



Erasmus+

CLUSTER SMART

CLUSTER MANAGEMENT ABILITIES, CAPACITIES, SKILLS AND COMPETENCES TOWARDS A SMART INDUSTRY (Cluster 4.0 and Industry 4.0)

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1 Introduction

This study aims to gather all relevant cluster management abilities, knowledge, skills, and competences that enable cluster organisations¹ to become the drivers of innovation, acceleration and collaboration, to foster cross-sectoral, and cross-border technological development (Cluster 4.0) towards a smart economy (in the fourth industrial revolution, Industry 4.0).

The study has been elaborated in the framework of the Cluster4Smart project (ERASMUS+ programme, 2017-2020), which aims to expand the knowledge of clusters' managers of Europe through the development of an innovative training resource tool.

For this project, clusters (SCS, France – leading partner, AMUEBLA, Spain,) ArchEnerg and IKOSZ, Hungary, a university (University of Strasbourg, France), and business stakeholders (European Business and Innovation Center of Burgos, Spain, Gnomon, France) have teamed up (See Annex 1).

Cluster4Smart project will create a novel and innovative training course/tool for current and future cluster managers that helps to improve their employability and to foster the competitiveness of their associated industry sectors. This training tool will have a strong capillarity effect towards hundreds of both SMEs and large companies of different sectors across Europe since it will provide potential learners and users with relevant cluster management skills knowledge and offer the opportunity to acquire other transversal skills and competences. The capillarity effect will be enhanced as the training course will be developed in different languages and will boost the use of online platforms, entrepreneurship, and self-learning, fostering the development of new regional cluster organisations and the creation of new enterprises. The training course will be conceived as an innovative training tool adapted and deployed in an online platform for interactive use that will also contribute to a more strategic and integrated use of ICT and open education resources by education and training.

In this respect, this study is the first intellectual output of Cluster4Smart project. It identifies for the first time the knowledge and expertise gaps to point out and define the skills and competences needed by cluster managers to face and address the challenges that the transformation to industry 4.0 entails. Cluster organisations currently need to give support and advice to their members and partners on how to adapt their industry to be more competitive and updated to what it is called the fourth industrial revolution or smart industries.

The study is one of the key outputs as it surveys the relevant, specialised, and high-quality skills and competences necessary for cluster managers. These include among others communication, entrepreneurship, digitalisation, enhancement of leadership capacities, or innovation and internationalisation management skills. The study will also be the basis for the development of the subsequent intellectual outputs under Cluster4Smart project and will serve as the starting point to define the learning outcomes and develop the Cluster4Smart Joint Curriculum (IO2). The content of the study will be used in other settings, like new projects, universities, associations, or VET centres. Likewise, readers and the broader public will also have access to the study in the public library of the European Cluster Observatory.

¹ A cluster is a concentration on a territory of companies and other related actors, working in the same field. Those companies may have a spontaneous more or less intense collaboration. When these actors decide to intensify their cooperation (because they want to grow faster or to tackle common challenges) a cluster initiative (conscious actions) is being launched and this initiative may lead to the creation of a cluster organisation. Our report is focused on the latter, established cluster organisations.

2 Executive Summary

The fourth industrial revolution (Industry 4.0)'s technological, social and business paradigm changes impact directly on the business environment and the ecosystems where clusters and companies operate. Small and Medium-sized enterprises (SMEs) and start-ups face difficulties to keep up with the pace of the technological development and digitalisation process. Likewise, firms of all sizes face important challenges like for instance substantiating in additional costs and risks that digital security entails. A lack of skills and willingness to adjust to the Digital Single Market prevails and the requirements for skills for the adaptation to Industry 4.0 are enormous. There are new emerging ways of work that demand a supply of specific skills and capabilities for Industry 4.0. In addition, companies participating in Industry 4.0 supply chains also face important challenges in terms of costs, risks and reduced flexibility and strategic independence. The implementation of Industry 4.0 at large scale also faces the challenge of standardisation.

Cluster organisations can strengthen their ecosystems that help firms in the process of transitioning to Industry 4.0. However, these disruptive changes also require that clusters adopt new business models to take on the opportunities of the changes and to mitigate the threats under this new industrial revolution. Such a model should enable them to provide their members with value added cluster services to become drivers of innovation, acceleration, and collaboration. In this regard, as part of the process of shaping clusters' need to be able to foster cross-border and cross-sectoral cooperation together with interregional collaboration and investments towards smart specialisation strategies as part of the process of shaping Industry 4.0. Clusters will induce cross-sectoral (e.g. digitalisation in a specific sector) global value chain development and creation to maintain their key role as integrators in national and regional ecosystems, and as drivers of regional development (Cluster 4.0).

For this purpose, this study aims to establish the gap between the current state of play and the future needs as regards cluster management and staff abilities, capacities, skills and competences. Considering the analytical studies, reports, and survey results in the area of Industry 4.0 skills and cluster management skills, and following the identification of the set of skills required for Industry 4.0, an endorsement survey has been conducted with 150 participants across different European clusters.

As a result, the following top 20 ability, capacity, skills, and competence needs have been identified for a world-class cluster driving towards a smart economy:

Work-related core skills and abilities
<ul style="list-style-type: none"> • Creativity • Complex problem solving skills • Judgement and decision making skills • People management: Motivation • Critical thinking
Leadership
<ul style="list-style-type: none"> • Knowledge on Cluster 4.0 and Industry 4.0 • Skills in strategy development and implementation along the related values chains • Fostering teamwork within the ecosystem and enabling others for collaboration
Internationalisation
<ul style="list-style-type: none"> • Knowledge on global megatrends, internationalisation • Knowledge on financing opportunities • Specific skills on joint collaboration with worldwide industry and research leaders
Entrepreneurship and Innovation
<ul style="list-style-type: none"> • Knowledge on innovation policies and innovation management tools, • Knowledge on funding opportunities and private VC know-how, and

<ul style="list-style-type: none"> • Skills to be able to identify opportunities for business development projects along the value chain gaps within and across clusters and targeting industrial modernisation, cross-sectoral, and cross-border value chain development or development of emerging industries.
<p>Management</p> <ul style="list-style-type: none"> • Knowledge on value chain management and cluster development and fostering value chain management skills and value chain analysis and the definition of the cluster role through for instance working groups and/or the involvement of cluster members, • Skills on steering team meetings, mediation and related soft skills.
<p>Digital skills</p> <ul style="list-style-type: none"> • Skills in new technologies (i.e. IoT, big data, Fin Tech), • Developer and manager skills to spot the wider business opportunity, • Skills to tailor AI applications to enhance companies and optimise business processes.
<p>Language capacities</p> <ul style="list-style-type: none"> • Proficient knowledge of English for daily work, meetings and related interactions

This list was established based on the own endorsement survey.

3 Current trends

Trends such as Industry 4.0, global mega trends, global value chain developments, internationalisation, and Cluster 4.0 shape global, national and regional economies and influence clusters' ecosystems.

3.1 Industry 4.0²

Industry 4.0 describes the organisation of production processes based on technology and devices autonomously communicating with each other along the value chain, namely, a model of the smart factory of the future where computer-driven systems monitor physical processes, create a virtual copy of the physical world, and make decentralised decisions based on self-organisation mechanisms. The concept takes into account the increased digitalisation of manufacturing industries where physical objects are seamlessly integrated into the information network, allowing for decentralised production and real-time adaptation in the future. Related terms and concepts used internationally include Internet of Things, Internet of Services, Industrial Internet, Advanced Manufacturing and Smart Factory.

The main features of Industry 4.0 are:

- *Interoperability*: cyber-physical systems like work-piece carriers, assembly stations and products allow humans and smart factories to connect and communicate with each other.
- *Virtualisation*: a virtual copy of the Smart Factory is created by linking sensor data with virtual plant models and simulation models.
- *Decentralisation*: ability of cyber-physical systems to make decisions of their own and to produce locally thanks to technologies such as 3d printing.
- *Real-Time Capability*: the capability to collect and analyse data and provide the derived insights immediately.
- *Service Orientation*³
- *Modularity*: flexible adaptation of smart factories to changing requirements by replacing or expanding individual modules.

Industry 4.0 is not the only term that describes these new phenomena in industrial production. In this regard, both the Internet of Things (IoT) and the Internet of Services describe the digital integration of production and services, and specifically Industry 4.0 is the application of the IoT in a manufacturing and service environment.

- **The Internet of Things**: it refers to IT systems connected to all sub-systems, processes, internal and external objects, supplier and customer networks, that communicate and cooperate both with each other and with humans.
- **The Internet of Services**: it refers to internal and cross-organizational services, which are offered and utilised by participants in the value chain and driven by big data and cloud computing.
- **The Industrial Internet**: it refers to the situation in which the industrial and the internet revolutions both come together, going beyond manufacturing to cover the wider adoption of the web into other forms of economic activity.
- **Advanced manufacturing**: it refers to innovations in technology improving products or processes.
- **Cyber-physical systems**: they are distributed smart systems - microsystems or MEMS (Micro Electro Mechanical Systems), which are made up of software embedded in hardware such

² European Parliament, Directorate-General for Internal Policies, Policy Department A: Economic and Scientific Policy, Industry, Research and Energy (ITRE), Industry 4.0 Analytical Study, February 2016

³ It is noted that Industry 4.0 is not only a technological matter. Industrial products are transformed into product-services, which have an impact on commercialisation and business models and by retro-action have an impact on processes.

as sensors, processors, and communication technologies and can autonomously exchange information, trigger actions and control each other independently. Thus, CPS relates to the Internet of Things (IoT) paradigm. They are capable of performing processes in perception, cognition, and action, which are expected to become increasingly closer to human performance. The intelligent capacities of CPS usually emerge from a more or less flexible cooperation of distributed systems. In this regard, CPS also relate to the concepts of Pervasive Computing and Ambient Intelligence.

- **Smart factory:** This and the related term 'factory of the future' both exemplify some of the technical innovations under Industry 4.0, such as integration of ICT in the production process.

The manufacturing transformation is characterised by:

- Horizontal integration through networks;
- End-to-end digital integration of engineering across the entire value chain; and
- Vertical integration and networked manufacturing systems.

In overall, the fourth industrial revolution is characterised by the **employment of Cyber-Physical Systems in industrial production** as shown in Figure 1 below⁴.

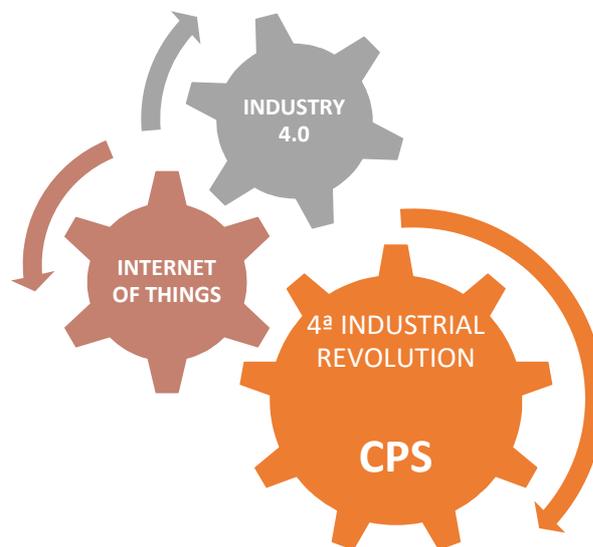


Figure 1: Interdependence of cyber-physical systems in industrial production

Beyond CPS and for a successful implementation of Industry 4.0, it is necessary to consider aspects of **Human-Machine-Interaction** or even **Human-Machine-Cooperation** as new forms of industrial organisation and socio-economic phenomena.

The IoT (Internet of Things) is a very broad concept. Several studies and reports exist on the topic and all converge in saying that it is a revolution, both in terms of innovation use cases, improvement of standards of living, and growth in various sectors like healthcare, automotive, transports. However, all agree to say that **it is in the industry that the IoT will have the most impact**.

Indeed, as stated by an official European Commission communication on the Internet of Things⁵, Smart Manufacturing is projected to be the "number one" IoT use case in Europe in the

⁴ „Skills Needs Analysis for Industry 4.0 Based on Roadmaps for Smart Systems", Institute for Innovation and Technology of Berlin (Ernst A. Hartmann, Marc Bovenschulte), 2013

⁵ Advancing the Internet of Things in Europe, COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, 2016

logistic chain and production line. The proliferation of machine-to-machine devices enhances the functionalities of smart products and smart services and leads to global plant floors and autonomous factories. In the future, all forms of advanced industry will have to become more intelligent to compete effectively. This intelligence may rely on advances through IoT and advanced connected objects that provide sensing, measurement, control, power management and communication. IoT will enable new levels of factory automation for greater efficiency, higher flexibility, agility and lower operational costs.

3.2 Definition of the IoT⁶

SCS cluster defines the IoT as the whole value chain from connected objects to data, and from end point devices, to application and services, as described in Figure 2 below.

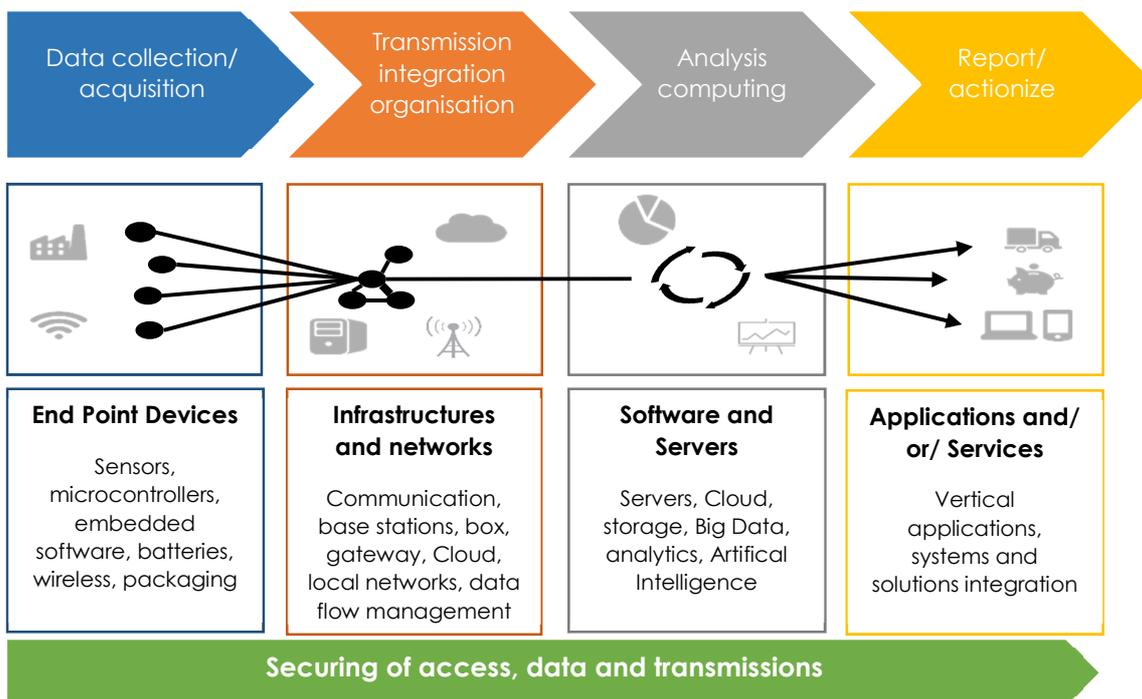


Figure 2: Process model of the Internet of Things

These technologies, combined and integrated in systems, machines, robots and industrial processes allow the modernization of the production capacity of manufacturing companies:

- Smaller, more resistant and more accurate sensors and actuators (MEMs, temperature, pressure, light, cameras...);
- Improved batteries and new energy harvesting solutions;
- Dedicated integrated circuits, increasingly smaller and optimizing energy consumption to fit industrial environments;
- Contactless and wireless systems, gateways, 5G and low power networks enabling the communication between objects;
- Embedded systems and software constituting end-point smart devices for Industry 4.0 uses;
- Software engineering, dedicated applications to specific industrial needs;
- Virtual Reality and advanced Human Machine Interface enabling worker's efficiency in its relationship with machine;
- Cloud infrastructure making industrial data available from anywhere and allowing remote and synchronized site management;

⁶ By SCS Cluster

- Big Data analytics to better understand industrial trends and to take smarter decisions, especially for Predictive Maintenance, while Deep Learning and Artificial Intelligence will bring a step further in automatizing decision taking;
- Security in smart manufacturing to reduce the risk of potential damage through an attack that would have considerable financial impact and put in danger human workforce. Security features must be everywhere, from the end point device (hardware security), through the communication (cryptography) to the cloud (secured cloud and trusted platforms)

3.3 The IoT in the industry

Many think tanks in the individual EU countries and at the European level like the EFFRA (European Factories of the Future Association) are converging about the vision of the Smart Factory of the Future, its benefits and challenges. These factories will be designed to optimize competitiveness together with sustainable and service-oriented business. Independently from the type of manufactured products and used process technology, the factories will be more and more aiming at increased flexibility (customers demand), adaptability and self-adaptability, fault tolerance, real time control for risk management, lean integration in a network of suppliers and customers, and last but not least adaptation and empowerment of their human work forces.

The merging of virtual (data and simulations) and physical worlds are enablers for these needs. The IoT, sometimes named Connected Cyber Physical Systems in certain countries, are key technologies to make this evolution possible.

Some companies like Siemens or SAP are foreseeing architectures of new value chains for companies connected in their business environment. On the other hand, other major industrial companies like Bosch and production lines automation companies like Trumpf or Festo have experimented with practical applications linked to "simple" identified needs in their own factories (representatives of these companies may be invited to the project Advisory Board or Expert Panel, they have also already indicated their intent of support, see Annexes). Learning by doing and sharing best practices is the right path towards these Smart Factories.

Some examples of these practical needs and applications:

- « Auto adaptive » production lines that will automatically:
- manage frequent product changes or even individual products in small production lots
- monitor and compensate quality of produced pieces versus specifications;
- Maintenance and downtime reduction thanks to dedicated sensors or monitored critical parts (mechatronics products or sub-systems);
- Monitoring of turning parts or more generally moving parts for predictive maintenance;
- Monitoring inside companies of machine "grids":
- to detect potential process deteriorations
- to optimize energy consumption
- Modular units within a production line ("Plug and Produce") to enable fast reconfigurations;
- Accelerated processes and reduced material consumption by optimization of key process parameters;
- "The right data at the right time and the right place" with zero paper factories and intuitive interfaces to facilitate human intervention within the factory;
- Sub-assembly and assembly of finished products with guided intuitive assembly cells;
- Automation for conveying technology (mobile robots) where human added value is less relevant;
- Improvement of ergonomics in particular to reduce potential injuries and more globally to increase human wellbeing and efficiency inside factories;

- Collaborative Robotics to facilitate Human/Robot interactions starting from the human side in order to optimize added value of workers;
- Smart logistics especially in the context of extended factories;
- Extension of products sales business to associated services and functional economy thanks data collection and treatment along the whole product lifecycle;
- Energy optimization of the production process;
- Environmental emissions reduction (in air, water, soil) of dangerous elements both for human health and eco-system;
- Global integration in a circular & functional economy;
- Workforce competences and adaptation to new technologies and functions

All these examples can be summarized in a **concept of cost and resources efficient, flexible and reconfigurable, human friendly factory**, as illustrated in the following figure.

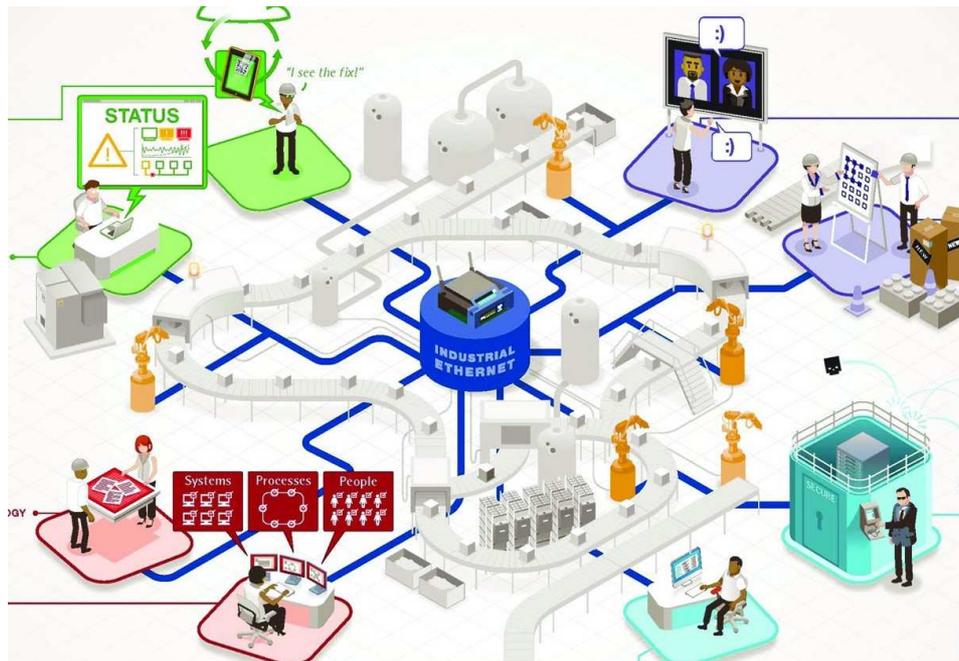


Figure 3: The Smart Factory (source: <http://www.localgridtech.com/>)

3.4 Industry 4.0 – SWOT Analysis:

Strengths	Weaknesses
<ul style="list-style-type: none"> Increased productivity, (resource) efficiency, (global) competitiveness, revenue Growth in high-skilled and well-paid jobs Improved customer satisfaction – new markets: increased product customisation and product variety Production flexibility and control 	<ul style="list-style-type: none"> High dependence on resilience of technology and networks: small disruptions can have major impacts Dependence on a range of success factors including standards, coherent framework, labour supply with appropriate skills, investment and R&D Costs of development and implementation Potential loss of control over enterprise Semi-skilled unemployment Need to import skilled labour and integrate immigrant communities
Opportunities	Threats
<ul style="list-style-type: none"> Strengthen Europe’s position as a global leader in manufacturing (and other industries) Develop new lead markets for products and services Counteracting negative EU demographics Lower entry barriers for some SMEs to participate in new markets, links to new supply chains 	<ul style="list-style-type: none"> Cybersecurity, intellectual property, data privacy Workers, SMEs, industries, and national economies lacking the awareness and/or means to adapt to Industry 4.0 and who will consequently fall behind Vulnerability to and volatility of global value chains Adoption of Industry 4.0 by foreign competitors neutralising EU initiatives

Figure 4: SWOT of Industry 4.0 (source: European Parliament, Directorate-General for Internal Policies, Policy Department A: Economic and Scientific Policy, Industry, Research and Energy (ITRE), Industry 4.0 Analytical Study, February 2016)

Consequently, Industry 4.0 will only succeed should certain key requirements are met, and related challenges are addressed, such as:

- standardisation of systems, platforms, and protocols;
- changes in work organisation reflecting new business models;
- digital security and protection of know-how;
- availability of appropriately skilled workers;
- research and investment needs;
- and, a common EU legal framework to support the dissemination of Industry 4.0 in the Internal Market.

Regarding the challenge of availability of skilled workers that can design and operate Industry 4.0 establishments, the main questions that arise are as follows: 1) Who will invest in reskilling and retraining the current workforce? 2) What are the implications in terms of employment/employability for those lacking the skills?

One emerging topic seems to be that of continued life-long learning, which becomes particularly relevant in the context of Industry 4.0, where highly sophisticated technological systems require very specific skills.

In relation to Industry 4.0, there are **three relevant dimensions of change**:

- technological change,
- social change,
- and, change in the business paradigm.

In the field of **social change, the level of awareness on Industry 4.0 outside the group of key stakeholders is low**. Larger firms tend to be more positively willing whereas trade unions remain cautious and have reservations. There are skills gaps and stakeholders are reluctant to adjust to the Digital Single Market, with estimations indicating that by 2020, Europe could lack some 825,000 digital specialists to complete the DSM). Besides, the skills requirements for a smooth adjustment to Industry 4.0 are much higher. In this regard, new ways of work are needed, which

could have positive and negative impacts on employees. The gap in domestic and EU supplies of skills is currently being addressed through sophisticated immigration strategies. The supply of skills and capabilities in Industry 4.0 across the EU is uneven, which is likely to lead to increased concentration and competition between existing centres.

3.5 Global Mega Trends⁷

Global mega trends can be understood as a sustainable force on a global and macro-economic level, influencing the developments of business, economy, society, cultures, and personal lives, on both local and global levels. Therefore, the mega trends have to be considered as a framework in which economies are obliged to function, and as a direct influence on the clusters driven ecosystems. According to the Cluster Internationalisation and Global Mega Trends report of the European Cluster Observatory, the following global mega trends are shaping the world economies:

Cross-linkage of subjects and objects (Internet of Things, etc.)

The use of computers and Internet linkages to manage an increasing spectrum of societal functions, including critical infrastructure, entails a broad range of social, economic, commercial, legal, and security implications. The convergence of markets and innovation and enabling technologies has driven the rise of the cross-linkage of subjects and objects. The capabilities of products will multiply and offer new forms of value doing things far beyond their primary function. This transformation process is shifting the sources of value and differentiation to software and services and is also creating entirely new business models.

