the supply chain included. Automotive industry is directly intertwined with the metal processing industry, electrical engineering industry, tool industry and mechanical-engineering industry, which is shown by numerous cooperation activities between the economy, public research and educational sectors.

To enhance the performance of Slovenian automotive supply industry, Slovenia should reach for a higher position in the supply chain, providing direct supply to vehicle manufacturers, or
This project is co-financed by the European Regional Development Fund through the Interreg Alpine Space programme.

develop niche products and technologies (pre-development supplier), duly protected by patents. These solutions will facilitate supplying exclusive products for global car manufacturers despite the lower position in the supply chain. Strategic partnership has already been established in the area of Mobility. It will have to be further strengthened to enhance specialization in niche markets by taking advantage of economies of scale, in particular when it comes to research, development and marketing.

**The research system**

The research system is composed of the following universities and research centres: University of Ljubljana - Faculty of Electrical Engineering, University of Ljubljana - Faculty of Engineering, University of Ljubljana - Faculty of Natural Sciences, Faculty of Industrial Engineering, ACS - Automotive Cluster of Slovenia, TECES - Technology Center for Electrical Machines, Institute of Chemistry, Center of Excellence for Low-Carbon Technologies (LCT) and others.

**The priority themes of technological development and research include:**

The priority themes of technological development include: New concepts of electric motors and electric drives, automotive starters and generators development, drive systems suitable for installation in hybrid-electric and electric vehicles and vessels. R & D activities focused primarily on renewable and alternative energy sources to establish the autonomy of the region and reduce CO2 emissions.

Systems for e-mobility and storing energy, especially new, affordable and more powerful batteries, metal and non-metal materials (polymers, composites), and development of materials for optimization of thermochemical treatment of steel semiproducts for the automotive industry.

Stakeholders in the field of mobility are actively involved in associations at European level and development initiatives. Among them: CLEPA (European Association of Automotive Suppliers), ERTRAC (European Road Transport Research Advisory Council), SmartGrids (European Technology Platform for the Electricity Networks of the Future), Earp (European Automotive Research Partners Association) and EGVI (European Green Vehicles Initiative)

**Development of materials as end products**

In the area of “Manufacturing of basic metals” and “Manufacturing of fabricated metal products, except machinery and equipment” Slovenia ranks comparable to leading European countries especially in terms of technological intensity (Burger and Kotnik 2014). In the framework of this economic activity Slovenia is involved in many supply chains.

Smart multi-component materials and coatings represent another field where Slovenia has great potential. Slovenian companies have a strong position also in “Manufacturing of paints, varnishes and similar coatings”, “Manufacturing of basic chemicals, fertilizers and nitrogen compounds, plastics and synthetic rubber in primary forms” as well as in “Manufacturing of other textiles”. This areas potential is evident by revealed comparative advantages as well as dynamic growth of value added per employee and exports.

**The research system**

IJS - Institut “Jožef Stefan”, University of Ljubljana - Faculty of Chemistry and Chemical Technology, Institute of Chemistry, University of Ljubljana - Faculty of Natural Sciences, Institut for mathematic, physic and mechatronic, IMT – institute for metals and technologies, Center of Excellence for Polymeric Materials and Technology (CO PoliMaT); Center of Excellence for advanced non-metallic materials with future technologies (CO NAMASTE); Center of Excellence of nanoscience and nanotechnology (CO NIN)
The priority themes of technological development and research include:
Priority themes of technological development and research are development of modern and ecologically acceptable new materials, with great emphasis on the development of nanotechnology, Development and research of made-man fibers, technologies development of shape memory AlCuNi alloys, techniques and technologies on the area of techniques and technologies in the fields of casting, grinding materials, cold and hot transformation and mechanical processing of metals, increasing development of systems for reverse engineering, Coatings and adhesives. Research in this area is focused on the development of smart multicomponent materials, the synthesis of functional polymers for use in paints, coatings and adhesives.

In the field of new material is provided cooperation with the following associations and programs: »Metallurgy Europe - Renaissance programme«, Central and East European Polymer Network (www.ceepn.org) in European Polymer Federation (www.europolyfed.org), CIRFS - European Man-Made Fibres Association.
5 CONCLUSIONS
This deliverable was aimed at providing a comprehensive overview of the FoF manufacturing framework in the Alpine Space regions. A first revision of the literature enabled the definition and identification of the main concepts related to the Factory of the Future. The national initiatives for the implementation of the FoF in the five countries involved in the project has been then analysed in order to highlight peculiarities and commonalities of the different approaches and measures undertaken.
To have a complete overview of ongoing activities in the most important regions, national and regional implementation actions for the FoF have been then collected focussing in particular on clusters founded in the manufacturing domains and on related roadmaps, highlighting enabling technologies considered, strategic priorities and long term visions defined. Many different actions are running and in some cases are still currently under definition, as for example, in Slovenia.
For what concerns the regional level, the Smart Specialization Strategies defined by the different regions have been then analysed in order to compare the existing manufacturing environments and related peculiarities. The specialization areas related to manufacturing and FoF have been selected and illustrated. According to these strategic documents, the priorities and competencies in the Alpin Space regions involved have been depicted identifying the main actors and players of the production and research systems. The description also includes the classification of the priority themes of technological development and the most significant enabling technologies of the areas.
According to this view, this document provides a framework to investigate the FoF scenario in the Alpin Space highlighting visions, priorities, actors and key research issues at each regional level. Moreover it represents the first input to build deliverable D.T.1.3.1 "Manufacturing sector maps at national level" and project output O.T1.2 " Manufacturing sector map at transnational level".