# Disruptive innovations and forward-looking policies towards smart value chains

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# Business Innovation Observatory

# Trend report

## Disruptive innovations and forward-looking policies towards smart value chains

*Internal Market, Industry, Entrepreneurship and SMEs*

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## Disruptive innovations and forward-looking policies towards smart value chains

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# Executive summary

## Disruptive innovations

With constant monitoring of the physical body and integration of the data into cyber systems major disruptive innovations emerge, specifically in health. The human body is actually becoming a digitally connected part of the value chain in the health sector. Small, wireless solutions make remote monitoring of patients possible, and can increase quality of life, e.g. for elderly people who want to remain living independently at home. However, these innovations raise new privacy issues and call for new legal arrangements. Besides a wide range of Information and Communication Technology (ICT) companies, many different stakeholders are involved: investors, healthcare providers, insurance companies, patients, and governments. Each of these parties has their own concerns, vested in current legal and financial frameworks. Constant body monitoring disrupts this system. Transforming the system or value chains requires the involvement of all relevant stakeholders at an early stage, for example by setting up platforms in hospitals that can serve as living labs and incubators for constant body monitoring innovations.

The latest generation of robots is designed for safe, adaptable, and user-friendly interactions with humans within a defined collaborative setting. A breakthrough in the uptake of collaborative robots (co-bots) will substantially increase productivity and allow Europe to better compete for parts of the industrial value chain which are currently offshored to low cost countries. Flexibility and adaptability makes co-bots suitable for SMEs and first-time robot users, but there is still a lack of awareness and understanding of such advantages. This is not only a marketing issue or commercialisation challenge for robot producers, but also a public policy challenge for governments. Besides tackling standardisation, safety, and skill issues, finding ways to promote a wider uptake of robots in Europe is a major policy challenge.

According to the European Roadmap: Smart Systems for Automated Driving (EPoSS 2015), high degrees of road vehicle automation will soon be feasible, such as a Highway Autopilot in 2025, which would allow the driver to do other things while driving on a highway. Automated City driving will probably be feasible by 2030. Automated driving will increase safety, productivity, social inclusion, and energy efficiency. A future with driverless cars will be in sight after 2030, but all the possible disruptive implications in the long term go beyond imagination and are difficult to predict, e.g. in terms of future urban planning and the loss of employment in the logistics sector. Indeed, the disruptive nature of this innovation is not about introducing a new car on the market, but about transforming the whole transportation system. This transformation is necessarily a collaborative public-private undertaking. Besides the development of technology inside the car, specific legal frameworks, standards and infrastructure have also to be developed (demonstrated and implemented) in parallel.

## Trends towards smart value chains

Through the three trends of service innovation, traceability, and the Internet of Things, smart industries get connected in smart value chains. Industrie 4.0 in Germany is an example of a national policy programme to enhance this development towards smart value chains. The Internet of Things and Services enables traceability and value creation by Smart Factories in smart value chains, which in turn serve other domains such as smart mobility and Smart Health.

Hyper connectivity leads to a major shift from the linear value chain, to a non-linear 'value network.' Cyber-Physical Systems (CPS) are at the heart of this transformation to a network-based economy. Also human-robot collaboration, digital education and traceability contribute to this change, which includes legal and cultural aspects. For all stakeholders in the systems and value networks concerned this implies a drastic transformation in how consumers (and others) are reached, connected with, and engaged.

## Policy challenges

Most people celebrate hyper connectivity and use it to disclose large volumes of personal data. This has become part of modern life, but there are also concerns over privacy and data protection. Many Europeans feel they are not in control of their data, they do not know what happens to it, who has access to it, and for what purposes. Also companies want to be in control of their data and to be able to protect and secure it if they want to.

The ongoing EU data protection reform should facilitate the future implementation of the Digital Single Market, the deployment of the Internet of Things and of smart value chains (networks or systems). In this context, clear rules for data protection, privacy and security need to be set. In fact, as a major concern for potential users and partners in smart value chains, it is an important obstacle to the wider uptake of the trends, which needs to be tackled.

Successful standardisation facilitates interoperability between the elements and actors of smart value chains. Interoperability is not just a matter of convenience, e.g. in the case of a driverless car approaching a traffic light; it is a matter of life or death. Standards allow machines (tags, chips, robots, phones, beacons, cars, etc.) to understand each other and us. They facilitate communication, diffusion, cooperation, quality assurance, reliability, and efficiency of the operations within smart value chains, networks or systems. Since standards also need to be updated at times, a major policy challenge is to involve all relevant stakeholders in the process at an early stage.

Good practice policies concerning standardisation include: the e-health records programme in the US, standardisation in the German Industrie 4.0 programme, and the French programme to engage SMEs in the standardisation process. Since the value network in Industrie 4.0 comprises different companies with different business models and production processes, a single 'reference architecture' is needed to pull together the different approaches. For this purpose a standardisation roadmap has been set up in Germany. As for France, financial support is provided to SMEs involved in standardisation committees at European and international levels.

Digital skills in Europe are lagging behind in terms of the "IT literacy" of the population, as well as of the specialised ICT competence of the workforce. This situation is a barrier for the development of a digital society and of the Digital Single Market as well as for the development of smart value chains. Indeed, the rise and success of smart value chains require skilled workers, and the market uptake of new technological products is based on consumers having the digital skills to use them.