3.5.1 Big data

- Using the torrents of available data, and applying the latest data channelling, transformation and database techniques will facilitate the reshaping of business operations from strategy to business processes and operations.

3.5.2 Impact of social media

Social media should be considered as the sum of tools, services, and communication facilitating the connection of peers with common interests. They include the online technologies and practices that people use to share contents, opinions, insights, experiences, perspectives, and the media themselves. They provide for social interaction and therefore, they facilitate social network. They also influence noticeably the methods, the result of product selection processes, and the marketing.

3.5.3 Personalisation of products and services

This concept regards the ability for a company to grant its customers the opportunity to choose product specifications. It encompasses the use of systems, combining the low unit cost of mass production processes with the flexibility of individual customisation, aiming to be able to offer customized products and services at standard prices. It is triggered by the changes in consumers' behaviour.

3.5.4 Immediate availability of products and services

The pervasive challenge for emerging industries is the fact to be steadily present in a global market environment. The global market is a buyer's market. The immediate availability of

⁷ Cluster Internationalisation and Global Mega Trends, European Cluster Observatory, Helmut Kergel, Thomas Koehler, Gerd Meier zu Köcker, Michael Nerger, 2015

products and services makes efficiency a high priority. This fact distinctly affects the manufacturing processes and the logistical infrastructure (resource efficient production).

3.5.5 Changes of geo-economical dynamics

- The development in emerging markets, representing usually low-cost production with increasingly large consumer market, has slowed down. Noticeably, the pro-convergence drivers in geo-economical dynamics balance out differences between developed countries and emerging markets.

3.5.6 Innovation dynamics

Innovation is a central driver of economic growth and development, but its appearance is changing. Fundamental trends can be observed (cloud, mobile, social) that are reshaping the technology industry. Companies need to embrace the full spectrum of innovation in both their R&D and their business model strategies to promote change and gain advantage over the competition. Likewise, the innovation process itself is also changing. In this regard, the acquisition of required knowledge becomes more and more challenging.

3.5.7 Changes in entrepreneurship culture (crowd funding, etc.)

Entrepreneurship has a crucial role in technology breakthroughs. Alternative funding systems for new ventures, such as crowd funding allows millions of individuals to make decisions about entrepreneurial projects. Increasing mobility of young people and the ability of linking-up of IT competences with other application fields in an interdisciplinary manner offers new sources for entrepreneurial ideas.

3.5.8 Convergence of products, devices, and services

This trend represents a merging of corporate and consumer capabilities within IT devices. The convergence of devices and services demands new business models and allows opportunities for revenue. It allows the users to gain access to the same technology devices for a broad spectrum of different activities, such as corporate data for a better insight, process data, communication data, measurements results, etc.

3.5.9 Consumerisation, proliferation and ubiquity of IT

The access to a user-friendly experience with mobile devices, tablets, or personal computers is crucial in service provision. The IT interfaces benefit from the effects of the economy of scale, driven by the consumer sector. Performance, reliability, functionality are in a brilliant balance and most of the consumer IT goods are well usable for lots of business processes. Applications that are easy to learn and thus improve productivity, and especially easier to use on smartphones and other mobile devices are the new demands in this respect. Accommodating these trends requires commitments to application development tools that address multiple platforms. It also requires commitments to increased security and privacy to ensure data integrity in every case.

3.5.10 Shortening of product lifetime cycles

Replacing a product or a service more rapidly than before is becoming a norm across many industries. Accurate demand planning and forecasting becomes more than ever imperative. A more coordinated approach to value chain management is required across businesses. A key reaction to this trend is the introduction of technologies that enable organizations to quickly and effectively manage operations and gain a greater perspective of the entire value chain. Technologies and business models that enable sophistication of value chain management are crucial (i.e. maximising the speed of market launch of a product, a re-brand, etc.)

3.5.11 Carbon foot-print reduction

Leading businesses, and especially in our industries, need to address changes in the consumer demand for lower carbon footprint and energy efficient services and products. Despite the tough economic climate, this demand is growing. This is also due to environmental regulations, and the green and climate consciousness awakening of the economy and the society.

	Mobility Technologies	Medical Devices	Logistical Services	Digital Industries	Experience Industries	Environmental Industries	Creative Industries	Blue Growth Industries	Biopharmaceuticals	Advanced Packaging
Cross-linkage of subjects & objects			●							
Big data				●						
Impact of social media			●				●			
Personalisation of products & services		●	●							●
Immediate availability of products & services										
Changes of geo-economical dynamics			●							
Innovation dynamics										
Changes in entrepreneurship culture										
Convergence of products, devices and services	●									
Consumerisation, proliferation and ubiquity of IT				●						
Shortening of lifetime cycles										
Carbon foot-print reduction	●					●		●		
● Areas of strong interdependencies										

Figure 5: Mega Trends vs. Emerging Industries – Areas of strong Interdependencies (AOSI's)

Figure 5. Mega Trends vs Emerging Industries (source: Cluster Internationalisation and Global Mega Trends, European Cluster Observatory, Helmut Kergel, Thomas Koehler, Gerd Meier zu Köcker, Michael Nerger, 2015)

The arising streams of the fourth industrial revolution induce most of the global mega trends that also empower further innovations in digitalisation and industrial modernisation. The global mega trends also affect the various industries and sectors differently with **external or downstream effects**. As a response to their own development with internal or upstream effects, the industries can also conversely influence the trends (**internal or upstream effect**). There is no doubt that almost all mega trends impact all emerging industries⁸ to some extent with diverse levels of significant impact depending on the area. The figure above represents the fields with **the strongest reactions** in both downstream and upstream directions, and in some exceptional cases, it also represents influences in one direction with an extreme effect. There is no doubt that these downstream and upstream effects have a serious impact on the global value chain

⁸ European Cluster Observatory (2014) has identified emerging industries as cross-sectoral thematically defined groups of industries in which the growth of dynamic cross-industry linkages is most likely. (Methodology and Findings Report for a Cluster Mapping of Related Sectors, European Cluster Observatory, 2014)

within the emerging industries and will lead to new cooperation models between involved actors. This provides a huge potential for new SMEs in clusters to enter new value chains and industrial niches within the emerging industries. At a cluster strategy set-up, in-depth analysis of these trends and further sub-trends as per the cluster related emerging industries is necessary to better address the cluster's role and therefore generate value added cluster services along the related value chains.

3.6 Value Chain Developments

Value chains define the flow of goods and services from basic raw materials to finished products and solutions for end users. They are key elements of every economy and are responsible for their functioning and their performance. They are a key element for the competitiveness, resilience and flexibility of a company, a branch (i.e. economic and/or industrial sector), or a national economy. Changes and transformation processes inside an industry are reflected in the value chains. Value chains are themselves rapidly evolving partly due to the income and wage convergence within the value chain, and to a certain extent to external influences (i.e. mega trends).

To successfully transform the value chain capabilities of companies and to accommodate a transition towards a sustainable business concept driven by societal and/or technology requirements, the parameters listed here-below need to be considered. These parameters reflect the substantial changes in the value chains triggered by mega trends:

- **Customer service orientation** relates to methods addressing new requirements for simple individualisation up to mass customisation. For instance, companies need to switch from the traditional 'one size fits all approach' to the 'different customers have different requirements' concept.
- The **change in business relationships** parameter is based on the recognition that the value chain is only as strong as its weakest link. The achievements in the value chain depend on the development of a stronger relationship between customers and suppliers, both internally and externally. Such relationships need to be based on trust and transparency leading to strengths sparing sustainability.
- **Agile implementation strategies**, which mean the ability to quickly adjust tactics and operations within the SMEs and large companies' value chain to respond to changes, opportunities or threats to their business environment.
- **Business process orientation**, which describes the ability of companies to overcome traditional functional orientation driven by the need for administrative efficiency. A business approach focused on the creation of customer value will be driven by business processes that cut across functional and companies' boundaries.
- **Sustainable competitive advantage orientation**, which means shifting focus from short-term profit to long-term sustainable business approach by identifying the relative value of the given business and defining alternative sustainable value chain model. This approach will assist in coping with the effects of sub-trends such as decoupling economic growth from environmental pollution, renewable energy, and sustainable development.
- **Information sharing**, which involves companies sharing real-time information along the value chain for efficient and effective management of material and financial flows, the use of technology, and for collaborative relationships and virtual integration. This is particularly important as regards the effects of big data sub-trend.
- **Knowledge-based learning orientation** to provide companies with capacity for interfirm competency development. High-level knowledge is a key element for successful further development of value chains in the increasing complexity of value chains and business environment. This will be especially important as regards managing the remediation and recycling economy sub-trend effects.
- The **virtual integration concept** relates to the companies' decision on make or buy. The outsourcing of processes to a third-party service provider requires a well-defined strategy to

optimise the leverage effect the third party will provide. Despite a set of benefits of the vertically integrated business model, the outsourcing trend continues to advance. The reasons relate to, amongst others, the lack of an available and dedicated know-how and workforce.

Among the value chain transformation, we can find some characteristics, such as:

- Vertical disintegration (i.e. subcontracting part of the value chain),
- Increasing complexity of products and services,
- Resilience in an environment of strongest competition,
- Increasing influence of costumers, and
- Internationalisation,
- which is the most important common characteristic since it will affect all the elements of the value chain ecosystem.

3.7 Cluster Internationalisation

Internationalisation relates to the expansion of operations within a global environment. It goes with increasing awareness regarding the direct and indirect influences of international activities and the planning and implementation of various cross-border transactions. In the course of this alignment, internationalisation becomes a process of adapting the companies' operations (i.e. strategy, structuring, resourcing, etc.) to an international environment.

In the past, internationalisation was thought to be the promotion of export and publicly financed R&D projects with foreign partners. Its interpretation today includes the following features but not exclusively:

- Promoting R&D&I and business collaboration for globally competitive value chain development,
- Joint publicly and privately funded R&D&I and business development projects,
- Trade promotion,
- Technology transfer, promotion of innovative investment with the establishment of new value chains,
- Information and knowledge sharing in a strategic and coordinated manner.

Clusters act as **real springboards for companies**, especially small and medium enterprises (SMEs) to help them increasing their competitiveness and thus supporting them in getting access to global value chains and new markets. Cluster participants can benefit from specialised business support services of cluster organisations stimulating and organizing these actions. In particular, if firms have to increasingly integrate their activities into global value chains in order to become and remain competitive, being part of a cluster is supportive.

Clusters in the emerging industries face the needs for internationalisation. Transformation processes within value chains urge clusters to think global and internationalise accordingly. Moreover, the prevailing reason for considering an international scope is to keep their lead in technological development, identify upcoming market needs, properly reacting to transformation processes and to strengthen their own position on markets worldwide. Consequently, cluster managers are more and more taking over the responsibility to initiate internationalisation of their cluster members.⁹ The cluster participants and mainly SMEs often lack time, resources, know-how, information or budgets to successfully realise internationalisation processes. There are many other reasons why SMEs are reluctant to go international.¹⁰ Clusters usually have more resources at their disposal and are more

⁹ Meier zu Köcker, Buhl: Internationalisation of Networks – Barriers and Enablers, Study on behalf of the BMWi, Berlin, 2007

¹⁰ Zombori, input papre „International Cluster Cooperation for SMEs: Towards an European Approach, EC, 2012

experienced in internationalisation matters.¹¹ A common understanding within clusters, a sophisticated internationalisation strategy and a consequent implementation of related actions are the prevailing key success factors for internationalisation of clusters.¹² However, this requires specific cluster manager internationalisation skills for building long-term transnational and cross-sectoral cluster partnerships.¹³

The main tools to apply for **internationalisation actions**:

- Exchange of information, networking,
- Carrying out business missions, representation at and organisation of business matchmaking events, business fairs and conferences,
- Creation of knowledge data base, joint on-line platform of collaboration,
- Establishment of representations in the target regions.

A formal cluster **internationalisation process** should include the following steps, but not exclusively:

1. Elaboration of a comprehensive internationalisation strategy based on analysis of resources and capacities,
2. Conducting market analysis, establishing target countries and stakeholders considering global mega trends and value chain developments,
3. Establishment/reinforcement of network of strategic partners in target regions through business missions, leading to collaboration agreements,
4. Developing internationalisation related cluster services and assisting it with online, digital tools (i.e. collaboration platform),
5. Establishment of representations in target regions,
6. Organisation and participation in business networking events, conferences, fairs,
7. Preparation and mobilisation of member SMEs/large companies for internationalisation process,
8. Conducting results driven Cluster to Cluster (C2C) and Business to Business (B2B for members) meetings,
9. Generation of joint projects (SME joint internationalisation projects, joint cluster/partnership R&D&I projects),
10. Joining European and/or international cluster and business association partnerships and alliances.

Cluster services and specific tailor-made services provided by clusters to their members are important tools for clusters, especially in the field of internationalisation. Clusters play a decisive role for the development of new industrial value chains and emerging industries, notably through the creation of a favourable environment. An appropriate strategy, mandate to internationalise and appropriate service spectrum, adapted to the transformation trends and needs of the cluster participants are the key to succeed.

3.8 Cluster 4.0¹⁴

Cluster 4.0 covers cluster organisations and cluster policies that support digitalisation, industrial modernisation along the fourth industrial revolution. The European Commission's Directorate

¹¹ Greenhalgh, Cluster internationalisation tactics projects – handbook for cluster internationalisation, European Cluster Alliance, on behalf of EC, DG Enterprise and Industry, 2012

¹² Meier zu Köcker, Müller, Zombori, Key Success Factors for the Internationalisation of Clusters, Journal of Competitiveness, January 2012, Volume 2, Issue 1, 72ff

¹³ Pattinson, et. al., Research Paper on Cluster Manager Internationalisation Skills and Key for Success in Managing and Promoting pan-European Strategic Partnerships, INNO-AG, 2014

¹⁴ Newsletter Issue No 4, European Cluster Observatory, February 2017

General for the Internal Market, Industry, Entrepreneurship and SMEs organised a European cluster conference on 'Cluster 4.0: Shaping smart industries' in December 2016. The conference examined how to effectively use clusters to capitalise on new technologies and service offerings that drive the digitalisation and industrial transformation trends, where everything is becoming interlinked and smart.

Clusters 4.0 calls for the development of a generation of advanced cluster policies that respond to these new industrial challenges through:

- facilitating cross-sectoral value chains,
- fostering internationalisation,
- boosting interregional investments,
- accelerating entrepreneurship,
- skills upgrading.

Key outcomes, conclusions, and messages of this conference were as follows:

- Clusters can assist in the implementation of industrial modernisation in regions.
- Clusters provide for favourable ecosystems to turn more start-ups into scale-ups and they drive innovation, acceleration and collaboration in the regional ecosystems to strengthen economic growth in the EU.
- Clusters play a key role as integrators in national and regional ecosystems and as drivers of regional development. Moreover, clusters should facilitate cross-border and cross-sectoral cooperation as part of shaping the industry 4.0. This requires maintaining agile and focused national cluster policy frameworks.
- Cluster managers and other cluster stakeholders considered that facilitating cross-sectoral value chains and the development of emerging industries; and promoting industrial modernisation by fostering the innovation uptake of advanced manufacturing, service innovation and resource efficient solutions, are the actions cluster can provide for accelerating industrial modernisation.
- Lack of resources is seen as the biggest challenge for clusters. Cluster organisations are concerned about ensuring their financial sustainability. Clusters in Eastern Europe have significantly less resources.
- Cluster excellence is still high on the agenda. Sharing good practices on cluster management, teaming up along smart specialisation priorities, and coaching on similar cluster development issues are required by cluster organisations.
- Clusters have a key role in enhancing and supporting entrepreneurship.

The following are some European actions supporting this policy and also considered in this study:

- European Cluster Excellence Initiative and policy
- European Strategic Cluster Partnerships
- Clusters Go International
- Initiatives to boost smart specialisation investments
- European Cluster Collaboration Platform
- Smart Specialisation Platform on Industrial Modernisation
- Enterprise Europe Network

4 Methodology

The purpose of this study is to provide a complete analysis of the current skills and needs to improve the European clusters and their management towards Industry 4.0 and through Cluster 4.0. The study was elaborated through a two-stage methodology, consisting of a desk research and survey followed by an endorsement on the key findings by relevant stakeholders.

4.1 Desk research

The desk research was carried out to know the existing gap on how to improve clusters and managers' capacity and skills to provide better services to partners in a smart economy (Industry 4.0 and Cluster 4.0).

To understand the context of the formulation of new ability, capacity, skills and competence need set of cluster managers/cluster staff, we carefully studied the ongoing and forthcoming trends related to clusterisation and cluster development. In this respect, terms, such as Industry 4.0, global mega trends, value chain development, cluster internationalization and Cluster 4.0 were considered as relevant forces influencing cluster policy, cluster strategy, and service development.

The basis of the desk research was to consider the general skills and competences needed by cluster managers. For this purpose, we carried out a search in the European Classification of Skills and Competences (ESCO) database as regards general skills required by the job types of a cluster manager (i.e. membership manager, special interest-group official). In addition, we also analysed the results of the Cluster Manager Qualification - CMQ survey, which was the first report that targeted cluster tasks, skills and training needs prepared within the PRO-INNO EUROPE initiative in April 2009. To learn about specific Industry 4.0 related skills and competences, we reviewed and considered the report 'The Future of Jobs, Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution' of the World Economic Forum of January 2016, and the 'Skills Needs Analysis for Industry 4.0 Based on Roadmaps for Smart Systems', a study completed by the Institute for Innovation and Technology of Berlin in 2016.

4.2 Endorsement survey

As a result of this desk research the cluster managers' ability, capacity, skills and competence needs set towards Industry 4.0 and Cluster 4.0 were established and detected. The endorsement of the researched needs was undertaken through a planned survey conducted with 150 participants from clusters and related stakeholders, including universities, regional administration and development agencies, research and innovation entities, VETs etc. In this respect, two questionnaires were developed, one for cluster manager/staff and another one for cluster stakeholders. The questionnaire was prepared in online format available in English to target international stakeholders, and was announced on the European Cluster Collaboration Platform. The survey was conducted between 20 November and 15 December 2017. The outturn of the respondents was as follows:

In total 146 replies were received: 97 from clusters and 49 from cluster stakeholder organisations.

As regards the 97 replies provided by cluster managers/staff, the following specification of respondents was observed:

4.2.1 Definition of respondents' role in the cluster

55,2 % of the respondents were cluster managers. The remainder is taking up various posts in the clusters, mainly managerial posts (see the chart below).

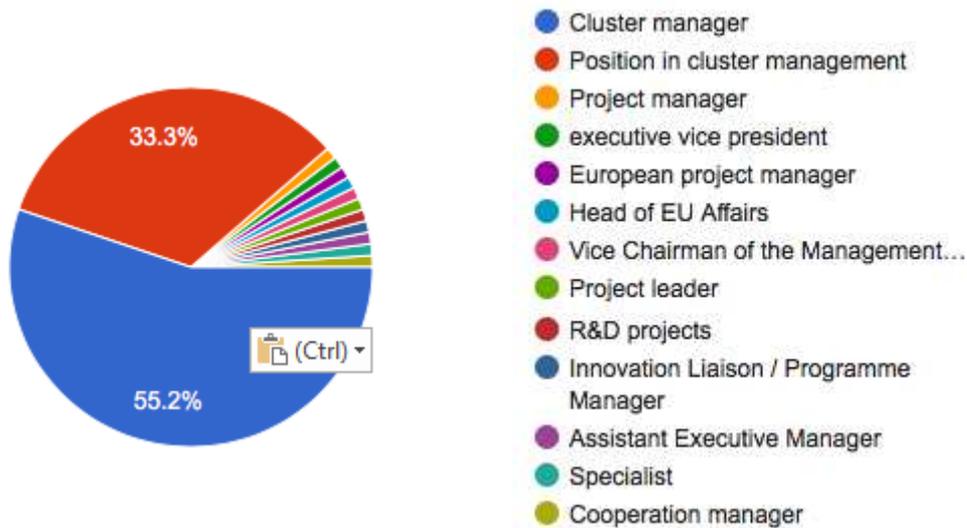


Chart 1: Respondents' position in the cluster

4.2.2 Number of years in the position

45 % of the respondents spent 5 years or more in the cluster whereas a scarce 10 % of them spent only 1 year. The rest acquires an experience of 1-4 years at clusters.

4.2.3 Year of establishment of the cluster

83 % of the respondent clusters were established in 2013 and before, with one founded in 1983. Thus, relatively small proportion of the respondents were from newly or recently established clusters.

4.2.4 Countries represented

As regards the geographical allocation of the replies, Spain (18,3 %) and France (10,8 %) provided the majority of the replies, followed by Romania (15,1 %), Germany (11,8 %), Italy (6,5 %) and Hungary (5,4 %).

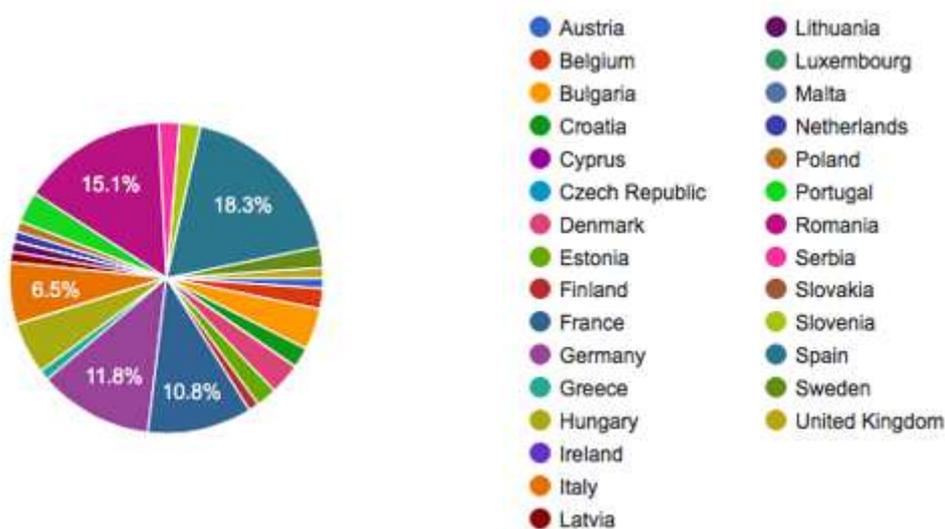


Chart 2: Countries represented by the clusters

4.2.5 Sectors represented by the clusters

In respect of the S3 EU - smart specialisation priorities - the following sectors are represented by the observed clusters:

- Manufacturing & Industry (20 %)
- ICT (14,5 %)
- Sustainable innovation (7,5 %)
- Digital Agenda (6,5 %)
- Energy production and distribution (6,5)
- KETS (6,2 %)
- Service innovation (4,8 %)

4.2.6 Cluster Management Excellence label - under the European Cluster Excellence Initiative - ESCA

65,6 % of the respondent clusters have Clusters Management Excellence label (17,7 % Gold) and 26 % of them do not acquire such label and are not either under the application and assessment process.

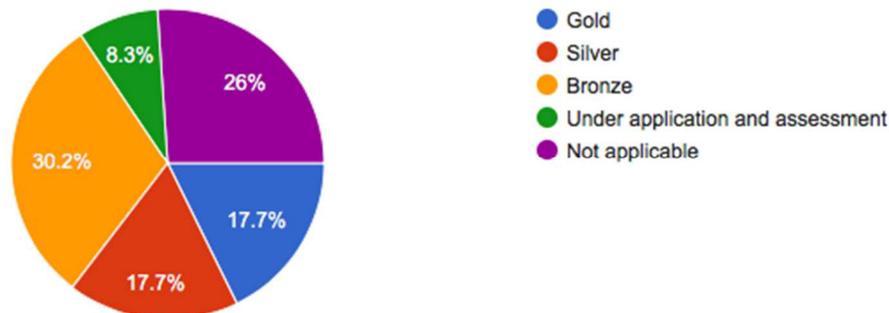


Chart 3: Cluster Management Excellence label

Clusters seem to be active in various national, regional or local cluster certification schemes too, such as e.g. Agrupación Empresarial Innovadora (AEI) in the Register of the Spanish Ministry of Economy, Industry and Competitiveness or Pôle de compétitivité, which is the national label for clusters in France recognised and supported by the French Government etc.

4.2.7 Relevance of Industry 4.0 as regards the interviewed cluster profile

6 % of the clusters replied that they are not related strongly to Industry 4.0 trends.

90 % of them are concerned either by both or one of the following trends:

- Digitalisation including ICT, IoT, CPS
- Vertical markets including, smart factory, energy (smart grids), mobility, health

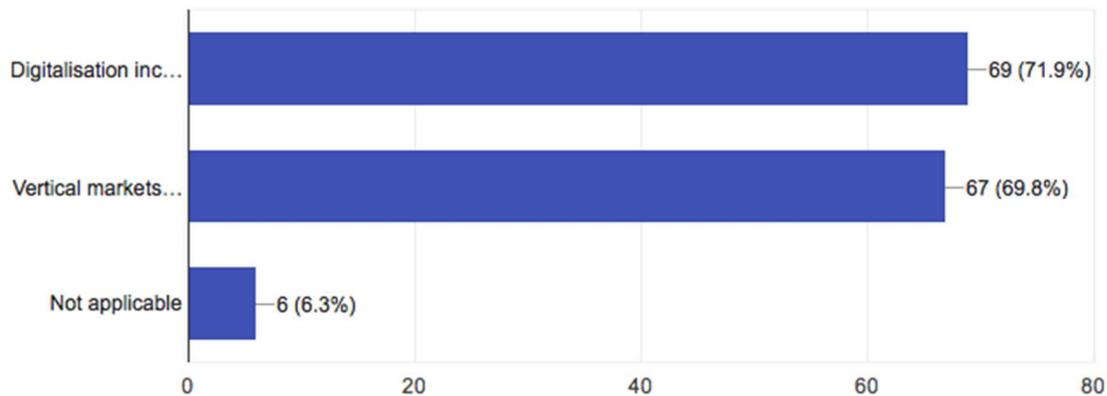


Chart 4: Relevance of Industry 4.0 trends

As regards the replies provided by cluster stakeholder organisations the allocation of respondents was as follows:

4.2.8 Type of cluster stakeholders

Based on the type of organisations indicated, it is assumed that at least around 10 clusters provided reply also under the cluster stakeholder survey.

Innovation and research facilities (27,7 %) and regional development agencies (14,9 %) provided the bulk of the replies, but chambers of commerce, universities and regional or local administrations also contributed meaningfully to the survey.

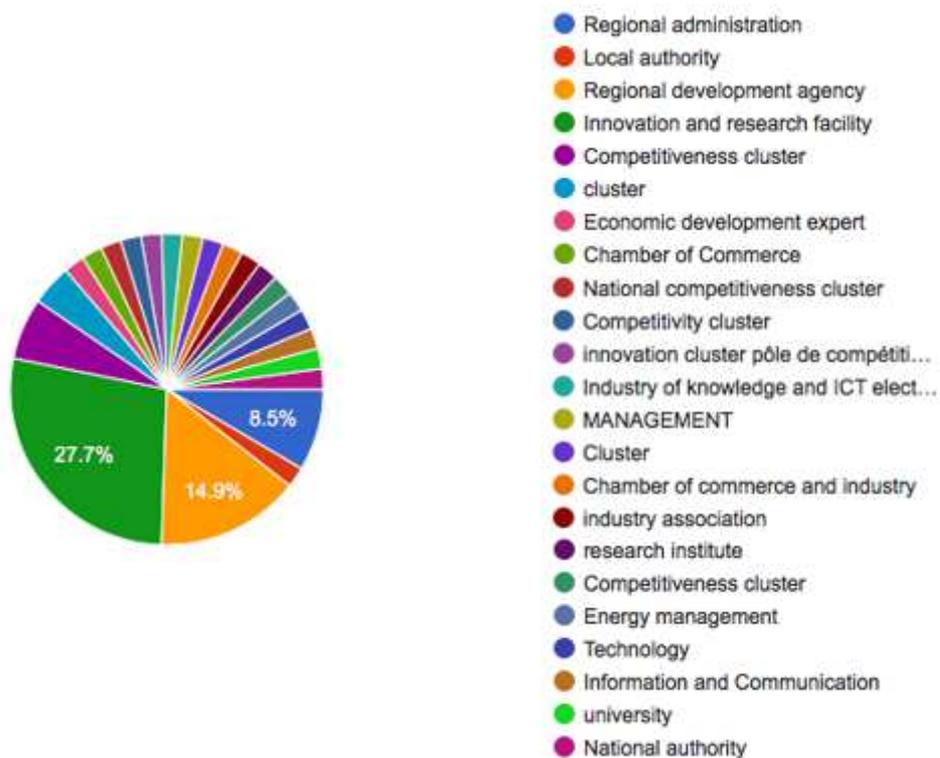


Chart 5: Type of cluster stakeholder

4.2.9 Geographical allocation of replies

As regards the geographical allocation of the replies, Spain (32,6 %) and France (28,3 %) provided the majority of the replies, followed by Hungary and Italy (8,7 % each).

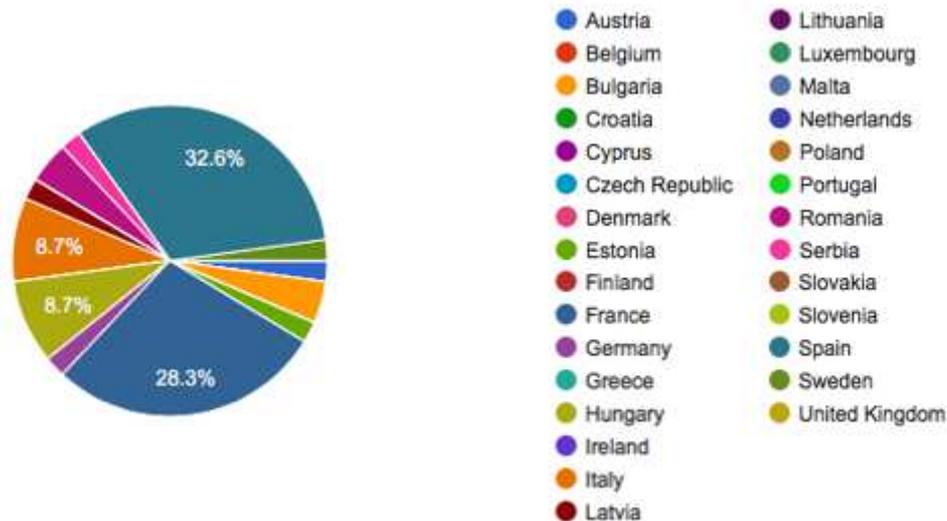


Chart 6: Countries represented

4.2.10 Sectors represented by the clusters considered

In respect of the S3 EU - smart specialisation priorities - the following sectors are represented by the observed clusters:

- Manufacturing & Industry (20,6 %)
- ICT (16,4 %)
- KETS (8,2 %)
- Sustainable innovation (8,2 %)
- Agricultural services (7,2 %)
- Aeronautics and Space (4,1 %)
- Cultural and creative industries (4,1 %)
- Digital Agenda (4,1 %)
- Public health and security (4,1 %)

5 Findings

Our study on skills, competences and abilities needed for cluster managers to successfully manage a cluster towards Industry 4.0 and Cluster 4.0, considers mostly and fundamentally the results of the following research, analyses and surveys:

- ESCO database,
- the 'CMQ – Cluster Manager Qualification', a survey conducted within the PRO-INNO EUROPE initiative in April 2009,
- 'The Future of Jobs, Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution' report of the World Economic Forum of January 2016, and
- 'Skills Needs Analysis for Industry 4.0 Based on Roadmaps for Smart Systems', conducted by Institute for Innovation and Technology of Berlin.

The abilities, capacities, skills and competences required from the management of a world-class cluster driving towards a smart industry were set out (section 5.5), after analysing the results and findings of the above-mentioned surveys (sections 5.1, 5.2, 5.3 and 5.4), taking into account the own endorsement survey (see it in the Annex) and considering the current trends defining the European cluster ecosystems (section 3). Besides, some preliminary observations are drawn as regards the training tool to be designed (section 5.6).

5.1 Research based on ESCO database

ESCO (European Skills/Competences, Qualifications and Occupations) is an online database focused on the classification of skills and competences as regards occupations. The European Commission Directorate General for Employment, Social Affairs and Inclusion and the Directorate General for Education and Culture both developed ESCO in collaboration with other stakeholders and with the European Centre for the Development of Vocational Training (Cedefop).

Cluster specific occupations were not found in the ESCO database. However, the following three occupations could be related to the occupation of a cluster manager.

Membership administrators ensure an effective membership administration, documentation and communication. They support the membership sales process, the current membership enquiries, and the renewal processes.

Membership managers oversee and coordinate the membership plan, support existing members and engage with possible new members. They analyse the market trend reports and develop marketing plans accordingly. Membership managers monitor and ensure the efficiency of processes, systems and strategies.

Special-interest groups' officials represent and act on behalf of special-interest groups such as employer organisations, trade unions, trade and industry associations, sports associations and humanitarian organisations. They develop policies and ensure their implementation. Special-interest groups' officials speak for their members in negotiations about topics such as working conditions and safety.

Related to the essential and optional skills of each of these occupations, the following chart has been elaborated. The skills common to two professions are marked in yellow. Those skills in common to all three professions appear in **seablue**.

	Membership administrators	Membership managers	special-interest groups' official
Essential skills and competences	complete membership administration	analyse membership coordinate membership work create solutions to problems develop membership strategies	advise on legislative acts analyse issues analyse problems for opportunities collaborate in the drafting of policies communicate with media deal with pressure from unexpected circumstances
	develop professional network	develop professional network	develop professional network
	execute administration	follow company standards identify customer's needs liaise with managers	ensure compliance with policies identify policy breach interact with the board of directors keep updated on the political landscape maintain relationships with government agencies manage budgets manage government policy implementation
	manage members	manage membership	manage members
	manage membership database	manage membership database manage staff	
	perform office routine activities	plan health and safety procedures	negotiate health and safety issues with third parties perform public relations present arguments persuasively
	provide membership service	provide information	
	recruit members	provide membership service recruit members	recruit members
		supervise the management of an establishment supervise work	represent special-interest groups' members represent the organisation show diplomacy
		think analytically	speak in public
	use communication techniques	use communication techniques	use communication techniques

	Membership administrators	Membership managers	special-interest groups' official
Optional skills and competences			<ul style="list-style-type: none"> advise legislators advise on consumer rights analyse membership apply diplomatic principles build international relations check payment circulate information
		complete membership administration	
	deal with pressure from unexpected circumstances	deal with pressure from unexpected circumstances	
	develop campaigns		<ul style="list-style-type: none"> defend human rights develop communications strategies develop economic policies develop employment policies develop manufacturing policies develop membership strategies develop trade policies evaluate humanitarian programme proposals
	handle complaints	handle complaints	handle complaints
	handle customer complaints		<ul style="list-style-type: none"> identify hazards in the workplace identify research topics influence legislators interview people liaise with local authorities liaise with sports organisations
	make independent operating decisions	make independent operating decisions	
	meet deadlines		<ul style="list-style-type: none"> manage fundraising activities manage sport competition programmes manage sports events
	process payments		<ul style="list-style-type: none"> prepare presentation material prepare speeches
	show responsibility	show responsibility	<ul style="list-style-type: none"> promote equality in sport activities promote free trade protect employee rights
stimulate creative processes	stimulate creative processes	<ul style="list-style-type: none"> study topics use databases visit places of work 	
write leaflets	write leaflets	write leaflets	
write work-related reports	write work-related reports	write work-related reports	

The following table summarises the list of common skills to the three professions related to the occupation of a cluster manager.

COMMON SKILLS	
Essential skills and competences	develop professional network
	manage members
	manage membership database
	provide membership service
	recruit members
Optional skills and competences	use communication techniques
	deal with pressure from unexpected circumstances
	handle complaints
	make independent operating decisions
	show responsibility
	stimulate creative processes
	write leaflets
write work-related reports	

The above skills and competences substantiate basic competences required in managing and administrating a cluster.

5.2 CMQ - Cluster Manager Qualification survey results (2009)¹⁵

This comprehensive survey at European scale among cluster managers and cluster stakeholders was conducted in the framework of the INNO-Net project CEE-Cluster Network, a network of Central and Eastern European innovation agencies and cluster stakeholders under the umbrella of the Pro INNO Europe initiative established by the European Commission DG Enterprise and Industry¹⁶.

5.2.1 Summary

The survey results have shown that cluster managers across Europe have a multifaceted range of tasks in their job profiles. It focuses very much, however, on working with and serving their cluster members, (i.e. the companies, research facilities and other institutions actually forming the cluster). Consequently, networking-type of job activities are clearly dominating the portfolio of tasks. In this respect, four out of the five top-ranked duties in terms of importance are concerned with establishing or developing contacts, including issues like integrating of and

¹⁵ CMQ – Cluster Manager Qualification, PRO-INNO EUROPE, April 2009
¹⁶ Growth, Internal Market, Industry, Entrepreneurship, and SMEs

fostering exchange between cluster members, lobbying activities with stakeholders, or organising events. Initiating and bringing forward various types of co-operation projects, within and outreaching the cluster, constitutes another major area of responsibilities.

Three most important skills:

- communicative skills
- leadership capacity
- knowledge of the cluster's specific industry/ sector

The cluster managers wish to receive training on '**innovation management tools**', '**knowledge management techniques**', and '**innovation policies**'. Moreover, there is also a significant interest in training on '**international co-operation and networking**' and on '**EU and international subsidies**'. Interestingly, from the perspective of cluster stakeholders, there is a strong need to improve the '**business consultancy know-how**' of cluster managers through further training in this area.

Needs of cluster managers are certainly not uniform across all cluster organisations in Europe. The following factors play an important role:

- The age and stage of development of the cluster (organisation)
- The national policy frameworks
- Location of the cluster

Measures at both the regional or national level might address training needs better, but there is also scope for educational offerings at international and/or cross-border levels.

Issues for international trainings are:

- EU cluster policies
- EU subsidies and support programmes
- Know-how on international co-operation
- Knowing other cluster organisations abroad
- Innovation policies
- Innovation management tools

In the context of any **international training, study visits** to other clusters should be an essential component.

5.2.2 Methodology

The survey targeted people involved in the management and/ or in the overall co-ordination of cluster organisations.

Cluster organisations may be considered as the legal entity engineering, steering and managing the clusters, including usually the participation and access to the cluster premises, facilities and activities. They are considered as new and highly efficient forms of innovation support providers that provide or channel specialised and customised business support services, especially to SMEs.

Respondents	Frequency	Percentage
Cluster Managers and their teams	107	67.3
Cluster Stakeholders	52	32.7
Total	159	100.0

Response rate of the survey

Frequency	Cluster Managers
22	Austria
19	Germany
16	Croatia
14	France
4 to 5	Each: Hungary, Slovakia, Belgium, transnational clusters
1 to 3	Each: Bosnia and Herzegovina, Czech Republic, Italy, Latvia, Norway, Poland, Spain, Sweden, Ukraine, United Kingdom
Frequency	Cluster Stakeholders
4 to 6	Each: Austria, Czech Republic, France, Germany, Italy, United Kingdom, transnational organisations
1 to 3	Each: Croatia, Finland, Greece, Hungary, Lithuania, Norway, Poland, Slovakia, Slovenia, Spain

Distribution of respondents by country

5.2.3 Results

5.2.3.1 Profiles of cluster managers

No common job profile for cluster managers in Europe could be defined. The results show how age, size and location of clusters influence the cluster managers' tasks and skills.

Age, education, professional experience and sex of cluster managers

The majority (56.0 %) of the surveyed cluster managers are aged between 30 to 49 years old. A proportion of 10.3 % of the cluster managers are between 20 to 29 years old and 7.5 % of the respondents are above 60 years old.

Cluster managers have various educational backgrounds:

- Business and management, law, political science (49,5%)
- Engineering, ICT, natural science (36,4%)
- Other (8,4%)
- Not specified (5,6%)

When examining the educational background of cluster managers by the clusters' economic sector, some major differences tend to appear. For instance, in the fields of ICT, aerospace and defence, and machinery there are remarkably more cluster managers with a social science background (66.7 % and 62.5 %). By contrast, especially in the fields of plastics, chemical products and pharmaceuticals as well as textiles and clothing, leather products and footwear there are clearly more cluster managers with a natural science or engineering background (57.9 % and 57.1 %).

Previous work experience

Before working in cluster management, the big majority of cluster managers respondents gained its main professional experience in the private sector. Only 3.7% of respondents worked in the public administration and 7.5% have a R&D background as researchers or engineers in universities or companies. Almost half of the cluster managers respondents worked in a management/executive position (33.6% top management, 9.3% middle management).

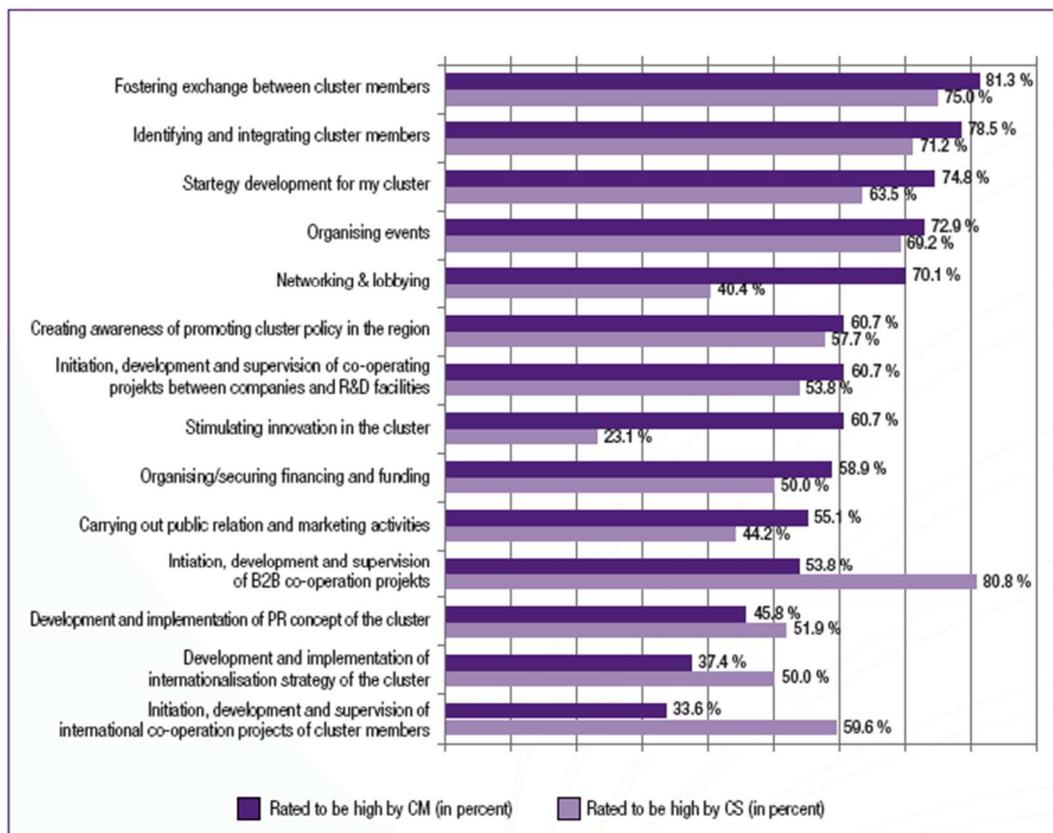
Nearly two thirds of the cluster managers respondents are male and only an overall one fourth of respondents female. This proportion varies depending on the sector the cluster belongs to. The sectors in the fields of textiles and clothing, leather products, footwear and automotive are dominated by male cluster managers (71.4 % and 68.4 %). On the other hand, the proportion

of female cluster managers is especially high in the sectors of health and wellness, hospitality and tourism (76.9 %). Likewise, more than half of the cluster managers respondents are female (57.1 %) in the sector of business and financial services.

Importance of specific tasks and duties of cluster managers

Cluster management usually comprises various tasks and duties including e.g. strategic tasks, cluster-internal exchange, internationalisation activities, public relations and marketing, training and advice, as well as securing financing, to name a few.

The survey aimed at clarifying how the age, size, sector and location of clusters influence a cluster manager's duties. These task profiles of cluster managers are also important to understand the training needs. Both groups of respondents, cluster managers and cluster stakeholders, were therefore asked to answer questions regarding the importance of specific tasks and duties of cluster managers.



Importance of tasks and duties in the current position/for the work of cluster managers

The importance of some tasks notably corresponds to the age of cluster organisations. To give an example, 'identifying and integrating cluster members' as well as the 'development of the cluster's strategy' is significantly more important for cluster managers in young' cluster organisations, whereas the importance of networking and lobbying rather increases over time.

Importance of tasks and duties regarding internationalisation issues

Nearly one fifth of the cluster managers (**17.8 %**) stated that one of these four internationalisation tasks would be of high importance for their work. A slightly higher proportion (**20.6 %**) of cluster managers said that two of these four internationalisation tasks are of high importance. **15 %** rated three tasks to be of high importance while **6.5 %** rated all four tasks to be very significant for their work.

Importance of skills and areas of competence for the work of cluster managers

Generally speaking, soft skills and knowledge of the cluster's specific industry constitute the most important skills and areas of competence. Two of the three top-ranked skills as important for the work of cluster managers are soft skills.

Both cluster managers respondents and cluster stakeholders respondents agree that interpersonal '**communicative skills (presentation and negotiation techniques, steering team meetings, mediation)**' are the most important skills for the work as a cluster manager. From the cluster managers respondents' point of view, also the '**knowledge of the cluster's specific sector/industry**' (76.6 %) as well as '**leadership capacities, team management**' (72.9 %) are of high importance, followed by '**English as a working language**' (64.5 %) and '**project management tools**' (59.8 %).

Besides the soft skills mentioned before, cluster stakeholders consider '**strategy development tools**' (63.5 %) very important. By contrast, only 45.8 % of the cluster managers respondents share this opinion.

Differences regarding the importance of skills and areas of competence can be identified when looking at the stage of clusters. Likewise, the importance of skills and areas of competence of cluster managers also differs by country.

Cluster managers in smaller clusters (0-24 members) attach more importance to skills and competences like 'business plans and financial planning', 'quality management tools' and 'how to develop cluster initiatives' as compared to cluster managers in larger clusters.

5.2.3.2 Training needs and interests

General results

There are some remarkable differences. For instance, cluster managers show a particular training interest regarding '**communicative skills**' (57.9 %), '**knowledge of the cluster's specific sector/industry**' (57.0 %), and/or '**knowledge management techniques**' (52.3 %). On the other hand, cluster stakeholders see a higher need in skills development for cluster managers in '**business consultancy know-how**' (55.8 %) and '**strategy development tools**' (51.9 %). Cluster stakeholders also do not consider **English language skills** (30.8 %) as relevant for further trainings as cluster managers themselves (**45.8 %**) do.

Within the group of cluster managers, we can find some remarkable differences regarding the interest in training. In this regard, while more than **60 %** of managers in cluster organisations established after 1999 have a high interest in '**leadership and team management**' training, only one third (33.3 %) of the managers in older ones show an interest for training in this field. Looking at training interests of cluster managers by country, there is a significant difference especially in the field of '**innovation management tools**'. For instance, Austrian cluster managers are highly interested in training in this field (**86.4 %**). However, cluster managers from Croatia (43.8 %) and Germany (31.6 %) have a rather low interest in being trained on 'innovation management tools'.

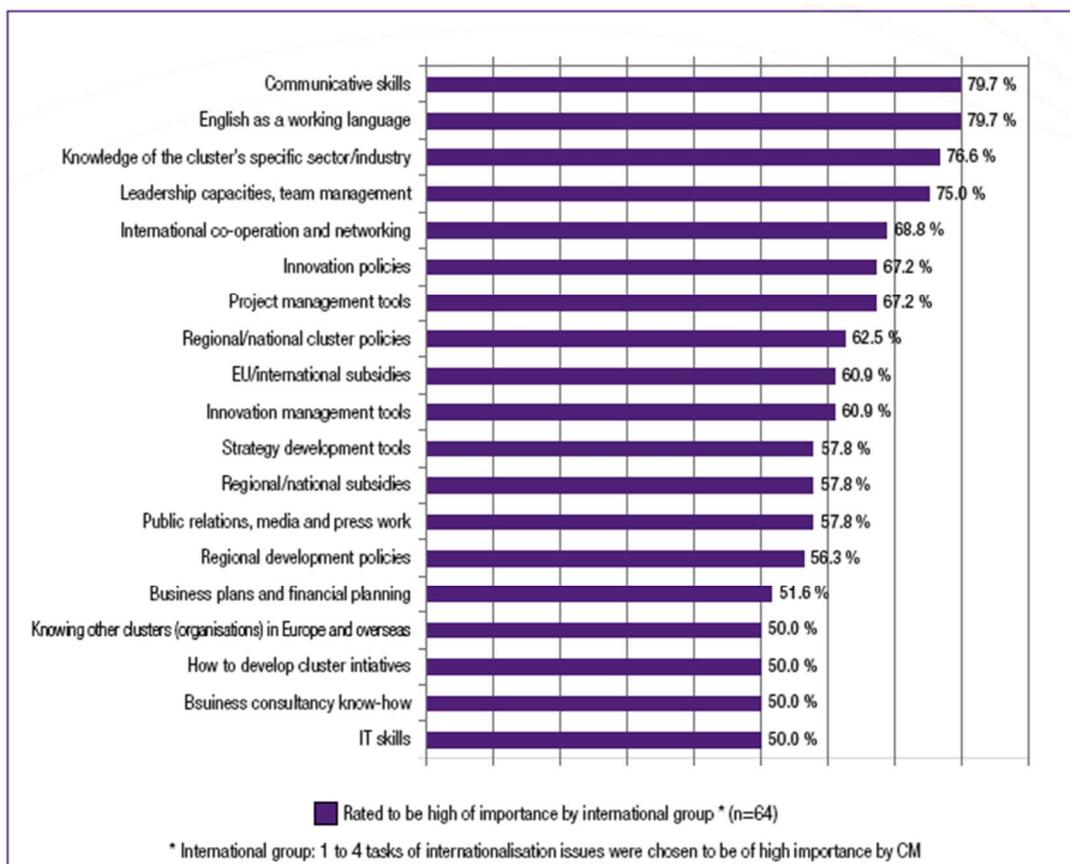
Further training related to 'knowledge of the cluster's specific sector/industry' is especially important in the fields of ecology, energy efficiency and sustainability. Cluster managers in the sector of 'construction service and materials' (76.9 %) show the highest interest in industry-specific training, followed by cluster managers in the sectors of 'food and agricultural products, fishing and fishing products' (69.2 %) and 'environmental technology, energy, oil and gas products and services' (68.4 %).