Addressing the paradox of skills shortages, increased "over qualification" of job seekers, and rising unemployment rates, has become vital in securing long-term economic growth and prosperity in Europe. The demand for ICT practitioners, with a growth of around 4% per year, is outstripping supply resulting in 500,000 unfilled jobs in 2015 compared to 274,000 in 2014. The deficit of ICT professional skills is forecast to reach 900,000 by 2020. Industry-academy collaboration should be encouraged and supported in all possible ways, notably through programmes like the Estonian MEKTORY programme or the Irish Webigate, or through the creation of dedicated platforms like the German PELIT or the British GO ON UK.

## Recommendations

Policy recommendations at various levels are provided in this report, with the aim of scaling-up existing good practices or developing new policy approaches. Based on the evidence of the case studies, relevant literature, interesting policy initiatives and the outcome of the Business Innovation Observatory Conference held in Brussels on 16 April 2015, policy makers (at EU, national and/or regional level) are invited to:

- Develop a smart regulation approach based on open and collaborative innovation ecosystems
- Develop an integrated and systemic approach to standardisation in order to ensure a higher degree of certainty and clarity for the introduction of innovative services and products
- Establish a regulatory framework for wearable technology
- Establish a solid cyber-security strategy
- Develop a systemic approach and methodology on industrial data protection to facilitate the introduction of innovations in smart value chains
- Harmonise and specify European regulations on minimum requirements for privacy provisions in new technologies such as connected cars, connected devices, and advanced tracking systems
- Carefully harmonise electronic health records initiatives while addressing privacy considerations
- Promote industry-academia collaboration in solving concrete business and engineering challenges in multi-disciplinary teams of students, as part of education
- Favour the accreditation of Massive Open Online Courses (MOOCs)
- Foster the access to market and the uptake of innovative solutions through increased support for pilots and demonstration programmes
- Encourage the creation of "smart financing chains" in line with Smart Value chains.

# 1. Disruptive innovations

Constant body monitoring, human-robot collaboration, and driverless cars are three of the most disruptive innovations likely to change our lives in the future: at home, at work and on our way to work. They will disrupt markets, sectors and value chains, and transform our transport and health systems. The stories of these three major innovations take a prospective view, anticipating breakthroughs in their wider uptake in the near future. Concrete examples in terms of the new products/services, companies, value chains and business opportunities concerned are discussed, as well as the transformative socio-economic impacts and related policy challenges.

## 1.1. Constant body monitoring

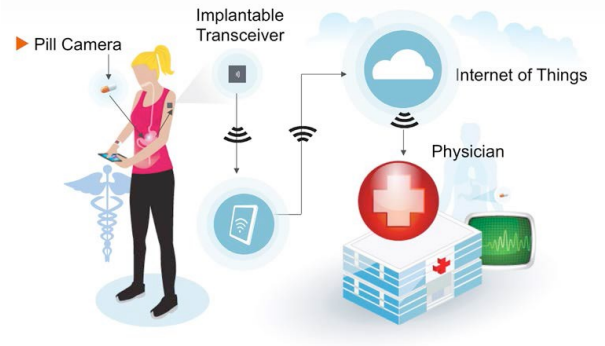
With constant monitoring of the physical body and the integration of data into cyber systems, major disruptive innovations emerge, specifically in health. The human body actually becomes a digitally connected part of the value chain in the health sector.

**Table 1: The disruption of constant body monitoring**

| | |
|---|---|
| Disruption | Integrating the physical body into cyber systems will change products, markets and value chains in health. |
| Challenges | Integration of ICT in the health system (cure, care and prevention).<br>Transformation of business models and value chains<br>Privacy issues and data security concerns. |
| Market opportunity | Multi-billion EUR market in health due to population ageing and increasing health costs<br>Opportunities across industries<br>Multiple stakeholders across value chains |
| Policy challenges | Address privacy issues<br>Update and harmonise regulations<br>Address data accessibility and security issues<br>Foster innovation in the public sector<br>Unleash the potential of public procurement of innovation<br>Invest in ICT infrastructure, organise Living Labs and support incubation<br>Identify and meet new workforce requirements (number, qualification, location of healthcare staff from nurses to doctors) |
| Relevant case studies | All case studies on the Internet of Things, more specifically: wearable technologies (case 44) and Smart Health (case 46). |

The disruption (Table 1) goes beyond new products and new companies replacing old ones. It also refers to the transformation of value chains in the private and public sectors which make up the health system. Furthermore, it raises new privacy issues, challenges outdated legal arrangements, and can improve the quality of life, e.g. for elderly people who want to remain living independently at home.

**Figure 1: Remote body monitoring**




*Source: David Niewolny*[1]

The key challenge faced by the health system is to integrate new ICT solutions. New business models have to be developed and adopted. Among the drivers there are growing health costs and an increasing demand due to an ageing population. Sweden's elderly care sector for instance will lack 150,000 trained healthcare staff by 2030[2]. The emergence of constant body monitoring is also driven by new ICT applications which enable patient data collection and analysis in real time. In remote monitoring (Figure 1), for instance, small, wireless solutions make it possible for patients in distant and rural areas to engage in effective health monitoring and to get advice from a specialist. Such digital monitoring solutions transform the traditional steps in the value chain of the health sector, because a physical visit to the doctor is not always necessary. The Serbian company *Nissatech*, for example, has developed MyCardioAdvisor, a mobile solution that can be personalised, allowing for dynamic, real-time monitoring of complex cardio issues.