Interest in training in an international context

Both cluster managers and cluster stakeholders respondents were asked which skills and areas of competence should be preferably trained in an international context, for instance involving colleagues and peers from other countries in joint trainings. The cluster managers respondents longed to have an international context in training especially in the fields of **'EU/international cluster policies'** (54.2 %), **'international co-operation and networking'** (49.5 %), **'innovation policies'** (44.9 %) and **'knowing other clusters (organisations) in Europe and overseas'** (44.9 %). In principle, cluster stakeholders respondents have a similar view, but would also like an international training context in the area of **'EU/international subsidies'** (53.8 %) which is not ranked that high among the cluster managers respondents. All in all, an international set-up of training is mainly requested for innovation-related subjects and for subjects having an international component per se.

Analysis of internationally most active cluster managers in terms of important skills and training interest

'Communicative skills' (79.7 %) are the most important skills for the internationally active group and for all cluster managers. However, within the internationally active group, **'English as a foreign language'** rates equally high (79.7 %) while this skill only ranks at 4th position when looking at the total of cluster managers respondents (64.5 %). The internationally active group also regards **'international co-operation and networking'** (68.8 %), **'innovation policies'** (67.2 %) and **'project management tools'** (67.2 %) as more important than the overall total of cluster managers do.



Internationally active group of CM: importance of special skills

5.2.3.3 Methods and organisation of training

Decision to attend a training

41.1 % of the cluster managers **decide on their own** when to attend a training. This can be linked to the fact that cluster managers often have budget constraints and limitations for this purpose. Nearly one third of the cluster managers respondents (**32.7 %**) acknowledged that their stakeholders and/or leading cluster companies' approval and agreement is necessary before taking a decision to attend a training. Just only **15.9 %** of the cluster managers decide on their own and do not have budget constraints or limitations.

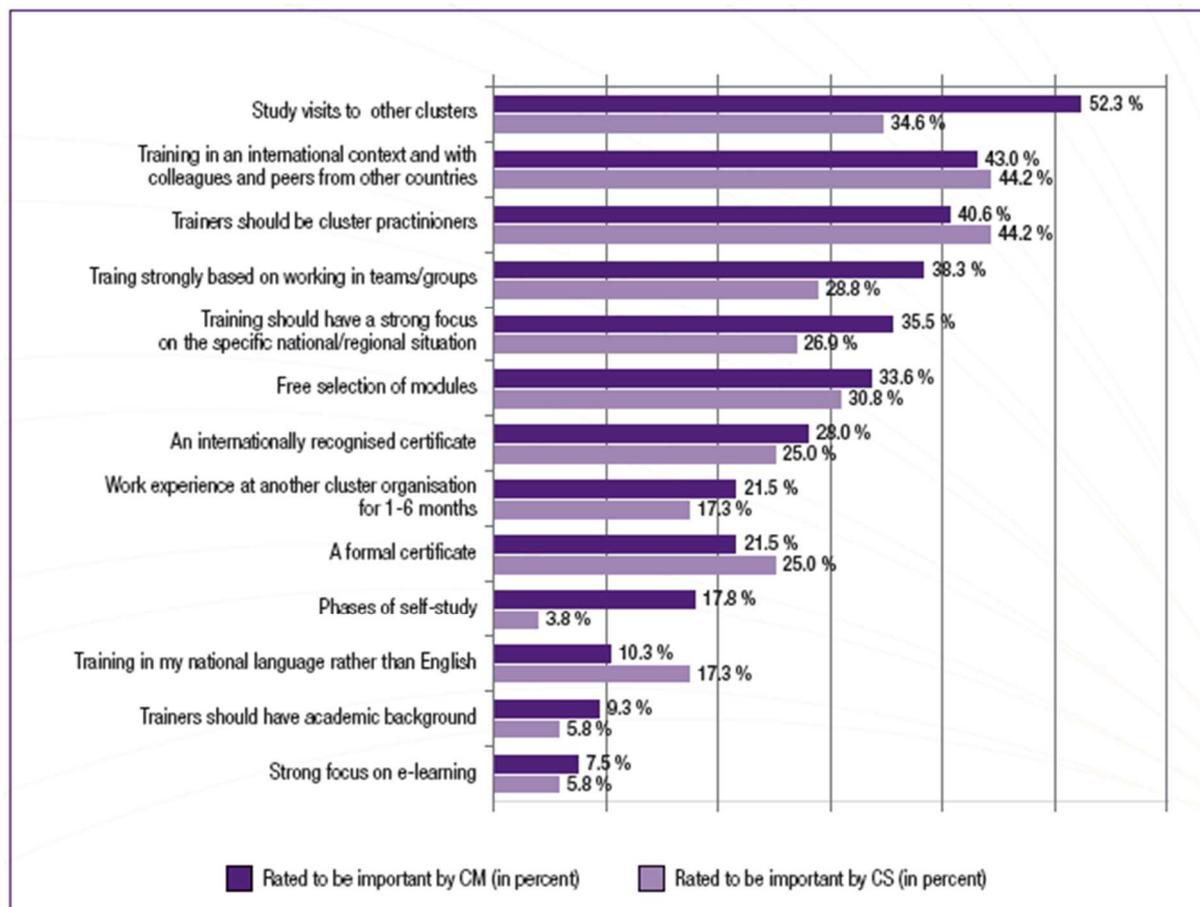
Time resources for attending a cluster management training

When comparing the views of cluster managers and cluster stakeholders, there are similar attitudes towards how much time could or should be spent in order to attend cluster management training. For both respondent groups, it appears that to spend **four to five days in total annually** (cluster managers: 34.6 %, cluster stakeholders: 40.4 %) is the most feasible way. Only a small minority of cluster managers could or would spend more than two weeks per year.

Money resources available for training fees

Comparing cluster managers and cluster stakeholders, the first remarkable aspect is that nearly one fourth (**23.4 %**) of the cluster managers **does not know** what annual amount of money is at their disposal for paying training course fees. Besides, we can find similar answers concerning the annual amount of money available to spend: **29.9 %** of the cluster managers and 28.8 % of the cluster stakeholders indicate **an amount ranging from € 500 to € 1,499**. In addition, around one fifth of the cluster managers (**21.5 %**) and one third of the cluster stakeholders (32.7 %) refer to a **margin gap of € 1,500 to € 2,999** to cover possible training costs. Only a small minority can afford to spend more than € 3.000 annually.

Other aspects of training organisation



Importance of aspects regarding trainings on cluster management (CM: N=107, CS: N=52)

According to the results, cluster managers and stakeholders grant similar importance to issues connected with '**mutual learning**', for instance as regards exchanges with other clusters, or colleagues and experts in cluster management. In this regard, **52.3 %** of the cluster managers highlight '**study visits**' and **43.0 %** would like to follow '**training in an international context with colleagues and peers from other countries**' as part of a cluster management training programme. For this purpose, **trainers should preferably be cluster practitioners** rather than having a strong academic and research background. Having **English as a training/ tuition language** does not seem to constitute a didactic problem as only 10 % of cluster managers show explicitly their preference to follow trainings in their own language. Likewise, respondents do not request a strong **e-learning** component as regards trainings.

5.3 Work-related skills in disruptive changes¹⁷

The World Economic Forum has drafted and prepared the report 'The Future of Jobs'. This report summarizes ongoing and expected employment trends, skills and workforce changes, and also gives strategy recommendations with a view on the disruptive changes arising as a result of the fourth industrial revolution.

¹⁷ The Future of Jobs. Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution – World Economic Forum, January 2016

5.3.1 Summary

Disruptive changes (i.e. technological, demographic and socio-economic disruptions) are expected to have a significant impact on skills requirements in all job families. They are already creating a range of opportunities and challenges across all industries and not just narrowly related to 'hard knowledge', technical skills, and technology. In order to manage these trends successfully, it is necessary to reskill and upskill talent embedded in an array of academic backgrounds across all industries.

There are currently big mismatches between the actual supply and demand of key work-related skills. In this regard, according to ManpowerGroup's Talent Shortage Survey¹⁸, 38% of employers reported difficulties in filling jobs in 2015. Skills mismatches emerge not only between the supply and demand of existing skills today, but also between today's skills base and future skills requirements. The efforts needed to narrow the skills gap will have to be grounded on a solid understanding of a country or given industry's current skills base and assessed against changing future skills requirements due to disruptive change.

The ability to understand the current skills base in near-real time and to accurately forecast across industries, geographies and job families, and to anticipate and prepare for future job contents and skills requirements will be increasingly critical for businesses, labour market policymakers, workers' organizations and individuals. Drivers of change to job markets such as Big Data analytics may themselves become useful tools in managing this process. Employers will have to focus on **reskilling and retraining**.

The report categorizes work-relevant skills into sub-abilities, basic skills and cross-functional skills, and forecasts a particularly strong demand growth in certain cross-functional skills, cognitive abilities and basic skills such as active learning and ICT literacy.

Considering the time needed to acquire these skills, it seems evident that **targeted training in cross-functional skills** is within the remit of an individual company or even a group of companies coming together for synergy and greater efficiency, like clusters. On the other hand, cognitive abilities and skills need much longer time to develop and need to be acquired often through formal high quality pre-school, primary and secondary education. This is a field where government policy will be required and therefore companies should work with governments to clearly define the need and introduce new delivery models. Finally, **basic skills** are also traditionally acquired through formal education and before entering the labour market, but they are relatively straightforward to acquire if we compare them with cognitive abilities. This is a field where companies and clusters have an opportunity **to take a proactive approach** by working much more directly and efficiently **with education providers** in order to build their talent pipelines.

5.3.2 Methodology

The research framework was shaped and developed in collaboration with the Global Agenda Council on the Future of Jobs, the Global Agenda Council on Gender Parity, and leading experts from academia and international organizations and professional service firms and the

¹⁸ Also see: World Economic Forum and the Global Agenda Council on Employment, Matching Skills and Labour Market Needs: Building Social Partnerships for Better Skills and Better Jobs, 2014.

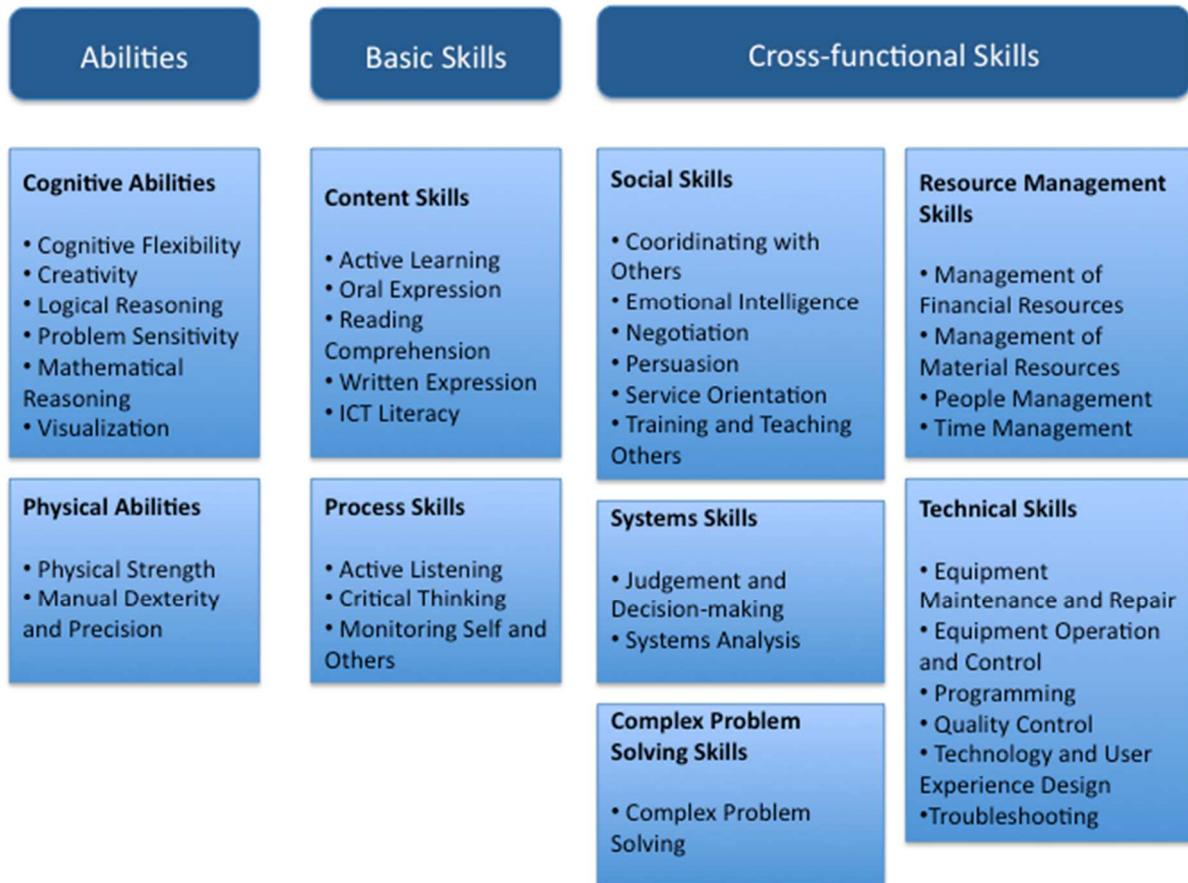
heads of human resources of major organizations. The World Economic Forum's membership helped to conduct an employer survey together with the particular support of three Employment, Skills and Human Capital Global Challenge Partners, namely, Adecco Group, ManpowerGroup, and Mercer.

The research was conducted with the overall objective to understand the current and future impact of key disruptions on employment levels, skill sets, and recruitment patterns in different industries and countries. The methodology included asking Chief Human Resources Officers (CHROs) of today's largest employers their vision on how jobs in their industry will change in the horizon of the year 2020 and how to take adaptation actions. CHROs and other senior talent and strategy executives of leading global employers, representing more than 13 million employees across 9 broad industry sectors in 15 major developed and emerging economies and regional economic areas participated in the survey. A quarter of the companies surveyed employ more than 50,000 people globally whereas another 40% have between 5,000 and 50,000 employees with the remainder split equally between employers with 500 to 5,000 staff and high-growth companies with currently up to 500 employees. To ensure geographical balance, the sample pool included at least 50 companies each from the list of target geographies. The countries and economic areas covered in-depth by the survey were the Association of Southeast Asian Nations (ASEAN), Australia, Brazil, China, France, Germany, the Gulf Cooperation Council (GCC), India, Italy, Japan, Mexico, South Africa, Turkey, the United Kingdom and the United States.

In addition, the survey sample was constructed on the basis of nine broad industry sectors as defined by the World Economic Forum. The analysis groups job functions into specific occupations and broader job families, based on a streamlined version of the O*NET labour market information system, which is widely used by labour market researchers worldwide.

5.3.3 Changes in skills set

Focusing on a core set of 35 work-relevant skills and abilities (See the below figure on Core work-related skills) the report finds that these practical skills will also be subject to accelerating change and significant disruption in the immediate future. On average, by the year 2020, more than a third of the desired core skill sets of most occupations will be comprised of skills that are not yet considered crucial to the jobs of today. There are various reasons behind such dramatic shifts in expected skills requirements. As noted earlier, in the face of rapidly rising computing power, **an ability to work with data and make data-based decisions will become an increasingly crucial skill across many job families.** Employers currently scramble to build a workforce with **solid skills in data analysis and presentation** (e.g. through visualization) and the amount of potentially useful digital information generated and stored keeps increasing exponentially.



Core work-related skills (source: World Economic Forum, based on O*NET Content Model)

While most jobs require use of a wide range of skills, somewhat different skill set combinations are sought after in different industry sectors. The set of data of the report allows for some general observations about the impact of various disruptive changes on skills demand at an aggregate industry level, such as follows:

With regard to the overall scale of demand for various skills in the horizon of the year 2020, the survey concludes that more than one third (36%) of all jobs across all industries are expected to require **complex problem-solving as one of their core skills**. This contrasts dramatically with the less than 1 in 20 jobs (4%) that will have as core requirement abilities such as physical strength or dexterity. However, along with the impact of disruptive changes on these sectors, the survey anticipates that **complex problem solving skills** will become somewhat **less important in industries that are heavily technical** today, such as Basic and Infrastructure and Energy. In these industries, technology is expected to automate and **take on a bigger part** of these complex tasks going forward. This will ascend in industries, such as **Professional Services and Information and Communication Technology**, that are expected to become more complex and analytical due to these anticipated trends.

Overall, social skills—such as persuasion, emotional intelligence and teaching others—will be in higher demand across industries than narrow technical skills, such as programming or equipment operation and control. Content skills, which include ICT literacy and active learning, cognitive abilities such as creativity and mathematical reasoning, and process skills such as active listening and critical thinking are expected to be a growing part of the core skills requirements for many industries.

If skills demand is evolving rapidly at an aggregate industry level, the degree of changing skills requirements within individual job families and occupations is even more pronounced. For example, the increasing ubiquity of mobile internet combined with the coming-of-age of the Internet of Things promises to transform the daily routine of many frontline roles in the Sales and Related, Installation and Maintenance, and Manufacturing and Production job families across all industries, requiring a **much higher level of technology literacy** than in the past. As an ancillary characteristic to increased automation in these fields, employees are expected to have **more responsibilities related to equipment control and maintenance and problem-solving skills, as well as a broader general understanding of the work processes of their company or organization.**

Many formerly purely technical occupations are expected to show a new demand for **creative and interpersonal skills**. For instance, in the field of healthcare practitioners, technological innovations will allow for increasing automation of diagnosis and personalization of treatments, redefining many medical roles towards communicating this data effectively to patients. Likewise, sales and related jobs may see an increased demand for creative skills and ideas for promoting a memorable shopping experience, as brick-and-mortar retail has to reposition itself in relation to e-commerce and online competition.

All in all, the respondents of the survey anticipate that a wide range of occupations will require a higher degree of cognitive abilities, such as creativity, logical reasoning and problem sensitivity, as part of their core skill set.

At the other end of the scale, out of all jobs requiring physical abilities less than one third (31%) are expected to have a growing demand for these in the future. This goes in line with the proportion of jobs in which physical abilities are anticipated to decline in importance (27%). The skills family with the most stable demand across all jobs requiring these skills today or in the future are technical skills. In this regard, nearly half (44%) of all jobs requiring these skills today will have a stable need for them in the coming years.

2020	2015
1. Complex problem solving	1. Complex problem solving
2. Critical thinking	2. Coordinating with others
3. Creativity	3. People management
4. People management	4. Critical thinking
5. Coordinating with others	5. Negotiation
6. Emotional intelligence	6. Quality control
7. Judgement and decision making	7. Service orientation
8. Service orientation	8. Judgement and decision making
9. Negotiation	9. Active listening
10. Cognitive flexibility	10. Creativity

Top 10 Skills as regards Industry 4.0 (source: Future of Jobs Report, World Economic Forum)

Observations as regards reskilling and retraining

The report indicates that business leaders are aware of the challenges but have been slow to act decisively. Two thirds of the respondents believe that future workforce planning and change management features as a reasonably high or very high priority on the agenda of their company's or organization's senior leadership and management. Across all industries, about two thirds of the respondents also report intentions to invest in the reskilling of current employees as part of their change management and future workforce planning efforts, making it by far the highest-ranked strategy in overall terms. Likewise, companies that report recognizing future workforce planning as a priority are nearly 50% more likely to plan to invest in reskilling than companies that do not (61% against 39% of respondents).

Companies and clusters can play a crucial role in acquiring the work-related practical skills or competences that employees or prospective new hires can use to perform various job tasks successfully. They can also promote reskilling and retraining as regards cross-functional skills, like complex problem-solving skills, social skills, interpersonal skills etc.

Besides, they can proactively collaborate with education providers as regards the acquisition of advanced basic skills, like content skills (i.e. ICT literacy and active learning) and process skills (i.e. active listening and critical thinking).

5.4 Industry 4.0 specific digital skills¹⁹

According to the 'Skills Needs Analysis for Industry 4.0 Based on Roadmaps for Smart Systems', developed by the Institute for Innovation and Technology of Berlin one option to analyse the skills necessary for Industry 4.0 is Visual Roadmapping.

5.4.1 The Visual Roadmapping method

The Visual Roadmapping method is particularly suitable for the identification of perspectives and milestones along the way from today towards the future. This method is an ideal tool that can be used in roadmapping and ex-ante evaluation of trends that facilitates the identification of key factors in future developments, the assessment of strategic potentials, and the deduction of needs and actions to be taken.

Using the method, the complex interplay of the topic investigated and significant factors can be analysed regarding future developments. For this purpose, four relevant dimensions are represented in a visual roadmap:

- Socio-economic factors (legal, economic, social conditions),
- Enabling Technologies (scientific and technical progress),
- Development of the topic itself (central aspects and milestones),
- Effects and implications (economic and social effects as well as new products and services)

The genesis of the roadmap is an expert based procedure that can be carried out with single experts or in groups of up to 10 persons. Starting with an empty matrix (the four dimensions versus a timeline of approximately 10 years from today), the experts are asked to discuss the topic and to identify single aspects/key issues of the future development concerning the four dimensions.

¹⁹ Skills Needs Analysis for Industry 4.0 Based on Roadmaps for Smart Systems, Institute for Innovation and Technology of Berlin (Ernst A. Hartmann, Marc Bovenschulte), 2016

Figure 4: A Visual Roadmap for Pervasive Computing (Gabriel, Bovenschulte, Hartmann et al., 2006)

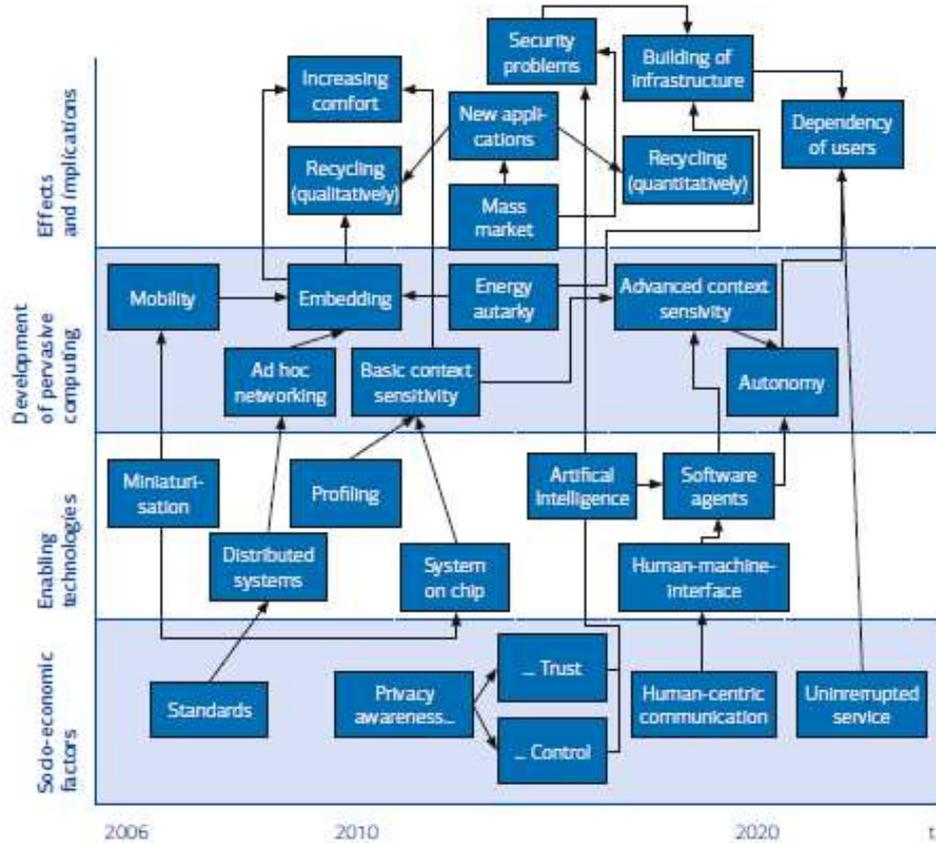


Figure 4: Visual Roadmap concerning Pervasive Computing, a precursor of Cyber-Physical Systems.²⁰

The general developments in the domain of Pervasive Computing are regarded with respect to industrial production as application area. Also, developments specific for this domain are taken into consideration.

²⁰ Gabriel, P., Bovenschulte, M., Hartmann, E.A. et al. (2006): Pervasive Computing — Trends and Implications. Study of VDI/VDE-IT in cooperation with FhG-SIT and Sun Microsystems on behalf of the Federal Office for Information Security; SecuMedia Verlags-GmbH, Ingelheim/Germany

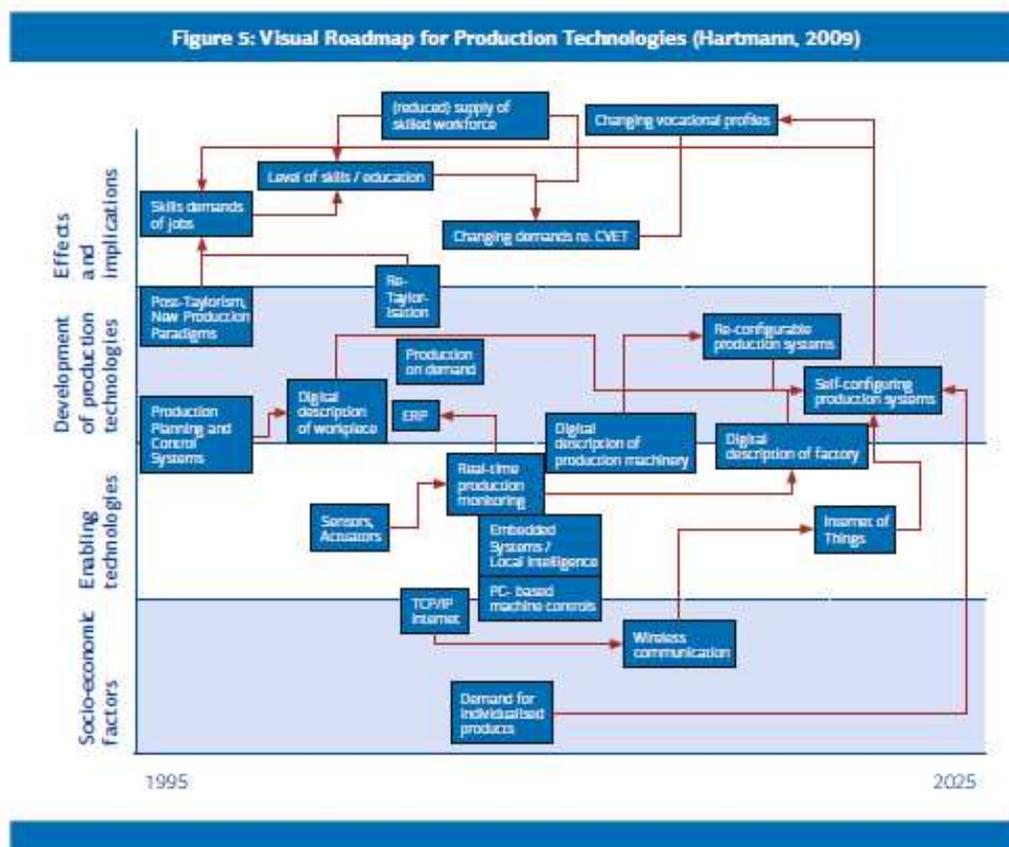


Figure nn: Visual Roadmap for Production Technologies in a time course from 1995 to 2025²¹

5.4.2 The Industry 4.0 skills need based on Visual Roadmapping

An integrative view across the technology roadmaps allows the identification of some **generic skills requirements**. One of these requirements relates to the **convergence between mechanical, electronic, software-based components or systems**, which will be occurring across scale levels (macro, meso, micro). A focus domain of these developments appears to be **robotics**, with core aspects such as **cooperating robots** and 'soft automation' (e.g. inherent safety by soft and flexible actuators of robotic systems).

Furthermore, **bionics** will probably play a more pronounced role in developing future robotic systems with human-like perception, cognition and behaviour. Regarding a flexible division of work between human and robot in the context of Human-Machine-Cooperation, **safety-related competences** will become more important.

With respect to these generic skills requirement, some first hypotheses can be set up regarding **qualitative skills needs**. In the German context, a to-be-developed vocation might be the **Industrial ICT Specialist, combining expertise in electronics and ICT (hardware/software)**. Within Higher Education, a future specialization could be something like '**Industrial Cognitive Sciences**', with distributed sensor/actuator networks, robotics, perception (e.g. 3-D vision), cognition (e.g. action planning, cooperation; swarm intelligence) as focus domains.

²¹ Hartmann, E.A.: Internet der Dinge-Technologien im Anwendungsfeld 'Produktion — Fertigungsplanung'; in: Botthof, A. & Bovenschulte, M. (Hrsg.) (2009): Das 'Internet der Dinge': Die Informatisierung des Alltags und der Lebenswelt. Hans-Böckler-Stiftung, AP 176, Düsseldorf/Germany

Similarly, a programme called '**Automation Bionics**' might also cover robotics, with emphasis on actuators (e.g. artificial muscles, limbs and organs), and perception/cognition aspects.

5.5 Cluster management abilities, capacities, skills and competences in a smart industry²²

To maintain the key role of clusters in the regional ecosystems, and to strengthen economic growth in the EU, clusters need to keep pace with the digitalisation, industrial modernisation and disruptive changes. Moreover, clusters need to become the drivers of innovation, acceleration and collaboration to foster cross-sectoral and cross-border technological development. In this respect the following set of abilities, capacities, skills and competences are deemed crucial for successful management of a cluster, to cope with new challenges towards Industry 4.0 and Cluster 4.0.

5.5.1 Work-related core skills and abilities

Based on the core set of 35 work-related skills and abilities cluster management and staff (World Economic Forum, based on O*NET Content Model) should acquire and strengthen the following abilities, basic and cross-functional skills to get prepared for successful management of a cluster in disruptive changes:

Cognitive Abilities:

- Creativity
- Cognitive flexibility

Basic skills:

- Content skills (ICT literacy)
- Process skills (Critical thinking)

Cross-functional skills:

- Complex problem solving skills,
- Social skills (Coordinating with others, Emotional Intelligence, Negotiation, Service orientation),
- Resource management skills (People management),
- System skills (Judgement and decision making).

Depending on the profile of the cluster and the role it fulfils in the sector related value chains (e.g. integrator, information broker, see section 5.5.5), cluster management and staff may need to master further work-related skills as a result of disruptive changes, digitalization and industrial transformation. For instance if a cluster provides sector/value chain related specialized certification, control and audit services it also needs to develop technical skills continuously with the technology development.

Creativity, Complex problem solving and Judgement and decision making skills were ranked high in the endorsement survey according to cluster managers/staff. In addition, **People management: Motivation and Critical thinking** were also considered as an important area of improvement by the cluster stakeholder respondents.

²² Newsletter Issue No 4, European Cluster Observatory, February 2017, European Cluster Excellence Initiative, Cluster Excellence Programme 2015

5.5.2 Leadership

Cluster managers should be fully conversant with EU and regional priorities, cluster policies, and trends regarding Cluster 4.0 and Industry 4.0 and related sector specific requirements and developments to be able to set out and implement the cluster mission/vision and strategy appropriately (i.e. to drive digitalisation and industrial transformation trends and to provide up-to-date cluster services to members in this respect).

Knowledge on:

- EU and regional priorities,
- EU and national cluster policies,
- trends regarding cluster development, such as Cluster 4.0,
- clusters' sector specific requirements and developments (Industry 4.0),

Competences and skills on:

- interpersonal skills,
- strategy development, which should target value added cluster services along the related value chains,
- strategy implementation, and
- monitoring, including rechanneling results for further adjustments,
- fostering team work with the cluster ecosystem,
- enabling others for collaboration.

Following appropriate set-up of communication channels and tools, cluster managers need to fully involve cluster staff in cluster service adjustments, and motivate them for proper implementation of related cluster service modifications.

Communication skills to motivate staff for:

- changing organisational set-up,
- improving cluster services,
- continuous self-development and lifelong training, and
- being the drivers of necessary changes and development of clusters.

Based on the endorsement survey the following knowledge and skills are critical for driving a cluster successfully towards smart industry:

- **Knowledge on Cluster 4.0 and Industry 4.0,**
- **Skills in strategy development and implementation along the related value chains and fostering teamwork within the ecosystem, enabling others for collaboration.**

In addition, cluster stakeholders considered the following skills for areas of required improvement as regards leadership:

- **Strategic management of the cluster,**
- **Communication skills.**

5.5.3 Internationalisation

Clusters play a key role as integrators in national and regional ecosystems, and as drivers of regional development. Cluster management needs to be able to foster cross-border and cross-sectoral cooperation in addition to interregional collaboration and investments towards smart specialisation strategies as part of the process of shaping Industry 4.0. This requires specific and in-depth knowledge on related megatrends, sector specific development forecasts towards industry 4.0, market trends, and competences in definition of cluster internationalisation process, and distinct skills for engaging clusters and cluster members in internationalisation process to generate cross-border and cross-sectoral projects.

Knowledge on:

- standard evolution,
- mega trends, global value chain development, cluster internationalisation,
- sector specific developments towards Industry 4.0,
- market trends and expectations,
- related financing opportunities (EU, national and other international donors financed subsidies, grants, investment incentives, loans, crowd-funding, business accelerators),
- technology trends.

Competences and skills on:

- Analysis of competences and resources of the cluster management and cluster members,
- Value chain and market analysis to establish the cluster and point cluster members' internationalisation potential,
- Definition of internationalisation processes, from cluster collaboration through members' engagement, to entering foreign/ third markets and generating joint projects (R&D&I, trade and investment projects),
- Generating joint projects (i.e. targeting and involving appropriate partners, designing project outline, establishing funding options and acquiring financial resources (projects of clusters/partnerships and stakeholders and/or projects of cluster members with other companies and stakeholders),
- Generating collaboration with worldwide industrial and research leaders.

Communication and communicative competences and skills on:

- Networking, fostering international cooperation,
- Building cluster co-operations and partnerships,
- Representation of the cluster, and cluster members' interests,
- Organising and engaging in results driven C2C and B2B meetings,
- Presentation and techniques for better negotiation,
- Raising the visibility and notoriety of the cluster strengths.

The endorsement survey revealed that cluster managers and staff and cluster management require specific trainings on:

- **knowledge on global megatrends, internationalisation,**
- **financing opportunities,**
- **specific skills on joint collaboration with worldwide industry and research leaders,**
- **generation of joint projects of cluster members,**
- **value chain and market analysis.**

*On the other hand, cluster stakeholders highlighted that skills on the **definition of internationalisation processes and related business development plans** are also very important.*

5.5.4 Entrepreneurship and Innovation

Clusters have a key role in enhancing and supporting entrepreneurship. Clusters are facilitators for entrepreneurs to navigate throughout the ecosystem and for large companies to find and engage with innovative small companies and start-ups. With regard to Industry 4.0 and Cluster 4.0, the cluster management needs to support entrepreneurship along with the facilitation of:

- innovation,
- cross-border, cross-sectoral value chain development, and development of emerging industries,
- promoting industrial modernisation by fostering the innovation uptake of advanced manufacturing, service innovation, and resource efficient solutions.

Knowledge on:

- Industry 4.0 and Cluster 4.0, as already integrated in the above mentioned needs,

- Innovation policies and innovation management tools,
- Business consultancy know-how,
- Private VC know-how.

Competences and skills on:

- Identifying opportunities for business development projects along the value chain gaps within and across clusters, and targeting industrial modernisation, cross-sectoral, cross-border value chain development or development of emerging industries,
- Engaging cluster members (i.e. SMEs, large companies, universities, research institutes, VET providers and other stakeholders) in innovation based business development projects, and,
- Provision of assistance in successful project implementation and follow-up.

Cluster managers and staff in the endorsement survey selected three main knowledge and skills, namely,

- **knowledge on innovation policies and innovation management tools,**
- **knowledge on funding opportunities and private VC know-how, and**
- **skills to be able to identify opportunities for business development projects along the value chain gaps within and across clusters and targeting industrial modernisation, cross-sectoral, and cross-border value chain development or development of emerging industries.**

*Clusters stakeholders ranked high both **engaging cluster members** (i.e. SMEs, large companies, universities, research institutes, VET providers) in **innovation based business development projects and fostering innovation policies and innovation management tools.***

5.5.5 Management

Clusters need to run their daily operations with a view on the global sectoral developments, trends and environment to be able to use the available cluster resources in the most efficient and effective way so that cluster members can be provided with a maximum number of benefits. Value added cluster services need to facilitate that cluster members can cope with challenges arising from Industry 4.0, and that they become drivers of further development. In this respect, it is essential that cluster management can analyse and organise tasks related to specific value chains covered by the cluster members. For managing the cluster successfully, and achieving better integration of cluster members along the value chain with the assistance of value added cluster services, clusters need to define the current roles of the cluster in value chain management, and target the most appropriate ones for fostering digitalisation and industrial transformation within.

Cluster can fulfil the following roles as regards value chain management:

- **Cluster as a direct resource provider:** access to resources (from both inside and outside the cluster);
- **Cluster as a broker:** exchange of resources (direct access to resources from both the cluster and outside the cluster);
- **Cluster as an integrator:** integrating functions, actors, processes etc. in a value chain (different dimensions of integration).

Knowledge on:

- General management concepts and tools,
- Value chain management,
- Cluster service development,
- Project management,
- Finance management.

Competences and skills on:

- Value chain management skills and value chain analysis and definition of cluster role (i.e. through working groups or the involvement of cluster members),
- Project management and team management capacities related to projects generated by the cluster,
- General organisational and management skills (i.e. running, supervising operational tasks, etc)
- Communicative skills (i.e. steering team meetings, mediation, soft skills, etc)

The respondents of cluster staff and management of the endorsement survey regarded as very important areas of further improvement:

- **the knowledge on value chain management and cluster development and fostering value chain management skills and value chain analysis and the definition of the cluster role through for instance working groups and/or the involvement of cluster members,**
- **skills on steering team meetings, mediation and related soft skills.**

*On the other hand, cluster stakeholders also endorsed **knowledge on the ecosystem** (i.e. cluster members and their skills) as a very important area for capacity development of cluster management.*

5.5.6 Digital skills

In the current fast-paced digital revolution, it is essential to acquire and continuously develop basic and advanced digital skills for smooth running of the daily operations of a cluster. Cluster management needs to keep up with these digital innovations and to implement necessary organisational and human resource changes triggered by the digital advancements. Likewise, based on the specific sector of a cluster, more distinct digital skills for the cluster management and staff with regard to industrial modernisation, cross-sectoral value chain development might be necessary.

As regards cluster service development, digital information provision and online platforms for collaboration of cluster members are essential tools in the course of digital revolution. Therefore, clusters should acquire appropriate capacities and competences to establish and widespread use digital tools throughout their service provision (See also section 5.3.1 Work-related core skills).

The current and intended digital competences of cluster management could be measured, assessed and established based on the EU digital competences framework²³, which assesses the skills in five main areas:

1. Information and data literacy,
2. Communication and collaboration,
3. Digital content creation,
4. Safety,
5. Problem solving

This framework identifies 21 competences for the 5 areas, with 8 levels of proficiency. Level 4 (intermediate) is considered as a minimum proficiency level for a cluster manager, but both levels 5 and 6 (advanced) and/or levels 7 and 8 (highly specialized) need to be represented by cluster staff and/or by the outsourced ICT service provider. In a cluster specialized in ICT and digital technologies levels 7 and 8 need to be compulsorily achieved by the staff.

²³ The Digital Competence Framework 2.0, DigComp2.1 „The Digital Competence Framework for citizens with eight proficiency levels and examples to use”

Proficiency level 4: The staff can independently and according to the needs solve well-defined and non-routine problems such as:

- Illustrate information needs,
- Organise the searches of data, information and content in digital environments,
- Describe how to access to these data, information and content, and navigate between them,
- Organise personal search strategies.

Proficiency level 7: At highly specialised level, the staff can:

- Create solutions to complex problems with limited definition that are related to browsing, searching and filtering of data, information and digital content,
- Integrate knowledge to contribute to professional practice and knowledge and guide others in browsing, searching and filtering of data, information and digital content.

Moreover, as regards the fourth industrial revolution, it is becoming clear that mastering digital technical skills, such as mobile, CRM, and analytics is becoming an essential part of the business toolkit, and not just related to technical roles. Therefore, the following skills will be crucial for future cluster service development:

- Developer and manager skills to spot the wider business opportunity (e.g. for AI, automation, cooperating robots, soft automation),
- Skills to tailor AI applications to enhance companies and optimise business processes,
- Digital project skills: team member (such as product owners/managers, channel managers and other highly skilled talent),
- Skills in new technologies (IoT, big data, Fin Tech, Bionics),
- Skills in convergence between mechanical, electronic, software-based components or systems,
- Safety-related competences,
- Data analytics,
- E-marketing, website and online platform development
- Skills to use of CRM etc.

Regarding specific tasks, such as for example internet related businesses, technological development, and industry process modernisation, clusters and companies will need to recruit highly-trained and qualified staff (e.g. coders, programmers, data analysts). This option becomes more resource efficient on a short-term or assignment basis than permanently. Nevertheless, for generation of own R&D&I cluster projects and facilitation of cross-sectoral value chain development and innovation, clusters managers will need to master the above mentioned skills to an extent which enables them to identify the opportunity and to plan and overview complex projects.

Regarding relevant skills to further develop towards Industry 4.0, the respondents among cluster managers and staff of the endorsement survey highlighted:

- **skills in new technologies (i.e. IoT, bi data, Fin Tech),**
- **developer and manager skills to spot the wider business opportunity, and**
- **skills to tailor AI applications to enhance companies and optimise business processes.**

*Alongside, cluster managers and staff also considered very important digital project skills and data analytics. Cluster stakeholders endorsed the previous skills but also highlighted **e-marketing, website and online platform development skills.***

5.5.7 Language competences

To manage successfully a cluster towards Industry 4.0 and Cluster 4.0, the proficient working knowledge of English is essential. This is not only because internationalisation processes require

continuous engagement with foreign partners, but also because both elementary and critical information on global value chain development, megatrends, industrial modernisation, digital technology development, market trends, funding and networking opportunities is often only available in English.

In addition, proficient working knowledge of other languages such as French, Spanish, Russian, or Arabic as regards internationalisation processes towards specific regional markets (i.e. Africa, America, Russia and CIS states, Middle East, Maghreb and Mashriq regions, Gulf countries, etc) is also very important and needs to be assessed in the light of the internationalisation strategy of a cluster. Other language competence needs are to be established accordingly.

*Among cluster management and staff, the respondents of the endorsement survey considered that clusters' management has a proficient knowledge of English for daily work, meetings and related interactions. Other language capacities were also mentioned, including Spanish, German, French, Chinese, Russian and Japanese. On the other hand, half of the clusters stakeholders' respondents considered that the **clusters' management lacks proficient knowledge of English for daily work, meetings and related interactions**. Cluster stakeholders mentioned other language capacities like Spanish for instance and language related skills such as active listening, machine languages and programming.*

6 Preliminary observations as regards the Cluster4Smart training tool

Analysing the reference material and considering the above outlined set of abilities, capacities, skills, and competences considered to be necessary for cluster managers towards smart economy, some preliminary observations are set out here below as regards the training to be designed within the Cluster4Smart project.

6.1 Options and limitations of a common training tool

The skills and training needs of cluster management vary significantly depending on the level (young – old), legal form (public – private – semi-public), financial background of the cluster (membership fee - public funds - project based etc.), geographical location (economic background of the region, cluster policy), sectors represented, cluster role in value chain management (information provider, broker, integrator) value added cluster services provided (promotion system, consultation, information platform, certification/audit, policy advocacy etc.).

Obviously, an online training tool will not address all needs across borders and sectors, but it shall target common requirements. For instance a joint training could be well fitted to trainings targeting:

As regards core work-related skills:

- Complex problem solving skills,
- ICT literacy,
- Social skills,

As regards other cluster management related skills:

- Communication and communicative skills,
- Cluster strategy development and implementation,
- Value chain management,
- Project generation etc.

6.2 Sharing experience and best practices

The need and request for sharing of experience in cluster management ranks high in the CMQ survey. It has also been observed in some ongoing cluster excellence projects that cluster management are keen on learning from others' practices. For instance a successful cluster mind-map can give a good input for other cluster managers to redesign the cluster's operational, networking and collaboration basis. The design of cluster trainings shall be based on practical examples, and the trainings shall provide for best practices in each training module addressing the various skills and competences. It is also to be considered if examples can be individualised, e.g. reference cluster could be mentioned, which could be consulted if further information is necessary. Moreover, the training tool shall be dynamic, meaning that additional examples, best practices could be added by the users, and/or it could be further developed in the future (new modules could be added) based on advancement of science, technology and skills requirements.

For some of the best practices regarding specific skills and competences, reference material is available at stakeholders, international organisations and specific technical bodies. This requires appropriate consideration during the design of the Cluster4Smart online training tool.

6.3 Interactions with other clusters

International collaboration, learning with colleagues and in working groups are important training aspects for the respondents of the CMQ survey. The training tool to be developed should facilitate interactions with others, participating in the training or using the training material. This interaction could be continued within or outside the training tool. The set-up of the tool should make it possible to interact with other participants, to share examples and exchange views during the training, and simply get in touch with peers.

6.4 E-learning – resource efficient training

E-learning need ranked low in the CMQ survey (in 2009), at the same time managers do not have too much time for training (mostly 4-5 days per year) and the budget is limited and/or not within the cluster manager's exclusive authority. According to the Future of Jobs Report of the World Economic Forum, the fast-paced digitalisation, technology development requires a certain level of ICT literacy in all job families and accelerated familiarisation with digital tools to keep work-related skills competitive.

An e-learning tool would meet resource efficient training requirements, thus could be a solution in the above-mentioned operational conditions of clusters. Moreover, it would provide for a training option that targets core work-related skills development, which proves to be essential in the age of disruptive changes.

E-learning cannot sufficiently and effectively target all skills to be developed (e.g. social skills, communicative and communication skills), though. Therefore, cluster management shall combine the use of this tool with appropriate combinations of other training options.

One option could also be that the Cluster4Smart online training tool develops and includes material to be used in working group, workshop sessions to complement the self-study, online training material, presentations, webinars, exercises, drills etc.

6.5 (Digital) reskilling

According to the policy paper 'Reskilling for the Fourth Industrial Revolution, Formulating a European Strategy'²⁴, reskilling opportunities should be industry-specific and provided at a local level. The companies themselves should preferably provide re-skilling jointly or in close cooperation with regional or local partners. The German automation expert Festo is for instance a successful example of such "Industrie 4.0" training provided by a company. In this regard, Festo has developed its own training programmes to reskill its global labour force in IoT applications. An example is for instance the training on the use of VR glasses on the shop floor. Festo is now willing to share its knowledge with other companies and educational institutions. The general purpose should be a decentralized distribution of knowledge and education, which can in turn provide tailor-made solutions for the specific reskilling needs of a company.

The main obstacle to a comprehensive provision of reskilling opportunities for European citizens is the multi-faceted digital division within the European Union. The need to develop reskilling programmes for connected production and the multi-faceted digital division within the EU has led to

1. Some recent training programmes coordinated and organized by the EU, and

²⁴ Reskilling for the Fourth Industrial Revolution, Formulating a European Strategy – Jacques Delors Institute, Berlin, November 2016

2. The creation of the network of Digital Innovation Hubs.

Training programmes:

The Grand Coalition for Digital Skills was launched in 2013. It now includes more than 100 stakeholders, including leading internet companies, NGOs, social partners and educational institutions that wish to provide decentralized training in digital skills for EU citizens. Each of the partners – they include global companies such as Google, Cisco and business associations – has given a pledge to train a certain number of citizens in digital skills, often jointly with local universities and other educational institutions. The coalition could organize training in digital skills, which included data analytics, modern e-marketing tools, and website building to name a few for around two million European citizens. In June 2016, the European Commission launched its successor, the Digital Skills and Jobs Coalition. In the framework of this new coalition, the European Commission has invited the Member States to build national coalitions based on the European one by mid-2017, and has once again asked for pledges by the various stakeholders to provide digital skills training throughout the EU.

Digital Innovation Hubs

Digital Innovation Hubs are regional centres of expertise in the areas of robotics, IoT or artificial intelligence, which can act as centres of expertise for SMEs and non-tech companies. At a Digital Innovation Hub companies have the opportunity to access and gather information on new internet-enabled production processes, and to experiment with new technology. The EU is supporting and establishing these hubs as a part of the Digitizing European Industries Initiative, which was launched by the European Commission in May 2016. As one pillar of a larger programme designed to accelerate the digital transformation of European industries and the use of IoT, Digital Innovation Hubs should function as regional IoT Competence Centres. These are conceived as one-stop-shops where SMEs can learn about the technology and the development processes, and use test beds for new production methods such as Fab Labs showcasing applications for 3-D printing. The European Commission intends to have one Digital Innovation Hub in each European region by 2020. In recent years, several European regions and cities have set up their own Digital Innovation Hubs. Local universities, technology centres, and businesses have in many cases already been involved in the ecosystem of these Hubs.

6.6 Languages used

It is considered that English should be the main language used for the design and the operation of the planned Cluster4Smart online training tool. First of all, because if it is supposed to be a dynamic tool, translation of spontaneous interactions, webinars, materials cannot be provided or it would delay the training process. Some core training modules that are more static could be translated into national languages, as it is considered necessary.