*Source: Nissatech (case study 46)*

[1] How the Internet of Things Is Revolutionizing Healthcare, Available at: http://www.epd-ee.eu/print.php?id=8594

[2] http://www.robotdalen.se/en/technological-solutions-health-care-sector-and-elderly?language=en

**Figure 2: Body monitoring value chain**


*Source: adapted from Beecham Research Ltd. & Wearable Technologies AG*

Another example is a system developed by the Spanish company *MYSPHERA,* which enables the assessment of real-time location and condition of patients, staff and equipment via tags, bracelets and labels (Figure 3). People and equipment carry a tag that sends an identification 'frame' by radio frequency (radio-frequency identification, RFID). A beacon network receives the frame, passes it on to a server, which then passes it on to computers, laptops, smartphones and tablets used by hospital staff to find where people and equipment are located. This enables a more efficient and safe arrangement of (value chain) activities within a hospital.

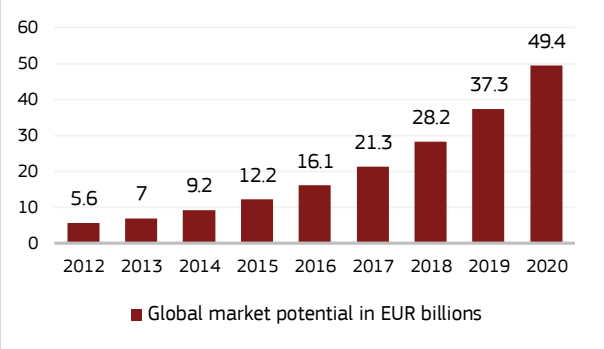
**Figure 3: MYSPHERA system of tags, bracelets and beacons to monitor patients, staff and equipment in a hospital**


*Source: MYSPHERA (case study 46)*

Companies that provide body monitoring solutions have a certain position along the Smart Health, or body monitoring value chain (Figure 2). They are often located in between technology developers and traditional healthcare providers. Many other stakeholders are also involved, e.g. for the financing. Indeed, the Smart Health or body monitoring value chain is financed by investors, healthcare providers (both from the public and private sector – big and small), insurance companies, patients and governments. Each of these stakeholders has their own concerns, vested in current legal frameworks. Constant body monitoring disrupts this system, and some stakeholders may obstruct the transformation. It is therefore important to collaborate and address the challenges in a systemic way, involving all relevant stakeholders in the process at an early stage.

The high market potential for this digital body monitoring is indicated by the size of the global market for mobile health solutions, which is estimated to reach EUR 49 billion by the end of 2020 (Figure 4). Besides, innovations for constant body monitoring may increase the efficiency and effectiveness of cure and care, generating new preventative treatments while limiting medical visits and even preventing hospitalisation.

**Figure 4: Global mobile health industry market size projection from 2012 to 2020 (in EUR billions)**




*Source: Statista - The Statistics Portal, available at http://www.statista.com/statistics/295771/mhealth-global-market-size/*

Constant monitoring is also disruptive in terms of privacy. In this respect, case study 44 on wearable technologies reports that 82% of respondents to a PwC survey said they were worried about wearable technology invading their privacy. Consumer concern is a clear barrier to the ongoing transformation and therefore needs to be addressed. Other obstacles to the uptake of constant body monitoring include: inadequate ICT infrastructure and culture in many hospitals; insurer behaviour; limited financial reach of public sector healthcare organisations; diverging approaches to electronic health records (EHR), and outdated legal frameworks with regard to modern technologies including wearable technologies. For instance, MYSPHERA products are only useful where electronic health records are in place. This is why Germany (not an early adopter of electronic health records) is a difficult market for MYSPHERA (case study 46).

*"Laws are pretty outdated with regard to modern technologies such as wearable tech. The digital self is a precious " – **Sensum** (case 44)*

*"Electronic Health Records are a necessary step before installing our product." – **MYSPHERA** (case 46)*

Medical insurance companies are already encouraging their participants to use health-improving wearable technology devices. However, because of the potential mishandling and abuse of the data collected, there are many legal challenges that need to be solved as body monitoring technology becomes more mainstream.

The differences within Europe concerning public procurement procedures and practices are another barrier to constant body monitoring innovations.

Besides these policy challenges, a number of good practices exist in the support of companies and start-ups operating in the field. One example is the Living Lab Salud Andalusia (LLSA), an open innovation network comprising public administration, universities, ICT corporations and end users (citizens, patients and healthcare professionals). LLSA consists of environments, platforms and resources for developing innovative technologies, services and initiatives. It started in 2008 with a framework agreement in which a pioneer group of 44 public and private stakeholders from both the technology-side and healthcare-side of the value chain took part in developing and validating new solutions.

**Figure 5: Giraff combines constant body monitoring with social interaction**


*Source: http://www.giraffplus.eu/*

Another interesting example comes from GiraffPlus, an EU-FP7 funded project combining constant body monitoring with robotics (the disruptive innovation dealt with in the next paragraph). Six elderly people across Europe currently have a new companion: a GiraffPlus robot (Figure 5). Mr. Robin, as people call the robot, helps elderly people who want to remain living independent at home. Using a network of sensors GiraffPlus[3] can monitor the body, as well as activities in and around the house. The sensors can for instance measure blood pressure and detect when someone falls down. The robot uses a Skype-like interface to allow relatives or caregivers to virtually visit an elderly person at home. This way it combines long-term monitoring with social interaction. *Giraff Technologies* is actually a US company which moved their business in 2009 from Silicon Valley to Robotdalen in Sweden, because of the strong reputation of the Swedish healthcare system. This confirms that body monitoring innovations thrive in strong and dynamic systems of value chain activities.

## 1.2. Human-robot collaboration

Traditional robots are used for large-scale, repetitive industrial work. For a long time human-robot collaboration has remained science fiction. However, a new generation of collaborative robots (or co-bots) is now entering the market, designed for direct interaction with humans within a defined collaborative setting. Co-bots are designed for safe, adaptable, and user-friendly interaction with the user, and often display human-like features such as dual arms and facial expressions.

*"OpiFlex' mobile robot platform opens up the automation segment for handicraft and small series production" – **Opiflex***

There is a division between military robots, agricultural robots, service robots, and industrial or manufacturing robots. The military robot share is expanding quickly, with 7,000 new robots per year, but other industries are also picking up fast. The agricultural sector is the runner-up, expanding with 4,000 robots per year. Consumer electronics robots are also showing promising growth, especially household robots (e.g. vacuum robots). The so-called soft and less programmable production and manufacturing robots for SMEs are also picking up speed, with 500 units growth annually (from 6,000 units currently)[4]. According to the World Robotics 2014 report, industrial robotics grew at an annual rate of about 9.5% between 2008 and 2013. Taking all sectors together, we are now witnessing a breakthrough for the collaborative robot.

*The e-vigilante is a surveillance robot for monitoring warehouses and other industrial sites.*

*Source: http://www.eos-innovation.eu/Produit/EVigilanteFr.sls*

[3] http://www.giraffplus.eu/

[4] Case study 45: Smart machines and tools

Cost savings and productivity gains are the main driving factors that fuel the demand for robots. It is currently almost as expensive to automate in European countries as it is in low-wage countries. Workforce salaries are different, but automation costs are mostly the same.

Collaborative robots for production are particularly apt at performing tasks such as packing, placing, storing, and searching. They can enhance the quality of workplace, as they free workers from 'dull, dirty and dangerous' jobs, thus allowing them to dedicate themselves to more interesting, creative and safe tasks. In general co-bots are inherently flexible and thus predestined for small-scale, adaptable production. This makes them particularly interesting for SMEs and first-time robot users.

Despite the market potential and positive societal impacts, there is still a lack of awareness and understanding of the relevance and added value of co-bots, a challenge which needs to be tackled not only at a marketing or commercialisation level by robot producers, but also by policymakers.

*"Production with robots is the only way to bring manufacturing back to the western world" – **Robotics Inventions** (Case study 45)*

Beyond productivity gains resulting from automation, the main disruption brought by co-bots concerns the complex transformative impact they have on labour (Table 2), whose nature (net impact on employment) is being debated and may not be answered conclusively. It is not that robots merely replace human labour and destroy jobs[5]. A breakthrough in the use of human-robot collaboration may also bring back 'offshored' parts of value chains, and thus contribute to maintaining manufacturing capabilities on the continent. Furthermore, it brings the emergence of new jobs and calls for the (re)training of the existing workforce to match the required qualifications. Public resistance to the introduction of robots for fear of job losses is a key policy challenge to be tackled.

**Table 2: The disruption of human-robot collaboration**

| | |
|---|---|
| Disruption | Robots bring (-back), change and destroy jobs and value chains |
| Challenges | Integration in society<br>Safety<br>Fears among potential users<br>Improve awareness and understanding through demonstrations and pilot projects |
| Market opportunity | Multi-billion EUR market<br>Across manufacturing and service industries |
| Policy challenges | Promote investment, experiments and usage in Europe<br>Promote demand for robots<br>Promote standards for safety<br>Address skill-gap and regulation gap |
| Relevant case studies | Human-robot collaboration (case 39), cyber-physical systems (case 37), smart machines and tools (case 45), and several cases from other semesters |

Standardisation of safety rules and mitigation of safety risks also form a crucial area for policymakers. Another key policy challenge is finding ways to promote investment, usage and experiments in Europe. For a long time, indeed, public policies have been focusing on the supply-side through support for R&D on robots.

As highlighted by the 2014 report of the Task Force on Advanced Manufacturing for Clean Production[6], Europe is the global leader in robotics research; yet our new robots are mainly used in Asia. New initiatives are needed to promote the use of robots in Europe, by for instance alleviating perceived risks of potential first time robot users. The implication of the fear among potential users for the disruptive aspects brought by robots is that producers' marketing costs for robot technologies are actually 10 times higher than their R&D costs. Most government bodies are reluctant to provide funding for 'commercial activities', but various policy instruments which promote demand for robots can fulfil an important role here (as financing robotics projects is a stumbling block for many companies, especially SMEs).

The "France Robot Initiative", which includes an initiative called "Robot Start SMEs", is an example of a relevant policy scheme to promote robots through the combination of financial and technical support. The idea is to help SMEs invest in their first robot (by covering 10% of the total amount of their investment) and to provide them with tailored technical support.