Thus the actual content, set and design of training modules to be covered by the online Cluster4Smart training resource tool will need to be compiled along with these and similar considerations, and taking account of the existing capacities in trainings, and collaborating with the relevant stakeholders.

7 References

1. CMQ – Cluster Manager Qualification, PRO-INNO EUROPE, April 2009
2. European Cluster Trends, European Cluster Observatory, March 2015
3. Cluster Internationalisation and Global Mega Trends, European Cluster Observatory, 2015
4. European Cluster Excellence Initiative related documents, such as:
 - a. Training materials, case studies developed under this initiative from the website of European Foundation for Cluster Excellence,
 - b. Documents from COSMENERG Cluster Excellence (ArchEnerg) project
5. Cluster Internationalisation – European Cluster Collaboration Platform – relevant documents: Overview of EU Instruments contributing to Internationalisation of the European Business - 2017, Call for proposals on Clusters Go International 2017
6. European Parliament, Directorate-General for Internal Policies, Policy Department A: Economic and Scientific Policy, Industry, Research and Energy (ITRE), Industry 4.0 Analytical Study, February 2016
7. Developing and running an establishment skills survey – Guide to Anticipating and Matching Skills and Jobs, Volume5, 2017, European Center for the Development of Vocational Training - CEDEFOP
8. The Future of Jobs Report, Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution, World Economic Forum, January 2016
9. European Cluster Panorama 2016, European Cluster Observatory, November 2016
10. Newsletter Issue No 4, European Cluster Observatory, February 2017 and The Story of European Cluster Conference 2016, Cluster 4.0: Shaping smart industries, Key policy messages
11. European Classification of Skills and Competences
12. The Digital Competence Framework 2.0, DigComp2.1 „The Digital Competence Framework for citizens with eight proficiency levels and examples to use” – Joint Research Center, Stephanie Carretero, Riina Vuorikari, Yves Punie, 2017
13. Reskilling for the Fourth Industrial Revolution, Formulating a European Strategy – Jacques Delors Institute, Berlin, November 2016
14. Hays (Specialist Recruitment, Australia): The Skills Needed For The Fourth Industrial Revolution
15. The Fourth Industrial Revolution Will Be Powered by Soft and Hard Skills – Lisa Tenorio, Director of Trailhead Marketing, Salesforce
16. Skills Needs Analysis for Industry 4.0 Based on Roadmaps for Smart Systems, Institute for Innovation and Technology of Berlin (Ernst A. Hartmann, Marc Bovenschulte)

8 Annexes

8.1 Annex 1: Brief description of project partners

SCS (Secured Communication Solutions) World Class Cluster is headquartered in the Provence - Alpes-Côte d'Azur region of France. It has more than 300 members in the field of micro-electronics, telecommunications and software, including companies, out of which 70% are SMEs, research centers and educational institutions. SCS (Secured Communication Solutions) represents 60,000 jobs, 26 multinational companies, 1,200 researchers in the public sector, and 18 educational institutions training around 1,500 engineers annually. SCS (Secured Communication Solutions) aims to promote the development of competitive R&D projects between all its players with the support of local communities and the objective of designing and developing new solutions targeting high-growth markets such as Industry 4.0, smart cities, smart grids, smart manufacturing, e-health, e-mobility, and retailer e-payment. SCS (Secured Communication Cluster) also aims to contribute to the creation of an appropriate ecosystem for the overall regional ICT landscape, especially through the support and development of SMEs. The three core smart specialisation areas of SCS (Secured Communication Solutions) are contactless technologies (NFC, RFID), networks (4G, LTE, IMS), M2M and mobile services, and digital securities and identities. SCS Cluster has a long list of partnerships with different stakeholders, including universities and VET centers such as Aix-Marseille University, Nice-Sophia Antipolis University, Eurecom, ISEN, IM2NP, and Telecom Paristech; cluster and cluster platforms such as Silicom Europe Alliance, Development Regional Agencies, etc. SCS cluster has been awarded with the ESCA (European Secretariat for Cluster Analysis) Gold Label in July 2013. It was subsequently renewed in July 2016 granting SCS with the gold excellence in terms of cluster management.

The **University of Strasbourg** was born on 1 January 2009, as a unique and pioneering example of merging universities in France: Louis Pasteur, Marc Bloch and Robert Schuman. The University's fundamental training and research goals include forging partnerships with European and international universities. The University of Strasbourg holds 4 campuses and is one of the largest universities in France, with nearly 46,000 students, including 19.5% of international students. The University of Strasbourg is involved in supporting its researches and students through the implementation of innovative projects that seek and foster excellence. As a leading European center for training and research, the University of Strasbourg has developed a strong French-German cooperation and is now a privileged partner among the Upper-Rhine universities. The University of Strasbourg has received the Certified Excellence Initiative (IdEx) in 2016 by the French national programme 'Investissement d'avenir'. ITIRI is an institute of the University of Strasbourg within the Faculty of Languages. It offers professional masters' degrees in translation, interpretation, international relations, European studies, communication and economic intelligence, and cluster management. 351 students are registered in the institute, with 50% coming from abroad and representing over 20 different nationalities. ITIRI works in close cooperation with several external partners, such as national and European institutions, local and regional authorities and companies. ITIRI has played an active role in a number of international cooperation projects including inter-university cooperation and EU funded programmes (i.e. Socrates, Tempus, Lingua, Leonardo, EuropeAid, etc) and bilateral projects with embassies and cultural institutes abroad.

Founded in 2009 **AMUEBLA** is a non-profit association that represents the interests of companies, research and training centers and public and private sector stakeholders of the Mediterranean area that work and collaborate together to address the needs of the furniture and habitat sectors. AMUEBLA promotes collaborative exchange processes and seeking to obtain advantages and benefits from the development and implementation of innovative projects.

AMUEBLA is the key furniture industry and related sectors cluster of the Region of Murcia. It has the Bronze Cluster Certification. The main purpose of AMUEBLA is to facilitate innovative practices to improve the competitiveness of partner companies, to defend the general business interests and to promote its projection and international visibility in the market. AMUEBLA has more than 80 companies, with 2,500 employees. The main activities are based on the promotion of joint actions and the development and establishment of convergent and common strategies in areas of innovation, environmental management and training activities, amongst others. AMUEBLA currently coordinates several projects under Erasmus + and participates in others as partner. The projects have for instance as objective to help SMEs of the furniture sector to align with the incoming Green Public Procurements, or to develop online sales manager profiles to push cross-border sales. Besides, AMUEBLA has also participated Leonardo projects and in other EU-funded project schemes.

The **European Business and Innovation Center of Burgos (CEEI-Burgos)** is a non-profit organisation created in 1994 and regrouping several partners, including the City council of Burgos, the Provincial Government of Burgos, and the Federation of Burgos Managers Associations. CEEI-Burgos is an active member of both the European Business and Innovation Center Network (EBN) and the European Microfinance Network (EMN). CEEI-Burgos is also a member of other organisations such as ANCES (National Association of Spanish BICs) and PAIT (Spanish Official Network for the Creation of New Companies under the SLNE regulation). CEEI-Burgos focuses on advising and mentoring SMEs. Its main services include incubation facilities, entrepreneurship and consultancy services, training and e-learning, national and international cooperation, renewable energy, biotechnology and innovative SME promotion and development, etc. CEEI-Burgos promotes several business sectors, including green and bio economy, creative industries, IT, agriculture, agro-industry, tourism, logistics, transportation, machinery, construction, environment, engineering services, telecom, etc.

ArchEnergy (International Renewable Energy and Building Trade Cluster) was established in 2007 with the aim of creating an economic and social model based on renewable energy sources and energy efficiency that moves green economy enterprises and society towards a more sustainable future. ArchEnergy is now a leading cluster in the renewable energy and building sector with an extended network in the Central and Eastern European region and holding a permanent certificate of 'Accredited Innovation Cluster'. ArchEnergy has 79 members, including 75 SMEs, three large companies, and one academic institution, the University of Szeged. The European Secretariat of Cluster Analysis (ESCA) granted ArcheEnergy with the Gold Cluster Management Excellence benchmark in 2015. ArchEnergy's main areas of activity are renewable energy, building industry, project management, research and training, environment protection, ensuring sustainability, and organisation and process development innovation. ArchEnergy assistance includes infrastructure development, advocacy, marketing, and generation of interest for products and services. ArchEnergy has more than 50 strategic collaboration agreements with national, regional and international stakeholders and offers complex services, such as training and curriculum design, project generation, cluster marketing, searching for financial solutions, tenders and calls for proposal watch, partner search, requirements and needs assessment, trainings and lectures, etc. Currently ArchEnergy is a leading partner in EU-funded COSMENERG Cluster Excellence (2016-2018) and COSMENERG-4i Clusters Go International (2017-2020) projects. Besides, it also runs and implements several smaller investment and innovation projects for the benefits of its members.

Gnomon is a consultancy company dedicated to cluster management and collaborative innovation founded by Alain Tubiana. He is an international expert and consultant on cluster management, working on collective intelligence topics for more than 20 years. He has worked 9 years as cluster manager in the Information Technology (IT) sector. In the past six years he conducted about 30 missions for cluster organisations as well as governments in France,

Lebanon, Morocco, Mauritius, Tunisia, Algeria and French Overseas Territories, (New Caledonia and La Réunion). He encompasses a broad range of activities from cluster policies to clusters' services. He trained more than 80 cluster managers on site and through distance learning. He contributed to activate several cluster initiatives in various sectors like textile, automotive, IT, mechanics, creative industry, energy efficiency and agro-food. He developed several projects to facilitate the technology transfer from laboratories to companies and has a strong experience in business support for SMEs. He is member of the board of directors of France Clusters since 2010 and head of the French-German Master of Cluster Management at University of Strasbourg. He is an expert in The Next Society, DG Near funded project on shaping innovation in the south Mediterranean, 2017-2020.

8.2 Annex 2: Questionnaire used in the endorsement phase

– CLUSTER4.0 INDUSTRY4.0

– ABILITIES, CAPACITIES, SKILLS, AND COMPETENCES OF CLUSTER MANAGERS

– QUESTIONNAIRE 1

–

– Introduction

–

– This survey aims to gather all relevant **cluster management abilities, knowledge, skills and competences** that enable clusters to become the drivers of innovation, acceleration and collaboration, to foster cross-sectoral and cross-border technological development (Cluster 4.0) towards a smart economy (in the fourth industrial revolution, Industry 4.0).

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– The survey is conducted in the framework of the **Cluster4Smart** project (ERASMUS+ programme, 2017-2020), which aims to expand the knowledge of clusters' managers of Europe through the **development of an innovative, online training resource tool**.

–

– For this project, clusters (SCS, France – leading partner, AMUEBLA, Spain, ArchEnerg and IKOSZ, Hungary), universities and research institutes (University of Strasbourg, France, and Fraunhofer Institute for Systems and Innovation Research, Germany) and a business stakeholder (European Business and Innovation Center of Burgos, Spain) have teamed up.

–

– This questionnaire targets cluster management and cluster staff.

–

– Reference

–

– **Ability:** permanent characteristic of the individual that influence performance

– **Knowledge:** organized sets of principles and facts applying in general domains

– **Skills and competences:** developed capacities that facilitate learning or the more rapid acquisition of knowledge and/or that facilitate performance of activities that occur across jobs

–

– **Industry 4.0** describes the organisation of production processes based on technology and devices autonomously communicating with each other along the value chain, namely, a model of the 'smart' factory of the future where computer-driven systems monitor physical processes, create a virtual copy of the physical world and make decentralised decisions based on self-organisation mechanisms. The concept takes account of the increased digitalisation of manufacturing industries where physical objects are seamlessly integrated into the information network, allowing for decentralised production and real-time adaptation in the future. Related terms used internationally include Internet of Things, Internet of Services, Industrial Internet, Advanced Manufacturing and Smart Factory.

–

– **Cluster 4.0** encompasses the terms used for of a World Class Cluster that provides competitive cluster services to foster regional development through cross-border and cross-sectoral cooperation in addition to interregional collaboration and investments towards smart specialisation strategies. These clusters of the front line are able to provide their members with business advisory services to cope with challenges of Industry 4.0 and to trigger value chain development and creation through innovation, acceleration and internationalisation.

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– Identification

-
- Position in the cluster:
 - cluster manager
 - other in cluster management
 - cluster staff
- Number of years in the position:
- Year of establishment of the cluster:
- Country:
- Name of the cluster:
- Optionally give your email address if you want to be invited to the online course:
-

–

–

1. The sector of your cluster as regards smart specialisation S3 EU priorities (select up to three specializations)

- Aeronautics & Space
- Agricultural Services
- Blue growth
- Construction
- Creative, cultural arts & entertainment
- Cultural and creative industries
- Digital Agenda
- Energy production & distribution
- Human health & social work activities
- Information & Communication Technologies (ICT)
- KETS
- Manufacturing & Industry
- Mining & quarrying
- Nature & biodiversity
- Public administration, security & defence
- Public health and security
- Service innovation
- Services
- Social innovation
- Sustainable innovation
- Tourism, restaurants & recreation
- Transporting & storage
- Water supply, sewerage, waste management & remediation activities
- Wholesale & retail trade

–

2. Cluster Management Excellence label – under the European Cluster Excellence Initiative - ESCA:

-
- Gold
- Silver
- Bronze
- Under application and assessment
- Not applicable
-

3. Other international cluster certification/accreditation schemes

-
- Please specify the scheme, the year of acquisition or put not applicable:

–

4. Other international cluster certification/accreditation schemes

-
- Please specify the scheme, the year of acquisition or put not applicable:

–

5. Relevance of Industry 4.0 as regards your cluster profile

-
- Indicate which areas mentioned below are in focus at your cluster and so it would require further capacity building:

—

Digitalisation including ICT, IoT, CPS

Vertical markets including:

smart factory

energy (smart grids)

mobility

health

Not applicable

-
- Indicate the level of necessity and relevance of further training of your cluster management for the listed abilities, knowledge, skills and competences:

6. Core work-related skills

– Necessity and relevance				
<ul style="list-style-type: none"> – – – – – Skills 	<ul style="list-style-type: none"> – Management lacks these abilities skills - specific trainings are strongly recommended 	<ul style="list-style-type: none"> – It is acquired by the management to some extent, endorsement is needed 	<ul style="list-style-type: none"> – Management masters it and training is not relevant 	<ul style="list-style-type: none"> – It is not relevant in our sector/c luster
– Abilities				
<ul style="list-style-type: none"> – Creativity: to think outside the box that results in innovative, novel solutions for a task 	<ul style="list-style-type: none"> – 	<ul style="list-style-type: none"> – 	<ul style="list-style-type: none"> – 	<ul style="list-style-type: none"> –
<ul style="list-style-type: none"> – Cognitive flexibility: mental ability to switch between thinking about two different concepts, and to think about multiple concepts simultaneously 	<ul style="list-style-type: none"> – 	<ul style="list-style-type: none"> – 	<ul style="list-style-type: none"> – 	<ul style="list-style-type: none"> –
– Basic Skills				
<ul style="list-style-type: none"> – Content skills – ICT literacy: Analyse software specifications, utilise computer aided software engineering tools, use programming, integrate system components etc. 	<ul style="list-style-type: none"> – 	<ul style="list-style-type: none"> – 	<ul style="list-style-type: none"> – 	<ul style="list-style-type: none"> –
<ul style="list-style-type: none"> – Process skills – Critical thinking: Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems 	<ul style="list-style-type: none"> – 	<ul style="list-style-type: none"> – 	<ul style="list-style-type: none"> – 	<ul style="list-style-type: none"> –



– Cross-functional skills				
– Complex problem solving skills: Developed capacities used to solve novel, ill-defined problems in complex, real-world settings	–	–	–	–
– Social skills – Coordinating with others: Adjusting actions in relation to others' actions	–	–	–	–
– Social skills – Emotional intelligence: self-awareness, self-regulation, self-motivation, empathy	–	–	–	–
– Social skills – Negotiation: Bringing others together and trying to reconcile differences	–	–	–	–
– Social skills - Service orientation: Actively looking for ways to help people	–	–	–	–
– Resource management skills – People management: Motivating, developing, and directing people as they work, identifying the best people for the job	–	–	–	–
– Systems skills - Judgement and decision making: Considering the relative costs and benefits of potential actions to choose the most appropriate one	–	–	–	–

7. Leadership

<ul style="list-style-type: none"> – – – – – Capacities and skills 	– Necessity and relevance			
	<ul style="list-style-type: none"> – Management lacks these skills/knowledge – specific trainings are strongly recommended 	<ul style="list-style-type: none"> – It is acquired by the management to some extent, endorsement is needed 	<ul style="list-style-type: none"> – Management masters it and training is not relevant 	<ul style="list-style-type: none"> – It is not relevant in our sector/cluster
– Knowledge				
<ul style="list-style-type: none"> – Trends regarding cluster development, such as Cluster 4.0 	–	–	–	–
<ul style="list-style-type: none"> – Clusters' sector specific requirements and developments towards Industry 4.0 	–	–	–	–
– Competences and skills				
<ul style="list-style-type: none"> – Cluster strategy development, implementation and monitoring (targeting value added cluster services along the related value chains) 	–	–	–	–
<ul style="list-style-type: none"> – Communication skills to motivate staff for cluster organisational and service change, self-development, lifelong learning, becoming drivers of cluster development 	–	–	–	–
<ul style="list-style-type: none"> – Interpersonal skills 	–	–	–	–

- Fostering teamwork with the cluster ecosystem, Enabling others for collaboration	-	-	-	-
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8. Internationalisation

- Capacities and skills	- Necessity and relevance			
	- Management lacks these skills/knowledge - specific trainings are strongly recommended	- It is acquired by the management to some extent, endorsement is needed	- Management and training is not relevant	- It is not relevant in our sector/cluster
- Knowledge				
- Standard evolution	-	-	-	-
- Global mega trends, global value chain development, cluster internationalisation, market trends and expectations	-	-	-	-
- Financing opportunities (EU, national and other international donors financed subsidies, grants, investment incentives, loans, crowdfunding, business accelerators)	-	-	-	-
- Technology trends	-	-	-	-



– Competences and skills				
– Analysis of competencies and resources of the cluster management and cluster members,	–	–	–	–
– Value chain and market analysis to establish the cluster and point cluster members' internationalisation potential,	–	–	–	–
– Definition of internationalisation processes, from cluster collaboration through members' engagement, to entering foreign/ third markets and generating joint projects (R&D&I, trade and investment projects)	–	–	–	–
– Generating joint projects (i.e. targeting and involving appropriate partners, designing project outline, establishing funding options and acquiring financial resources (projects of clusters/partnerships and stakeholders and/or projects of cluster members with other companies and stakeholders)	–	–	–	–
– Generating collaboration with worldwide industrial and research leaders	–		–	–

– Communication and communicative competences and skills				
– Networking, fostering international cooperation, Building cluster co-operations and partnerships, Representation of the cluster, and cluster members' interests, Raising the visibility and notoriety of the cluster strengths	–	–	–	–
– Organising and engaging in results driven C2C and B2B meetings	–	–	–	–
– Presentation and techniques for better negotiation	–	–	–	–

9. Entrepreneurship and Innovation

– Necessity and relevance				
– Capacities and skills	– Management lacks these skills/knowledge - specific trainings are strongly recommended	– It is acquired by the management to some extent, endorsement is needed	– Management masters it and training is not relevant	– It is not relevant in our sector/cluster
	– Knowledge			
– Innovation policies and innovation management tools	–	–	–	–

– Business consultancy know-how	–	–	–	–
– Funding opportunities, Private VC know-how	–	–	–	–
– Competences and skills				
– Identifying opportunities for business development projects along the value chain gaps within and across clusters, and targeting industrial modernization, cross-sectoral, cross-border value chain development or development of emerging industries	–	–	–	–
– Engaging cluster members in innovation based business development projects	–	–	–	–
– Provision of assistance in successful project implementation and follow-up	–	–	–	–

10. Management

– – – – – Capacities and skills	– Necessity and relevance			
	– Management lacks these skills/knowledge – specific trainings are strongly recommended	– It is acquired by the management to some extent, endorsement is needed	– Management masters it and training is not relevant	– It is not relevant in our sector/cluster

– Knowledge				
– General management concepts and tools	–	–	–	–
– Ecosystem (members of the cluster and their skills)	–	–	–	–
– Value chain management, Cluster service development	–	–	–	–
– Project management	–	–	–	–
– Competences and skills				
– Value chain management skills and value chain analysis and definition of cluster role (i.e. through working groups or the involvement of cluster members)	–	–	–	–
– Project management and team management capacities related to projects generated by the cluster	–	–	–	–
– General organisational and management skills (i.e. running, supervising operational tasks, etc)	–	–	–	–
– Communicative skills				
– Steering team meetings, mediation, and related soft skills	–	–	–	–

11. Digital skills

– – – – Competences and skills	– Necessity and relevance			
	– Management lacks these skills and competences - specific trainings are strongly recommended	– It is acquired by the management to some extent, endorsement is needed	– Management masters it and training is not relevant	– It is not relevant in our sector/c luster
– Skills on the use of CRM	–	–	–	–
– Developer and manager skills to spot the wider business opportunity (e.g. for AI, automation)	–	–	–	–
– Skills to tailor AI applications to enhance companies and optimise business processes	–	–	–	–
– Digital project skills: team member (such as product owners/managers, channel managers and other highly skilled talent)	–	–	–	–
– Skills in new technologies (IoT, big data, Fin Tech)	–	–	–	–
– Data analytics	–	–	–	–
– E-marketing, website, online platform development	–	–	–	–

– Safety related competences	–	–	–	–
------------------------------	---	---	---	---

12. Language skills

- Indicate the level of necessity and relevance of further training of your cluster management and staff for the listed language skills:

– Language	– Necessity and relevance			
	– Management lacks language capacity -trainings are strongly recommended	– It is acquired by the management to some extent, endorsement is needed	– Management masters it and training is not relevant	– It is not relevant in our sector/cluster
– English				
– Proficient English for work, meetings, interactions	–	–	–	–
– Other language				
– Language:.....	–	–	–	–

13. Other

- Mention any other abilities, capacities, skills and competences that are relevant in your cluster towards a smart economy, and indicate training needs if relevant:

–

–

–

–

–

– **CLUSTER4.0 INDUSTRY4.0**
– **ABILITIES, CAPACITIES, SKILLS AND COMPETENCES OF CLUSTER MANAGERS**
– **QUESTIONNAIRE 2**

– Introduction

– This survey aims to gather all relevant **cluster management abilities, knowledge, skills and competences** that enable clusters to become the drivers of innovation, acceleration and collaboration, to foster cross-sectoral and cross-border technological development (Cluster 4.0) towards a smart economy (in the fourth industrial revolution, Industry 4.0).

– The survey is conducted in the framework of the **Cluster4Smart** project (ERASMUS+ programme, 2017-2020), which aims to expand the knowledge of clusters' managers of Europe through the **development of an innovative, online training resource tool**.

– For this project, clusters (SCS, France – leading partner, AMUEBLA, Spain, ArchEnerg and IKOSZ, Hungary), universities and research institutes (University of Strasbourg, France, and Fraunhofer Institute for Systems and Innovation Research, Germany) and a business stakeholder (European Business and Innovation Center of Burgos, Spain) have teamed up.

– This questionnaire is developed for cluster stakeholders such as regional administrations, local authorities, regional development agencies, innovation and research facilities involved in cluster policy or cluster related project development and is expected to gather the overall skills of the staff and not only the skills of the person directly in charge of cluster management of the given cluster(s) in the related ecosystem. If potentially several clusters can be evaluated in the given region, for each cluster separate questionnaire shall be prepared.

– Reference

– **Ability:** permanent characteristic of the individual that influence performance

– **Knowledge:** organized sets of principles and facts applying in general domains

– **Skills and competences:** developed capacities that facilitate learning or the more rapid acquisition of knowledge and/or that facilitate performance of activities that occur across jobs

– **Industry 4.0** describes the organisation of production processes based on technology and devices autonomously communicating with each other along the value chain, namely, a model of the 'smart' factory of the future where computer-driven systems monitor physical processes, create a virtual copy of the physical world and make decentralised decisions based on self-organisation mechanisms. The concept takes account of the increased digitalisation of manufacturing industries where physical objects are seamlessly integrated into the information network, allowing for decentralised production and real-time adaptation in the future. Related terms used internationally include Internet of Things, Internet of Services, Industrial Internet, Advanced Manufacturing and Smart Factory.

– **Cluster 4.0** encompasses the terms used for of a World Class Cluster that provides competitive cluster services to foster regional development through cross-border and cross-sectoral cooperation in addition to interregional collaboration and investments towards smart specialisation strategies. These clusters of the front line are able to provide their members with

business advisory services to cope with challenges of Industry 4.0 and to trigger value chain development and creation through innovation, acceleration and internationalisation.