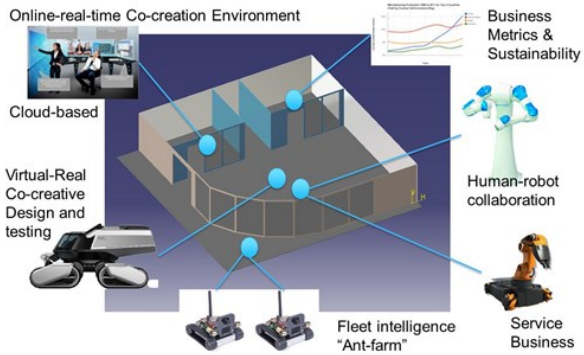
The Innovation Arena which is being built at the University of Tampere (Finland) is another example of a relevant policy initiative in the field[7]. The aim of this centre is to make abstract research on human-robot collaboration more tangible and understandable by providing an intelligent environment and "context-aware distributed systems showroom" (see Figure 6). This best practice shows that developing disruptive innovations should not be an isolated activity, but rather calls for arenas, showrooms, playgrounds and test beds as infrastructures for demonstration, experimentation and co-development.

[5] PwC, 2014, "The new hire: How a new generation of robots is transforming manufacturing"

[6] http://ec.europa.eu/enterprise/policies/innovation/policy/amt/index_en.htm

[7] See also the RIM plus thematic paper on initiatives at regional level (Wintjes 2014)

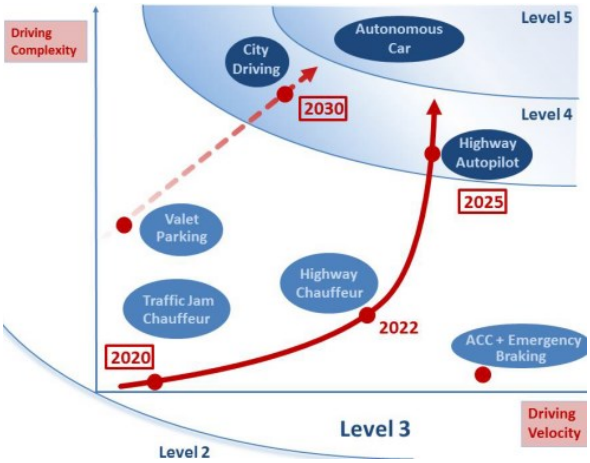
**Figure 6: Sketch of the planned Innovation Arena at Tampere University of Technology (2015)**




## 1.3. Driverless cars

A specific future application of human-robot collaboration and the Internet of Things that is likely to have major disruptive implications is the so-called driverless or autonomous car. Currently available driver assistance systems of level 2 (partial automation) include for instance valet parking and advanced forms of cruise control. Higher degrees of road vehicle automation (conditional automation of level 3 and high automation which is often referred to as level 4), will soon be feasible. By 2025 this should include Highway Autopilot, which would allow the driver to do other things while driving on a highway. Automated City Driving will probably be feasible by 2030 (Figure 7).

**Figure 7: European roadmap for automated driving**




*Source: European Roadmap: Smart Systems for Automated Driving (EPoSS, 2015)*

The main challenge for city driving lies in the traffic complexity, e.g. in communication among vehicles, negotiation with traffic signs, and monitoring of pedestrians. Another complication is also the regional specificity of this complexity. Since not all cities in Europe are the same, they do not share the same requirements for automated driving. In the Netherlands, for example, the many cyclists are a complicating factor, while elsewhere hilly and narrow streets are challenging.

According to the European Roadmap: Smart Systems for Automated Driving (EPoSS 2015)[8] automated driving will, in the long term, contribute to the reduction of road fatalities, increase productivity and social inclusion, and add value in terms of energy efficiency and environmental benefits. Since European car manufacturers and automotive suppliers have been successful in developing driver assistance systems, the trend towards Automated Driving also serves the competitiveness of European industry. A future with full automated driving will be in sight after 2030, but further disruptive implications can be difficult to predict: e.g. in terms of future urban planning and implications for employment in the logistics sector (Table 3).

**Table 3: The disruption of driverless cars**

| | |
|---|---|
| Disruption | The use of driverless vehicles will disrupt mobility, logistics, and value chains across a number of industries (e.g. the automotive, telecom and ICT sectors), and imply a loss of chauffeur jobs in the transport sector. |
| Challenges | Driverless vehicles are currently undergoing testing on public roads. Short-term challenges include: R&D, legal frameworks, awareness raising and infrastructure investments. Long-term challenges include rebalancing urbanisation and transport, e.g. adapting to new commuting and distribution patterns. |
| Market opportunity | Multi-billion EUR market for the various levels of automated driving<br>Multiple opportunities across industries in various supply chains with multiple stakeholders concerned |
| Policy challenges | Infrastructure investments<br>Address legislative and regulatory (liabilities) issues<br>Facilitate demonstration projects<br>Address safety and security<br>Standards |
| Relevant case studies | Mainly connected cars (case 43), but also human-robot collaboration (case 39). |

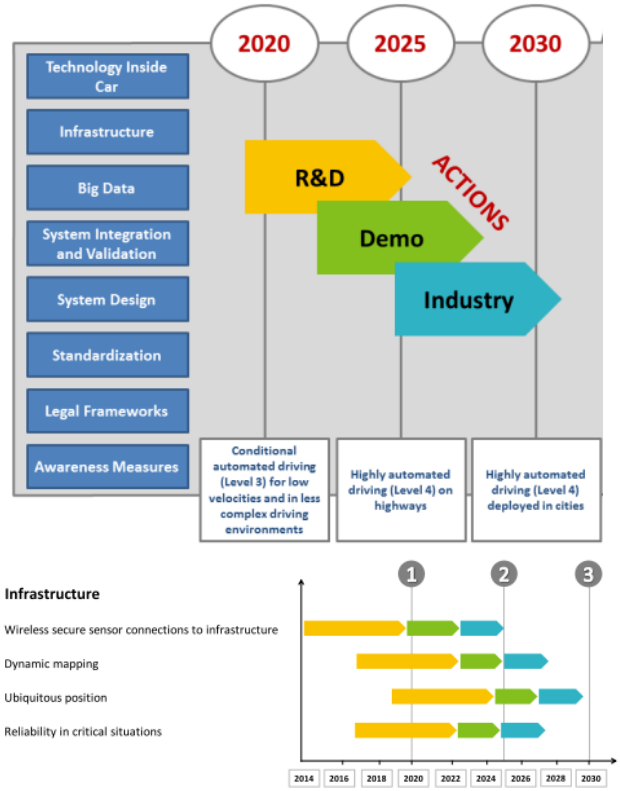
As the Swedish Transport Agency (2014)[9] reports: "the technology cannot be developed in isolation [...] development has to take place via a number of stakeholders acting in cooperation". The autonomous car is not only about introducing a new car on the market, but about transforming a whole traffic system. This transformation is necessarily a collaborative public-private undertaking.

[8] http://www.smart-systems-integration.org/public
[9] http://www.unece.org/fileadmin/DAM/trans/doc/2014/wp1/Autonomous_driving_eng_short.pdf

The aforementioned EU roadmap discusses the short term challenges and efforts which have to be made by the various stakeholders concerning R&D, demonstration and testing, and industrial and public investments on a wide range of activity fields, such as: technology inside the car, infrastructure, big data, system design, standardisation, legal frameworks and awareness measures (Figure 8). The roadmap shows indeed that 'the driverless car' is not only about the developing, testing, producing and marketing of a car. In parallel, also the transformation of infrastructure, standards and legal frameworks have to be developed, tested, implemented and lobbied for. This calls for public intervention and investments that go beyond R&D subsidies.

A very basic example of a regulatory hurdle is the Vienna Convention of 1968. According to Article 8: *"vehicles shall have a driver"*, and according to Article 13 *"Every driver of a vehicle shall in all circumstances have his vehicle under control..."*. An amendment to Article 8 from March 2014 allows the car to drive by itself, as long as the system *"can be overridden or switched off by the driver"*.

**Figure 8: Milestone structure of fields and actions for R&D, demonstration and testing, and production for automated driving, level 3 and 4**





*Legend: yellow= R&D; green=demonstration and testing; blue= production and market*
*Source: European Roadmap: Smart Systems for Automated Driving (EPoSS, 2015)*

As highlighted in the European roadmap, the lack of appropriate legal framework conditions is a major obstacle to the introduction of driverless cars. New legal frameworks have to be developed in parallel to technologies and infrastructure. Many different interests are at stake in this disruption and many actors have a role in transforming the traffic system.

In order to ensure social acceptance, it is for instance necessary that issues concerning data security and liability are discussed, demonstrated and solved. Moreover, these issues must be tackled at various levels and from the perspective of multiple stakeholders, ultimately reaching harmonised solutions.

An example of the successful integration of driverless vehicles in a protected urban environment is the European CityMobil2 project[10]. This project is based on an earlier developed French concept of "CyberCars". A small-scale demonstrator was tested in Sardinia in summer 2014. This involved two electric vehicles, without drivers, taking passengers in a loop between a beach and hotels.

The demonstration of a self-driving car by Google clearly showed how important it is to announce an ambition, present a vision and organise a demonstration that fuels imagination and innovation concerning driverless cars. Even when such demonstrations fail in some respects, they are still important for raising awareness, understanding, and participation of a wide range of stakeholders, including the general public.

[10] http://www.citymobil2.eu/en/

European vehicle manufacturers are therefore organising demonstration events which show impressive features and enable the broader audience to learn more about the latest developments. The EU roadmap (EPoSS 2015) and Meyer and Deix (2014) mention several examples of this.

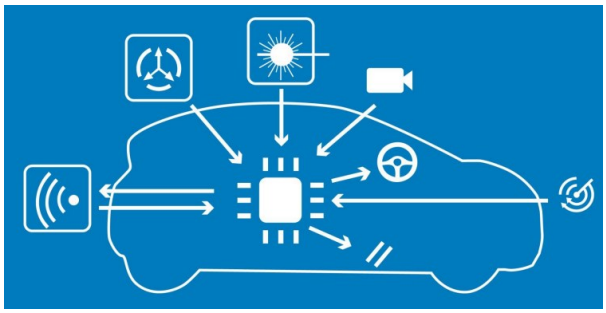
In 2013 Daimler tested its autonomous prototype car on public roads between Mannheim and Pforzheim. The so-called Future Truck from Daimler would also run without a driver (EPoSS 2015).

Renault demonstrated an autonomous valet parking technology, also in 2013, showing that an electric vehicle can drive without passengers in autopilot mode from a drop-off area to a parking lot or wireless charging station (Meyer & Deix 2014). In 2014 Renault unveiled its self-driving car prototype. The objective is to launch a self-driving electric vehicle by 2020, aiming at low-speed applications for city driving and autonomous valet parking.

According to Pultarova (2014) Spanish researchers from the University of Alicante succeeded in developing an automated driving system capable of learning from its environment, using interactive sensors for mapping the area and a camera to support the navigation system[11].

National policy initiatives to promote testing and demonstration have also been taken, e.g. in France, Germany, Sweden, the UK, and the Netherlands. The rationale for such initiatives includes environmental, social, and economic considerations. The priority among motives seems to differ among countries. E.g. for Sweden safety seems to be the most significant aspect, while in the UK fostering the competitiveness of the sector seems to be the main purpose .