–

– **Identification**

-
- Cluster stakeholder type:
 - regional administration,
 - local authority,
 - regional development agency,
 - innovation and research facility,
 - other (please specify):
 -
 - Number of clusters considered for the survey:
 - Country:
-

–

1. The sector of the cluster considered for the survey, as regards smart specialisation, S3 EU priorities (select up to three specializations)

-
- Aeronautics & Space
 - Agricultural Services
 - Blue growth
 - Construction
 - Creative, cultural arts & entertainment
 - Cultural and creative industries
 - Digital Agenda
 - Energy production & distribution
 - Human health & social work activities
 - Information & Communication Technologies (ICT)
 - KETS
 - Manufacturing & Industry
 - Mining & quarrying
 - Nature & biodiversity
 - Public administration, security & defence
 - Public health and security
 - Service innovation
 - Services
 - Social innovation
 - Sustainable innovation
 - Tourism, restaurants & recreation
 - Transporting & storage
 - Water supply, sewerage, waste management & remediation activities
 - Wholesale & retail trade
-

–

2. Cluster Management Excellence label – under the European Cluster Excellence Initiative - ESCA:

-
- Gold
 - Silver
 - Bronze
 - Under application and assessment

- Not applicable

–

3. Other international cluster certification/accreditation schemes

–

- Please specify:

–

4. Other international cluster certification/accreditation schemes

–

- Please specify:

–

–

–

5. Relevance of Industry 4.0 as regards the considered cluster's profile

–

- Indicate which areas mentioned below are in focus at the considered cluster and so it would require further capacity building:

–

Digitalisation including ICT, IoT, CPS

Vertical markets including:

smart factory

energy (smart grids)

mobility

health

- Not applicable

–

- Indicate the relevance of further training of the considered cluster's management and staff for the listed abilities, knowledge, skills and competences:

6. Core work-related skills

–

- Select the 3-5 most important abilities, basic and cross-functional skills for which further trainings are to be pursued by cluster management.

–

<p>–</p> <p>–</p> <p>– Core work-related skills</p>	
<p>– Abilities</p>	
– Creativity: to think outside the box that results in innovative, novel solutions for a task	–
– Cognitive flexibility: mental ability to switch between thinking about two different concepts, and to think about multiple concepts simultaneously	–
<p>– Basic Skills</p>	
– Content skills – ICT literacy: Analyse software specifications, utilise computer aided software engineering tools, use programming, integrate system components etc.	–
– Process skills – Critical thinking: Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems	–
<p>– Cross-functional skills</p>	
– Complex problem solving skills: Developed capacities used to solve novel, ill-defined problems in complex, real-world settings	–
– Social skills – Coordinating with others: Adjusting actions in relation to others' actions.	–
– Social skills – Emotional Intelligence: self-awareness, self-regulation, self-motivation, empathy	–
– Social skills – Negotiation: Bringing others together and trying to reconcile differences	–
– Social skills – Service orientation: Actively looking for ways to help people	–

– Resource management skills – People management: Motivating, developing, and directing people as they work, identifying the best people for the job	–
– Systems skills - Judgement and decision making: Considering the relative costs and benefits of potential actions to choose the most appropriate one	–

–

7. Leadership

- Select the 3 most important capacities, skills and competences for which further trainings are to be pursued by cluster management.

– Capacities and skills	
– Knowledge	
– Trends regarding cluster development, such as Cluster 4.0	–
– Clusters' sector specific requirements and developments towards Industry 4.0	–
– Competences and skills	
– Cluster strategy development, implementation and monitoring (targeting value added cluster services along the related value chains)	–
– Communication skills to motivate staff for cluster organisational and service change, self-development, lifelong learning, becoming drivers of cluster development	–
– Interpersonal skills	–
– Fostering teamwork with the cluster ecosystem, Enabling others for collaboration	–

8. Internationalisation

-
- Select the 3 most important capacities, skills and competences for which further trainings are to be pursued by cluster management.

–	
– Capacities and skills	
– Knowledge	
– Standard evolution	–
– Global mega trends, global value chain development, cluster internationalisation, market trends and expectations	–
– Financing opportunities (EU, national and other international donors financed subsidies, grants, investment incentives, loans, crowdfunding, business accelerators)	–
– Technology trends	–
– Competences and skills	
– Analysis of competencies and resources of the cluster management and cluster members,	–
– Value chain and market analysis to establish the cluster and point cluster members' internationalisation potential,	–
– Definition of internationalisation processes, from cluster collaboration through members' engagement, to entering foreign/ third markets and generating joint projects (R&D&I, trade and investment projects)	–

– Generating joint projects (i.e. targeting and involving appropriate partners, designing project outline, establishing funding options and acquiring financial resources (projects of clusters/partnerships and stakeholders and/or projects of cluster members with other companies and stakeholders)	–
– Generating collaboration with worldwide industrial and research leaders	–
– Communication and communicative competences and skills	
– Networking, fostering international cooperation, Building cluster co-operations and partnerships, Representation of the cluster, and cluster members' interests, Raising the visibility and notoriety of the cluster strengths	–
– Organising and engaging in results driven C2C and B2B meetings	–
– Presentation and techniques for better negotiation	–

–

9. Entrepreneurship and Innovation

–

- Select the 3 most important capacities, skills and competences for which further trainings are to be pursued by cluster management.

–

–	
– Capacities and skills	
– Knowledge	
– Innovation policies and innovation management tools	–
– Business consultancy know-how	–

– Funding opportunities, Private VC know-how	–
– Competences and skills	
– Identifying opportunities for business development projects along the value chain gaps within and across clusters, and targeting industrial modernization, cross-sectoral, cross-border value chain development or development of emerging industries	–
– Engaging cluster members in innovation based business development projects	–
– Provision of assistance in successful project implementation and follow-up	–

–

10. Management

–

- Select the 3 most important capacities, skills and competences for which further trainings are to be pursued by cluster management.

–

<p>–</p> <p>–</p> <p>– Capacities and skills</p> <p>–</p> <p>–</p>	
– Knowledge	
– General management concepts and tools	–
– Ecosystem (members of the cluster and their skills)	–
– Value chain management, Cluster service development	–

– Project management	–
– Competences and skills	
– Value chain management skills and value chain analysis and definition of cluster role (i.e. through working groups or the involvement of cluster members)	–
– Project management and team management capacities related to projects generated by the cluster	–
– General organisational and management skills (i.e. running, supervising operational tasks, etc)	–
– Communicative skills	
– Steering team meetings, mediation, and related soft skills	–

–

11. Digital skills

–

- Select the 3 most important capacities, skills and competences for which further trainings are to be pursued by cluster management.

–

– Competences and skills	
– Skills on the use of CRM	–
– Developer and manager skills to spot the wider business opportunity (e.g. for AI, automation)	–
– Skills to tailor AI applications to enhance companies and optimise business processes	–

– Digital project skills: team member (such as product owners/managers, channel managers and other highly skilled talent)	–
– Skills in new technologies (IoT, big data, Fin Tech)	–
– Data analytics	–
– E-marketing, website, online platform development	–
– Safety related competences	–

–

12. Language skills

–

- Indicate if further trainings for English and other language skills are considered to be necessary for the clusters:

–

– – Language Skills	
– Proficient English for work, meetings, interactions	–
– Other languages, such as:.....	–

13. Other

–

- Mention any other abilities, capacities, skills and competences that are relevant in the clusters considered towards a smart economy, and indicate training needs if relevant:

–

8.3 Annex 3: Endorsement phase own survey results

Cluster 4.0 Industry 4.0 Abilities, Capacities, Skills and Competences of Cluster managers

ENDORSEMENT SURVEY RESULTS

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28 December 2017

Introduction

This survey aimed to gather all relevant cluster management abilities, knowledge, skills and competences that enable clusters to become the drivers of innovation, acceleration and collaboration, to foster cross-sectoral and cross-border technological development (Cluster 4.0) towards a smart economy (in the fourth industrial revolution, Industry 4.0).

The survey was conducted in the framework of the Cluster4Smart project (ERASMUS+ programme, 2017-2020), which aims to expand the knowledge of clusters' managers of Europe through the development of an innovative online training resource tool.

For this project, clusters (SCS, France – leading partner, AMUEBLA, Spain, ArchEnerg and IKOSZ, Hungary), universities and research institutes (University of Strasbourg, France, and Fraunhofer Institute for Systems and Innovation Research, Germany) and a business stakeholder (European Business and Innovation Center of Burgos, Spain) have teamed up.

The online survey targeted cluster management/staff and cluster stakeholder organisations respectively in separate questionnaires during 4 weeks (20 November – 15 December 2017).

In total 146 replies were received: 97 from clusters and 49 from cluster stakeholder organisations.

In this report we provide a short summary of the results, which will be considered in the overall study prepared on clusters management abilities, skills and competences required towards smart industry.

Reference

Ability: permanent characteristic of the individual that influences performance.

Knowledge: organized sets of principles and facts applying in general domains.

Skills and competences: developed capacities that facilitate learning or the more rapid acquisition of knowledge and/or that facilitate performance of activities that occur across jobs

Industry 4.0 describes the organisation of production processes based on technology and devices autonomously communicating with each other along the value chain, namely, a model of the 'smart' factory of the future where computer-driven systems monitor physical processes, create a virtual copy of the physical world and make decentralised decisions based on self-organisation mechanisms. The concept takes account of the increased digitalisation of manufacturing industries where physical objects are seamlessly integrated into the information network, allowing for decentralised production and real-time adaptation in the future. Related terms used internationally include Internet of Things, Internet of Services, Industrial Internet, Advanced Manufacturing and Smart Factory.

Cluster 4.0 encompasses the terms used for of a World Class Cluster that provides competitive cluster services to foster regional development through cross-border and cross-sectoral cooperation in addition to interregional collaboration and investments towards smart specialisation strategies. These clusters of the front line are able to provide their members with business advisory services to cope with challenges of Industry 4.0 and to trigger value chain development and creation through innovation, acceleration and internationalisation.

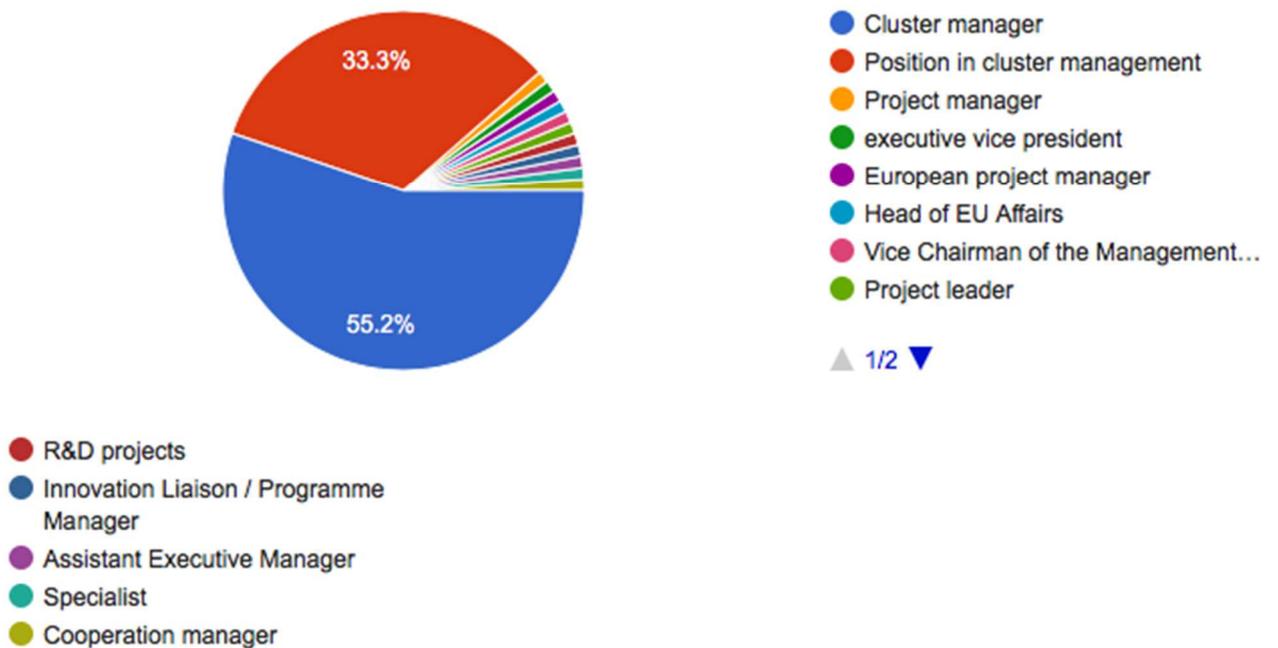
Survey results of Cluster managers/staff

In total 97 replies were provided by cluster managers or cluster staff.

Definition of respondents' role in the cluster

55,2 % of the respondents were cluster managers. The remainder is taking up various posts in the clusters, mainly managerial posts (see the chart below).

Chart 1: Respondents' position in the cluster



Number of years in the position

45 % of the respondents spent 5 years or more in the cluster. 10 % of them spent only 1 year. The rest acquires an experience of 1-4 years at clusters.

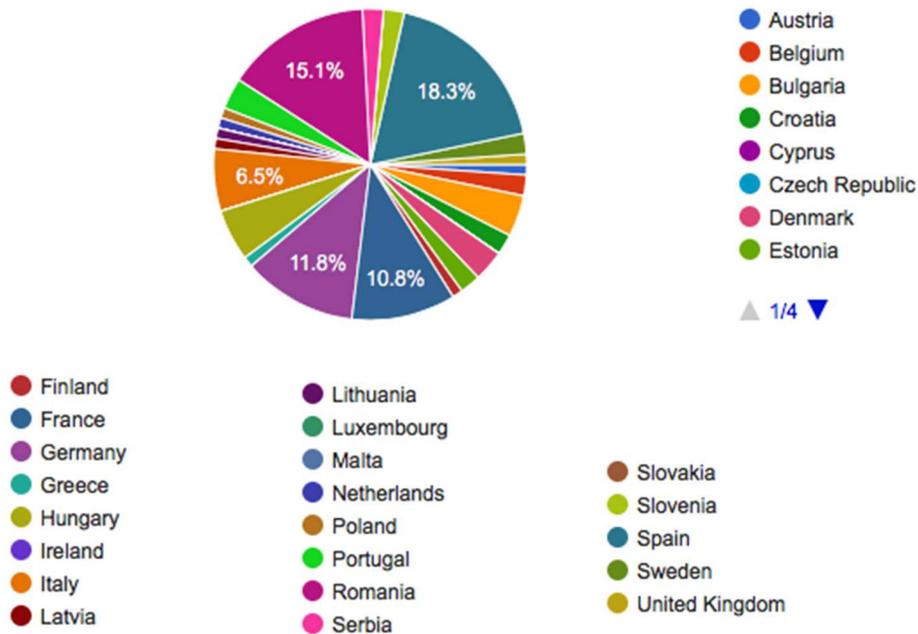
Year of establishment of the cluster

83 % of the respondents' clusters were established in 2013 and before, one in 1983. Thus, relatively small proportion of the respondents were from newly or recently established clusters.

Countries represented

As regards the geographical allocation of the replies, Spain (18,3 %) and France (10,8 %) provided the majority of the replies, followed by Romania (15,1 %), Germany (11,8 %), Italy (6,5 %) and Hungary (5,4 %).

Chart 2: Countries represented by the clusters

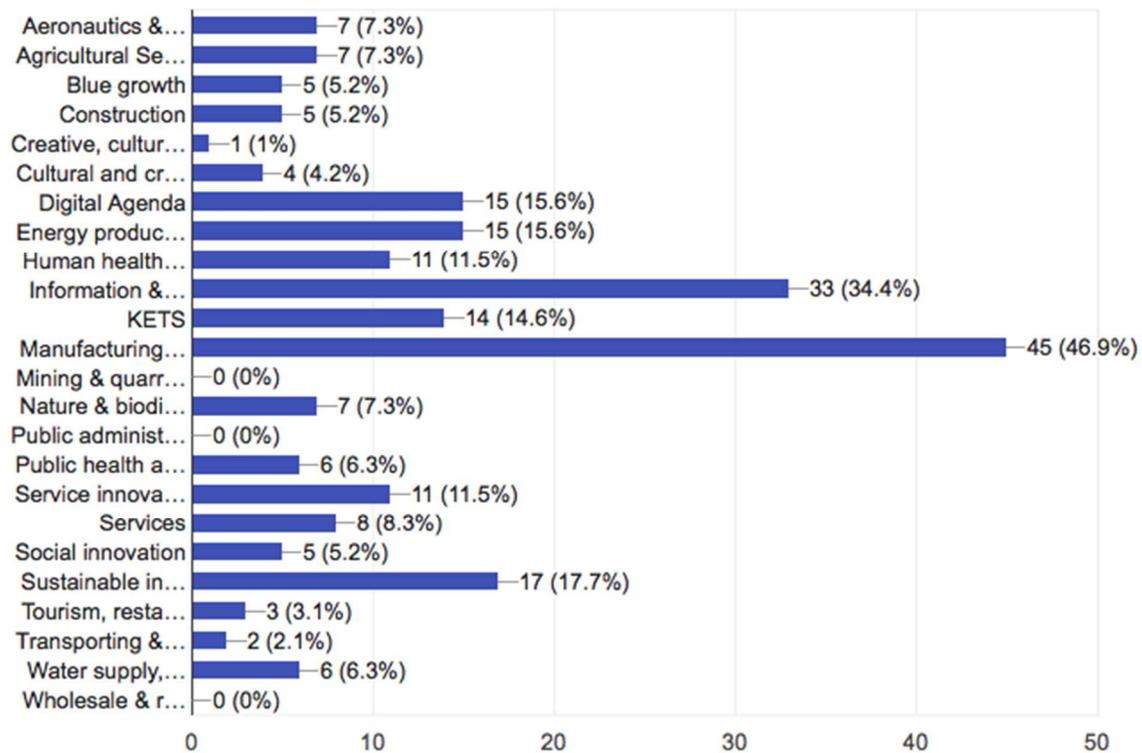


Sectors represented by the clusters

In respect of the S3 EU - smart specialisation priorities - the following sectors are represented by the observed clusters (proportion within total replies: 100 %):

- Manufacturing & Industry (20 %)
- ICT (14,5 %)
- Sustainable innovation (7,5 %)
- Digital Agenda (6,5 %)
- Energy production and distribution (6,5)
- KETS (6,2 %)
- Service innovation (4,8 %)

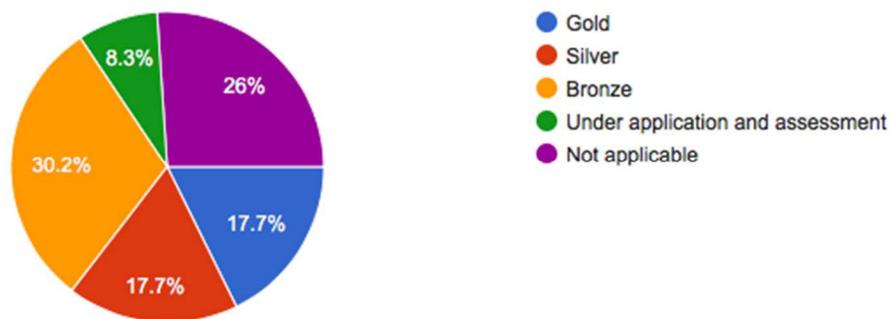
Chart 3: S3 EU smart specialisation priorities represented



Cluster Management Excellence label - under the European Cluster Excellence Initiative - ESCA

65,6 % of the respondent clusters have Clusters Management Excellence label (17,7 % Gold) and 26 % of them do not acquire such label and are not either under application and assessment.

Chart 4: Cluster Management Excellence label



Other international cluster accreditation/certification schemes

The following certification models were mentioned, although some of them belong to the national cluster accreditation/certification schemes:

- EFQM-Model silver
- Trace-kie
- Copernicus Relay
- ISTMA
- AEI - Innovative Grouping Clusters recognised by the Ministry of Industry Competitiveness and Energy of Spain
- ECHA Alliance
- Cluster Exzellenz Baden-Württemberg, Invented in Germany

Some specific international cluster collaborations were also listed:

- ESCP-4i 2017
- ENW ESCP-4i
- ECCP (2013), EPIC, (2016)
- ESCP for SEAMICI project (deep sea mining) and SpaceWave (Earth Observation)

Other national cluster accreditation/certification schemes mentioned:

- Polo di Innovazione regione Piemonte
- Agrupacion Empresarial Innovadora (AEI) in the Register of the Spanish Ministry of Economy and Competitiveness Education - cluster collaboration
- Go-cluster
- Bundesministerium für Wirtschaft und Energie (BMWi)
- ISO 9000
- Hungarian Accreditation for Innovation Cluster
- Questio Lombardy region
- Pôle de compétitivité: The national label for clusters in France recognised and supported by the French Government
- CEA and RSA - Aragon Region
- Grappes d'entreprises
- VIS
- Ranked 3rd as a developing cluster (national scheme)
- Cluster recognition and accreditation by Portuguese Government
- Excellence Cluster Label (Spanish Ministry of Economy)
- GZS, ACS
- POLO DI INNOVAZIONE in PIEDMONT region
- Catalonia clusters
- IAPMEI accreditation
- Accreditation by the National Associations of the Romanian Cluster
- Green certificate by CLUSTERO
- Romanian Cluster Association (CLUSTERO) certificate

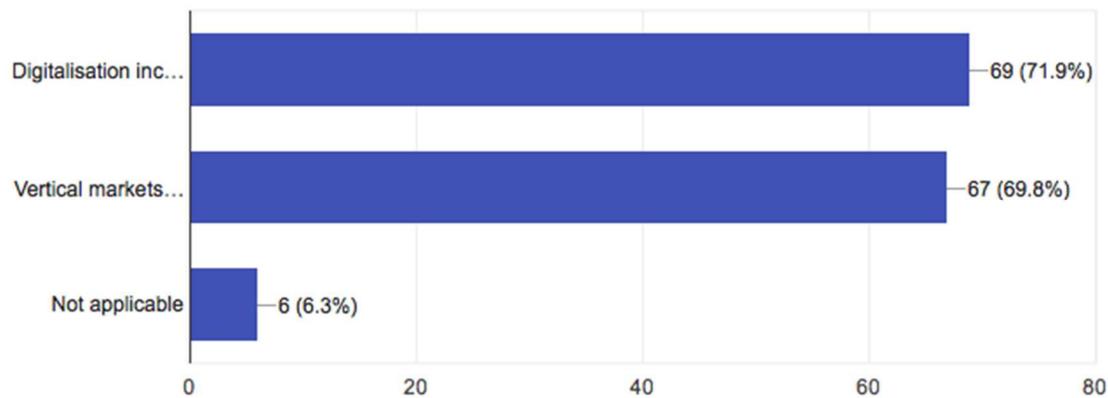
Relevance of Industry 4.0 as regards the interviewed cluster profile

6 % of the clusters replied that they are not related strongly to Industry 4.0 trends.

90 % of them are concerned either by both or one of the following trends:

- Digitalisation including ICT, IoT, CPS
- Vertical markets including: smart factory, energy (smart grids), mobility, health

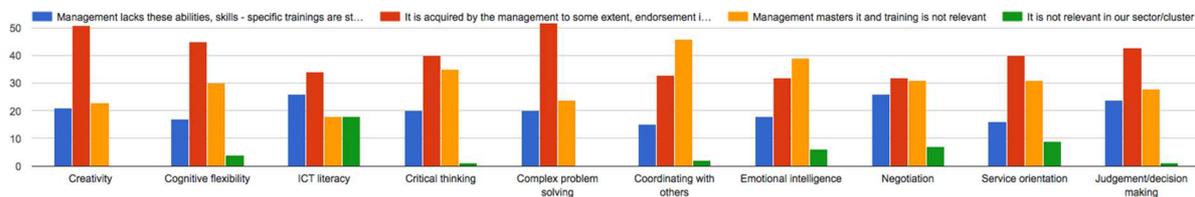
Chart 5: Relevance of Industry 4.0 trends



Core work-related abilities and skills in Industry 4.0

Creativity, Complex problem solving and Judgement and decision making skills were ranked high in the survey, signalling that over 70 % of the respondents consider that training is required for clusters management in these areas. In addition, cluster management needs training as regards Cognitive flexibility, ICT literacy and Critical thinking skills according to 60 % of the respondents.