In France a plan to build autonomous vehicles is part of 34 selected innovation fields which will contribute to a “new industrial France”[12]. A special role is foreseen for the development of sensors, control systems, software and services. The main aims are to improve traffic flow and allow elderly and disabled persons to take an active role in daily traffic.



In Germany a "Round Table for Automated Driving" has been established, led by the Federal Ministry of Transport and Digital Infrastructure[13]. This platform consists of experts in politics and insurance, vehicle manufacturers, suppliers and research institutions. Their main objective is to establish a legal framework to support automated driving on roads.

In Sweden, the initiative "Drive Me; Self-driving cars for sustainable mobility" has enabled a large research and testing project[14]. On about 50km of selected roads, in and around Gothenburg, 100 self-driving Volvo cars will be used daily by real commuters. The specific focus in this demonstration project is to test the impact on traffic flows in congested areas.

The British government initiated in 2014 "the green light to driverless cars". For policymakers in the UK the main motive is to develop a competitive advantage in the future market for driverless car innovations[15]. Four UK cities won a competition to host a driverless car trial and a portion of the about £9 million budget.

The Dutch Automated Vehicle Initiative (DAVI) is a public-private partnership initiated by scientific institutes and transport organisations[16]. This year (2015) the Netherlands will introduce legislation which enables automated driving on public roads. “The Amsterdam Group” is another relevant initiative, which consists of a strategic alliance working on cooperative ITS Services in Europe[17]. Inter alia they will offer a Roadworks Warning service between Rotterdam and Vienna in 2015.

[11] http://eandt.theiet.org/news/2014/may/automated-driving.cfm
[12] http://www.economie.gouv.fr/nouvelle-france-industrielle

[13] http://www.autonomes-fahren.de/runder-tisch-zum-autonomen-fahren/
[14] http://www.lindholmen.se/en/news/drive-me-self-driving-cars-lindholmen
[15] https://ts.catapult.org.uk/
[16] http://davi.connekt.nl/
[17] https://amsterdamgroup.mett.nl/default.aspx

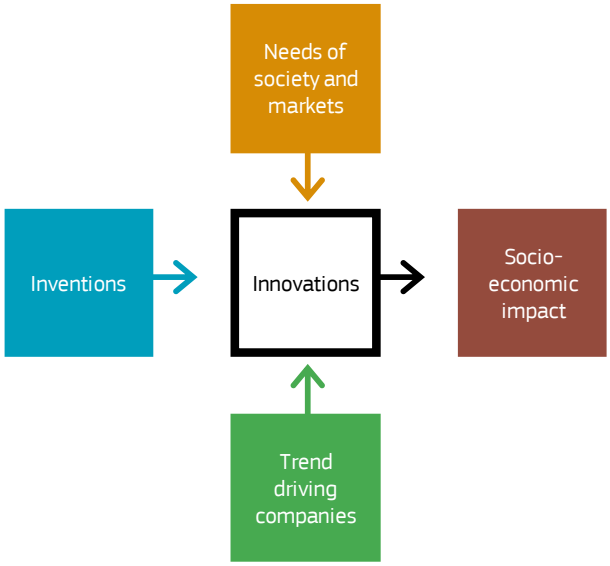
# 2. Trends towards smart value chains

Three trends in business innovation have been identified and analysed by the Business Innovation Observatory in the case studies of the fourth semester:

- Service innovation for smart industry
- Traceability across the value chain
- Internet of Things

The evidence-based selection of these trends and successful companies to be featured in the case studies was based on a thorough review of business literature, databases and policy documents. The guiding criterion for the choice has not been the identification of promising new technological inventions, but rather the selection of existing innovations which have been successfully brought to the market and which have a high potential in terms of their socio-economic impact (Figure 9).

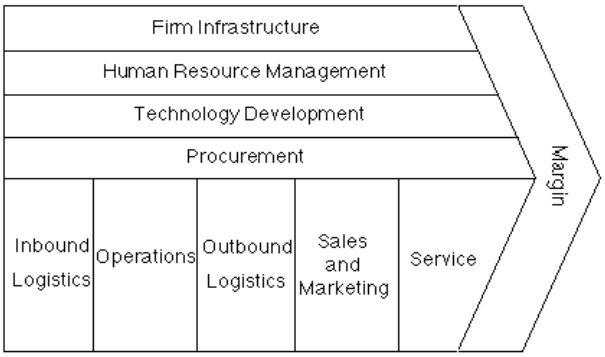
**Figure 9: Selecting companies with successful innovations and high socio-economic impact**




## 2.1. Background: Smart value chains

A common red line in the analysed trends and case studies is the contribution of the selected innovations towards the rise of smart value chains. A value chain refers to a chain of activities that a firm performs in order to deliver a valuable product or service to the market. The concept has become popular as described by Porter in 1985 (see Figure 10). It distinguishes sequential steps referred to as the primary activities, as well as support activities, such as Human Resource Management. The idea is based on a process view, seeing a manufacturing (or service) organisation as a system made up of subsystems, each with inputs, transformation processes and outputs. How value chain activities are carried out determines costs and affects profits.