Chart 6: Abilities - skills/relevance - necessity



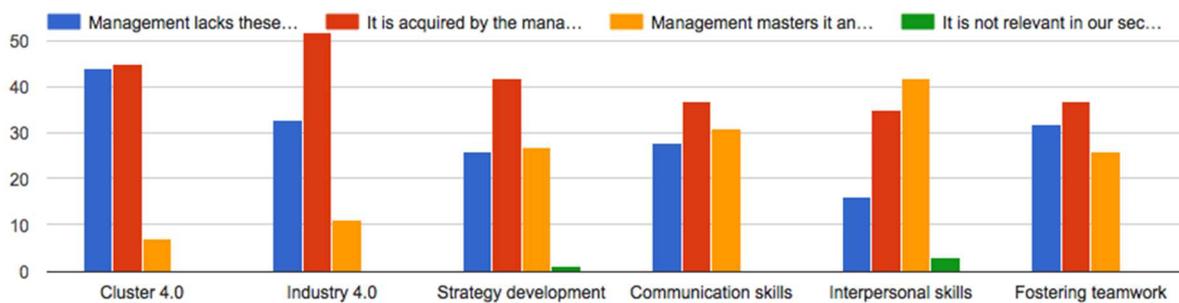
CAPACITIES, SKILLS AND COMPETENCES

Leadership

As regards leadership, the respondents considered the following knowledge and skills critical for driving a cluster successfully towards smart industry:

- Knowledge on Cluster 4.0 and Industry 4.0, (according to more than 90 % of respondents)
- Skills in strategy development and implementation along the related value chains and Fostering teamwork within the ecosystem, enabling others for collaboration (according to more than 60 % of respondents)

Chart 7: Leadership

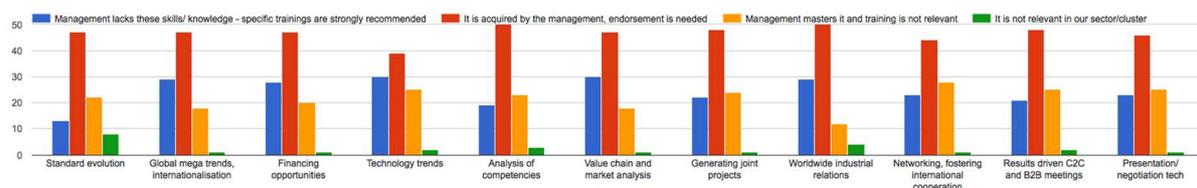


Internationalisation

For internationalisation, according to more than 70 % of the respondent cluster managers and staff, cluster management would need specific trainings as regards:

- Knowledge on global megatrends, internationalisation and financing opportunities
- Skills on collaboration with worldwide industry and research leaders, generation of joint projects of cluster members, value chain and market analysis

Chart 8: Internationalisation

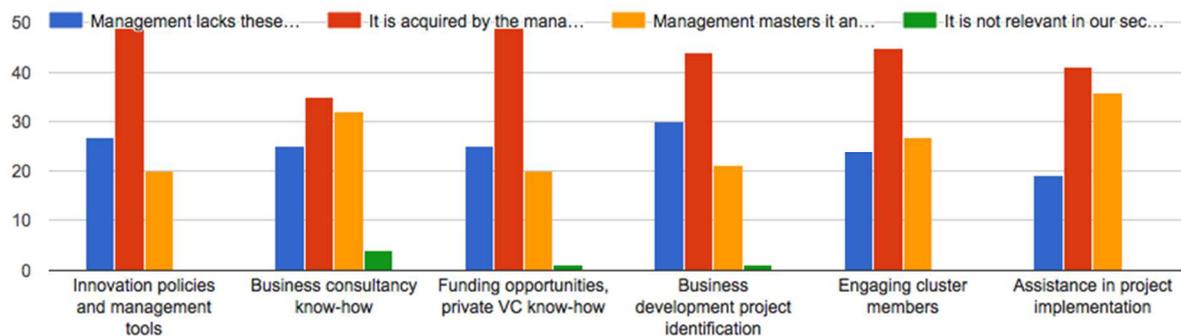


Entrepreneurship and Innovation

The 3 top ranked knowledge and skills (selected by more than 75 % of the respondents) in the survey were as follows:

- Knowledge on innovation policies and innovation management tools,
- Knowledge on funding opportunities, private VC know-how,
- Skills to identify opportunities for business development projects along the value chain gaps within and across clusters, and targeting industrial modernization, cross-sectoral, cross-border value chain development or development of emerging industries

Chart 9: Entrepreneurship and Innovation



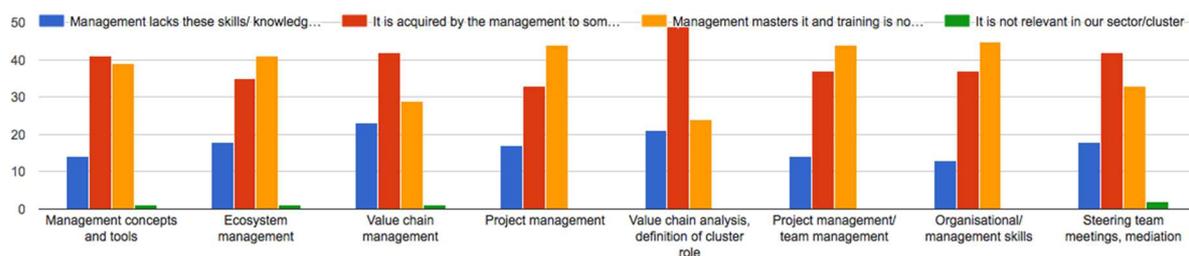
Management

As regards management:

- Knowledge on value chain management, cluster service development,
- Value chain management skills and value chain analysis and definition of cluster role (i.e. through working groups or the involvement of cluster members)
- Steering team meetings, mediation, and related soft skills

were considered the most important areas for capacity development of cluster management (by more than 60 % of the respondents).

Chart 10: Management



Digital Skills

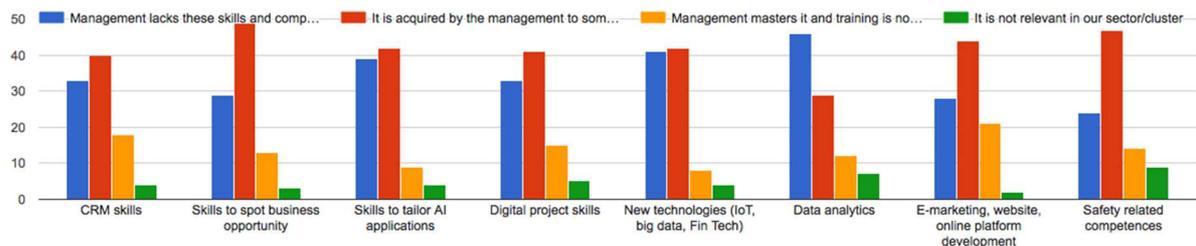
Among the digital skills, such as:

- Skills in new technologies (IoT, big data, Fin Tech)
- Developer and manager skills to spot the wider business opportunity (e.g. for AI, automation)
- Skills to tailor AI applications to enhance companies and optimise business processes

were considered the most relevant skills to further develop towards Industry 4.0 (by more than 82 % of respondents). However, the following skills were also considered important - with somewhat less significance than the previous ones:

- Digital project skills: team member (such as product owners/managers, channel managers and other highly skilled talent)
- Data analytics

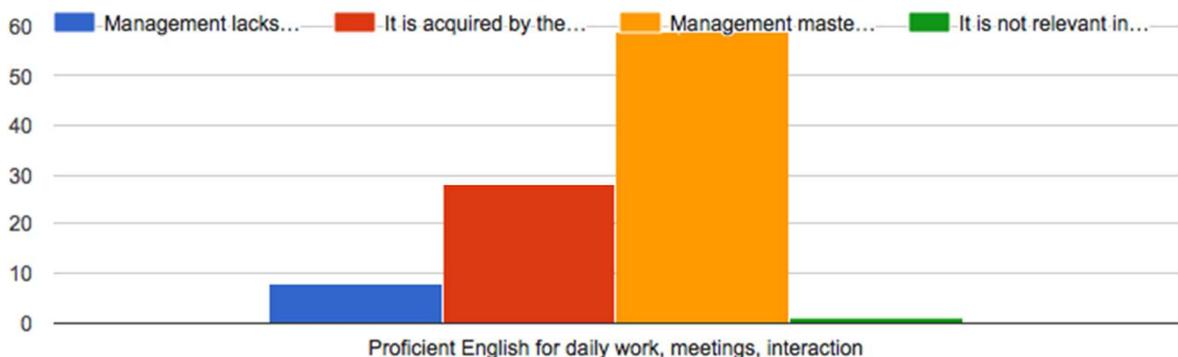
Chart 11: Digital skills



Language skills

62 % of the respondents consider that clusters' management have proficient English for daily work, meetings and interactions.

Chart 12: English language capacities



Under other language capacities Spanish (6), German (5), French (3), Chinese (2), Russian (2), Japanese were listed.

Other

As regards other abilities, capacities, skills and competences that are relevant in the clusters towards a smart economy training needs and other considerations were indicated as follows:

- Design thinking, strategic thinking, coaching skills, KPI definition and management,

- All methodologies working to identify need on the demand side,
- Power Point Training and presentation skills,
- Education of state management to support clusters and their internationalization, inclusion of volunteers and students,
- When dealing with I4.0 digital transformations, we also need to consider the traditional operations, better understanding how to hook traditional companies into transforming into digital. This should be through quick identification of a series of typical traditional business challenges traditional companies are faced with, in order to point to transformation opportunities. We sometimes lack the vertical, traditional operational expertise to make such a connection - resulting in being regarded too general and too much hype on I4.0
- Knowledge about alternative funding opportunities e.g. crowd-funding, venture capital
- Compliance on public programs on Digital Transformation, Industry 4.0
- Financial management

Survey results of Cluster Stakeholders

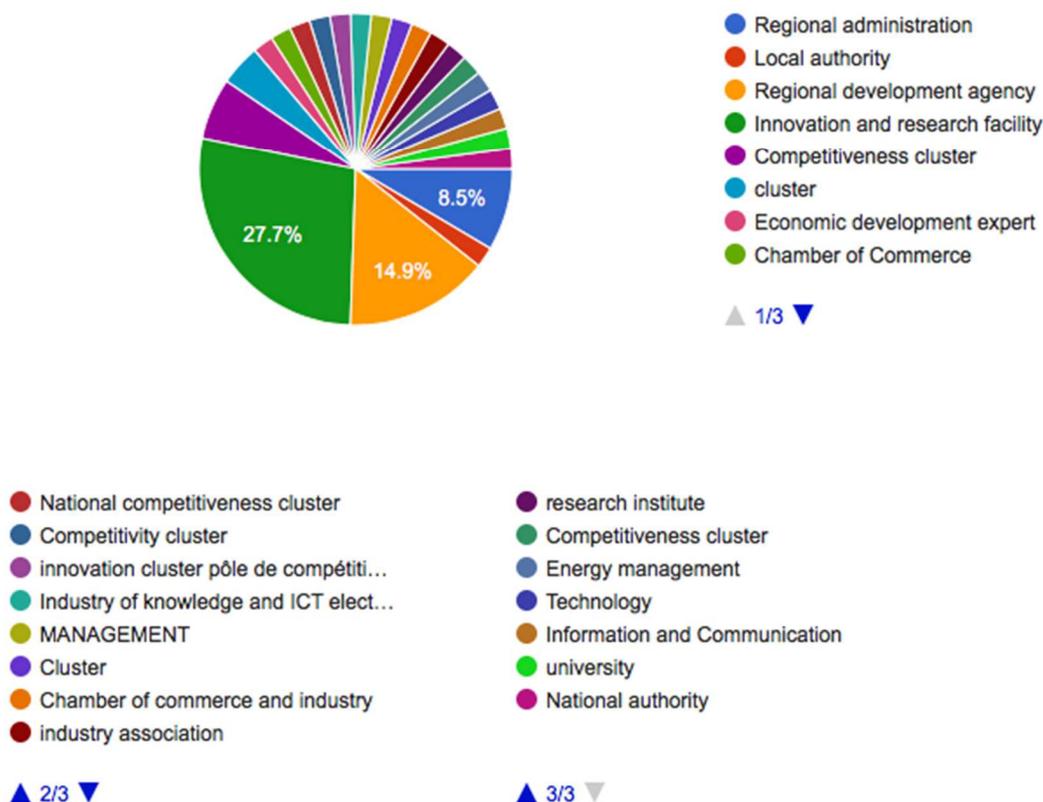
There were in total 49 answers received for the specific online questionnaire targeting cluster stakeholders.

Type of cluster stakeholders

Based on the type of organisations indicated, it is assumed that at least around 10 clusters provided reply also under the cluster stakeholder survey.

The bulk of the replies was provided by innovation and research facilities (27,7 %) and regional development agencies (14,9 %), but chambers of commerce, universities and regional or local administrations have also contributed to the survey.

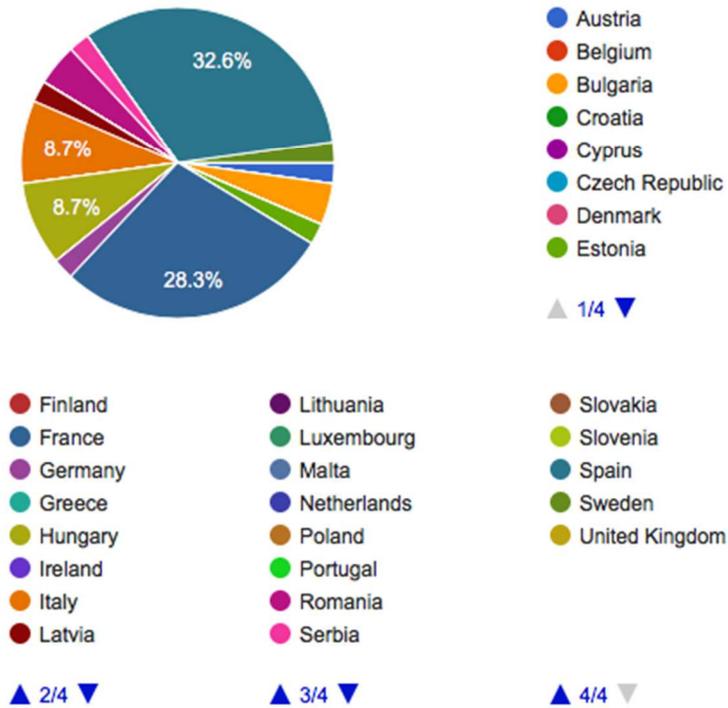
Chart 1: Type of cluster stakeholder



Geographical allocation of replies

As regards the geographical allocation of the replies, Spain (32,6 %) and France (28,3 %) provided the majority of the replies, followed by Hungary and Italy (8,7 % each).

Chart 2: Countries represented

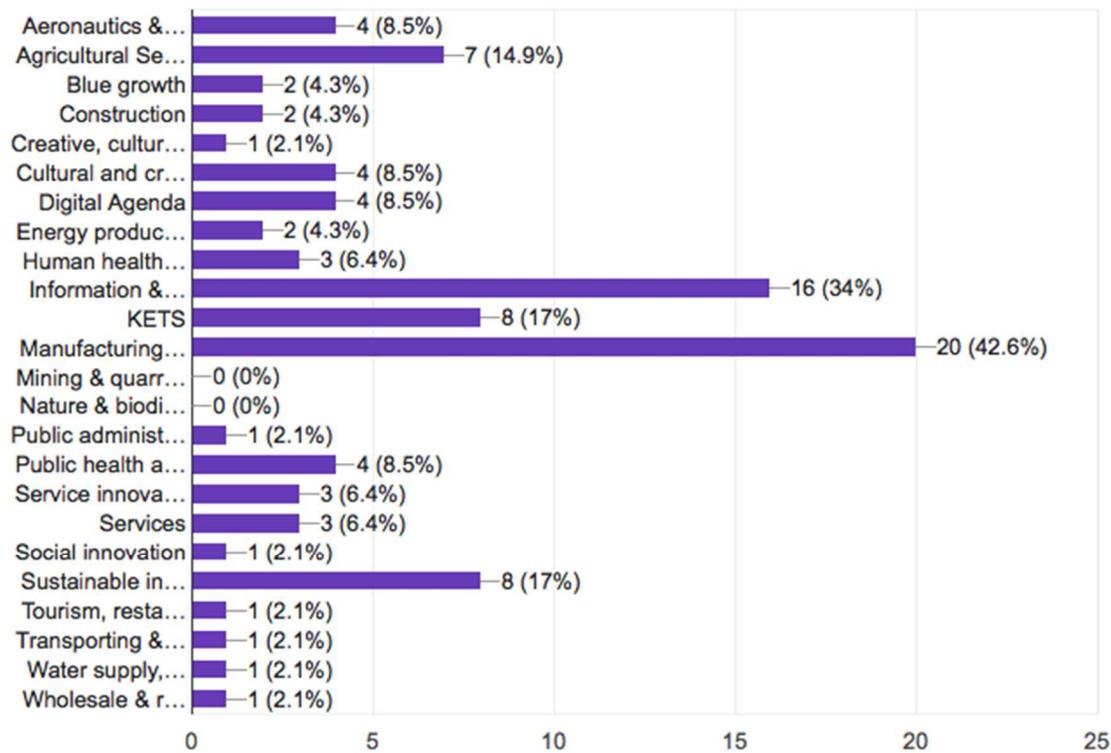


Sectors represented by the clusters considered

In respect of the S3 EU - smart specialisation priorities - the following sectors are represented by the observed clusters (proportion within total replies: 100 %):

- Manufacturing & Industry (20,6 %)
- ICT (16,4 %)
- KETS (8,2 %)
- Sustainable innovation (8,2 %)
- Agricultural services (7,2 %)
- Aeronautics and Space (4,1 %)
- Cultural and creative industries (4,1 %)
- Digital Agenda (4,1 %)
- Public health and security (4,1 %)

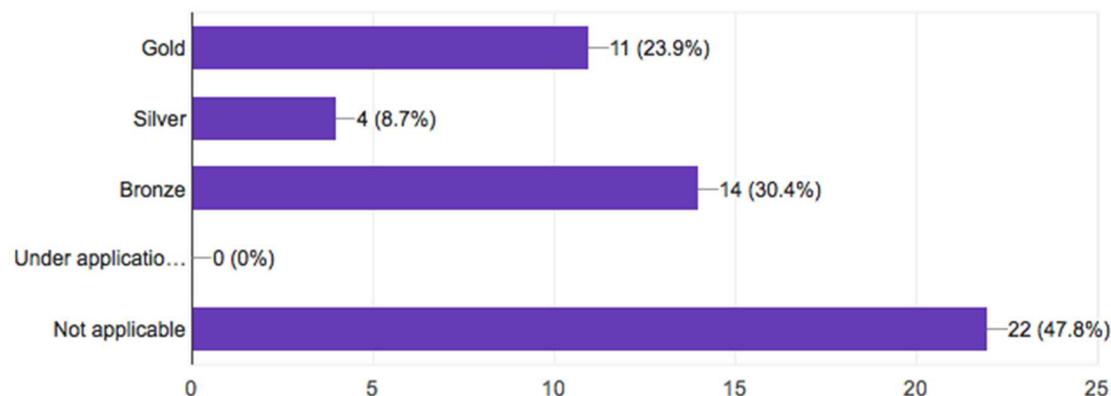
Chart 3: S3 EU smart specialisation priorities represented



Cluster Management Excellence label - under the European Cluster Excellence Initiative - ESCA

29 of the 51²⁵ considered clusters have Clusters Management Excellence label (out of which 11 Gold) and 22 of them do not acquire such label.

Chart 4: Cluster Management Excellence label



Other international cluster accreditation/certification schemes

²⁵ In some cases the respondents (49 in total) considered several clusters for the purpose of the survey.

Two of the clusters have specific certification scheme: EFQM Model Silver

Other national cluster accreditation/certification schemes mentioned:

- Catalonia Cluster / AEI - Agrupaciones Empresariales Innovadoras (3)
- Pôle de compétitivité (2)
- Official R&D centre
- Spanish Industry Ministry label (2)
- ISO 9001
- Spanish Label on Association of Innovation (Ministry of Industry)
- French Tech
- Questio Lombardy Region
- Polo di Innovazione

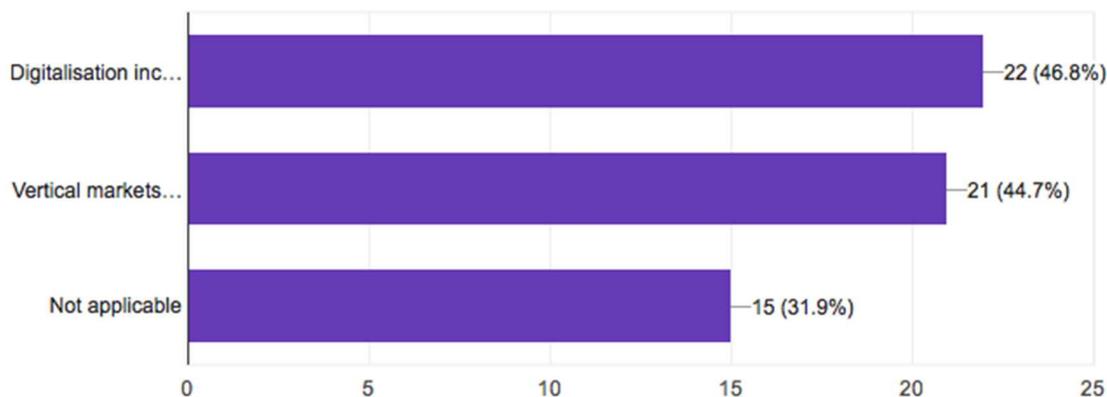
Relevance of Industry 4.0 as regards the concerned cluster profile

30 % of the clusters considered are not related strongly to Industry 4.0 trends.

70 % of them are concerned either by both or one of the following trends:

- Digitalisation including ICT, IoT, CPS
- Vertical markets including: smart factory, energy (smart grids), mobility, health

Chart 5: Relevance of Industry 4.0 trends



Core work-related abilities and skills in Industry 4.0

Creativity, Critical thinking and People management: Motivation were ranked high in the survey, signalling that in 40-50 % of the clusters considered, management lacks these core work-related abilities and skills.

Chart 6: Abilities - skills/relevance - necessity



CAPACITIES, SKILLS AND COMPETENCES

Leadership

As regards leadership, the respondents considered the following knowledge and skills critical for driving a cluster successfully towards smart industry:

- Stimulating teamwork in ecosystem,
- Strategic management of the cluster,
- Knowledge on Cluster 4.0 and Industry 4.0,
- Communication skills

Chart 7: Leadership



Internationalisation

For internationalisation, according to the cluster stakeholders, cluster managers of the considered clusters would need specific trainings as regards:

- Knowledge on global megatrends, internationalisation
- Skills on collaboration with world leader clusters and research facilities
- Knowledge on financing opportunities matched with the project needs

- Skills on generation of joint projects of cluster members
- Skills on definition of internationalisation process and related business development plan

Chart 8: Internationalisation



Entrepreneurship and Innovation

The 3 top ranked skills in the survey were as follows:

- Business development projects along the value chain gaps within and across clusters, and targeting industrial modernization, cross-sectoral, cross-border value chain development or development of emerging industries
- Engaging cluster members (i.e. SMEs, large companies, universities, research institutes, VET providers and other stakeholders) in innovation based business development projects
- Innovation policies/innovation management tools

Chart 9: Entrepreneurship and Innovation



Management

As regards management:

- Value chain management skills and value chain analysis and definition of cluster role (i.e. through working groups or the involvement of cluster members),
- Knowledge on the ecosystem (members of the cluster and their skills),
- Knowledge on value chain management, cluster service development, and
- Steering team meetings, mediation, and related soft skills

Were considered the most important areas for capacity development of cluster management.

Chart 10: Management



Digital Skills

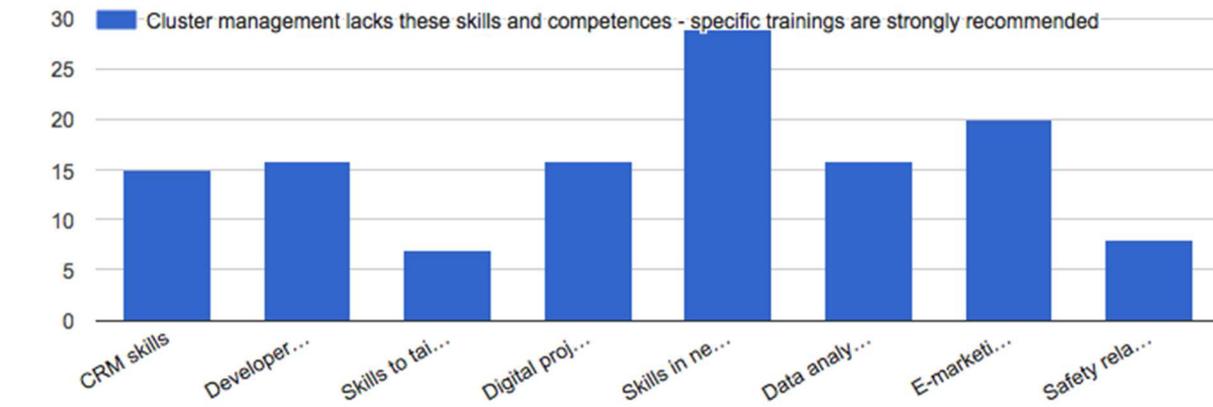
Among the digital skills, such as:

- Skills in new technologies (IoT, big data, FinTech)
- E-marketing, website, online platform development skills

were considered the most relevant skills to further develop towards Industry 4.0. However, the following skills were also considered equally important - with somewhat less significance than the previous two:

- Developer and manager skills to spot the wider business opportunity (e.g. for AI, automation)
- Data analytics
- Digital project skills: team member (such as product owners/managers, channel managers and other highly skilled talent)

Chart 11: Digital skills



Language skills

Half of the respondents considers that the considered clusters' management lacks proficient English for daily work, meetings and interactions.

Under other language capacities Spanish was mentioned in one case and techniques, such as active listening and machine languages and programming were listed.

Other

As regards other abilities, capacities, skills and competences that are relevant in the considered cluster towards a smart economy training needs in finances and need for capacity to continued learning were mentioned by the respondents.