**Figure 10: Porter's value chain**

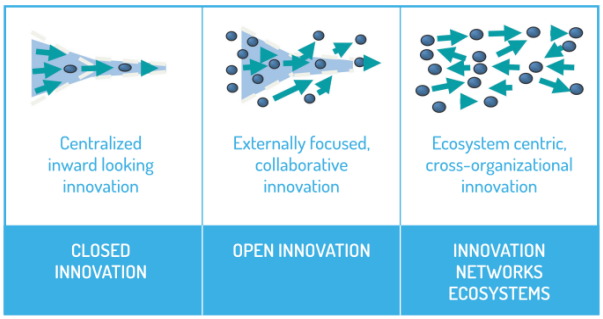



*Source: Porter (1985)*

Since the development of this concept in 1985, a lot has changed in the way value chain activities are carried out. Globalisation is one of the reasons. Many European firms have for instance offshored manufacturing activities to low-cost locations. Value chains have become fragmented and linkages between firms have become more complex, with a shift from linear value chains to interrelated ones, and from a single firm's perspective to a system level approach. In terms of innovation processes, this means moving from closed innovation to open innovation ecosystems (see Figure 11).

The term "innovation ecosystems" derives from the concept of business ecosystems. Innovation ecosystems are built upon clusters, whether geographic, economic, industrial or entrepreneurial. When compared to traditional business ecosystems, open innovation ecosystems create greater value by leveraging more ideas or assets. Working in symbiosis, actors create value by using key assets, resources, or positions that benefit not only a single company but the ecosystem as a whole.

**Figure 11: From closed innovation to open innovation ecosystems**




*Source: EC 2014*

The collaboration between partners is indeed more crucial than ever. Successful innovation ecosystems will be the ones which turn competitors into "complementors" and outsiders into collaborators.

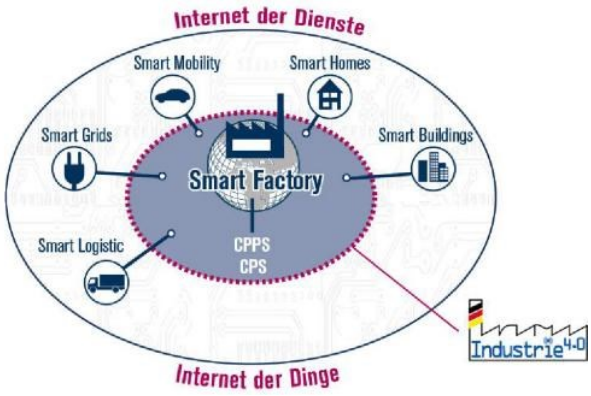
In line with this, disruptive innovations such as the driverless car (cfr. chapter 1) are not emerging from the closed, isolated setting of a single R&D lab. In particular, a range of ICT technologies is increasingly fuelling innovation across certain aspects of value chains for smart industries. This phenomenon emerges as the overarching, common thread to the three business innovation trends investigated, and it is referred to as smart value chains.

Smart value chains involve the introduction of new processes or solutions, so as to save at least one step. This leads to enhanced productivity and cost savings; reduced time-to-market and environmental impact; and better quality output. Ultimately, a smart value chain makes solid business sense by delivering better value for companies, intermediaries and consumers.

Smart value chains often result from cross sectorial and cross-border cooperation. Innovative smart materials, machines, devices and objects are already transforming value chains across a wide range of sectors. New materials and processes are drivers of change in manufacturing. Especially the Internet of Things (the phenomenon in which all sorts of devices with embedded computing capacity are interconnected) is transforming a wide range of industries, such as healthcare, mobility and mobile services.

The German Industrie 4.0 is an example of a national policy programme to enhance this development (Figure 12). The Internet of Things and Services enables traceability and value creation by Smart Factories in smart value chains, which in turn serves other domains such as mobility and health.

**Figure 12: Industry 4.0: linking the Internet of Things and Services to Smart Factories in smart value chains**




## 2.2. Service innovation for smart industry

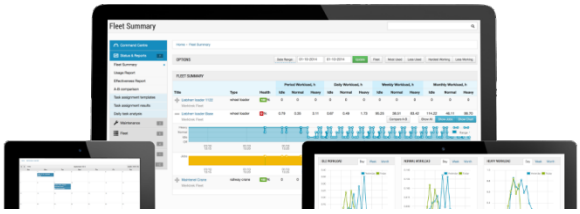
The rise of technologies like the Internet of Things, embedded systems, Machine-to-Machine (M2M) communication, and cloud computing heralds the fourth industrial revolution. In parallel, hyper connectivity will lead to a major shift in the structure of the current economic system, with the passage from the linear value chain to a non-linear 'value network.' Cyber-Physical Systems (CPS) are at the heart of this radical transformation to a network-based economy. The emergence of the so-called smart factories or smart industry is also supported by solutions concerning human-robot collaborations, as discussed in the former chapter.

**Table 4: Examples of Service innovation for smart industry**

| Company | Business innovation and success signal |
|---|---|
| eWON (BE) | A solution that provides cloud connectivity for industrial machines. eWON has received several awards: "M2M Product of the Year 2014"; "Wallonia Export Award 2010","Best Innovative Product in Wireless". |
| Netbeiter (SV) | Solutions that allow cloud-based remote access and monitoring service. HMS, the mother company, has been named "Swedish Export company of the year". |
| School 42 (FR) | A tool serving as an unconventional IT institute using a new pedagogical learning model promoting peer learning. Over 70,000 student applications per year for 1,000 places. |
| Robotnik (ES) | Customised mobile robot platforms. The company has a growth rate of 40% per year. |

Some of the companies featured in the case studies under the trend of 'Service innovation for smart industry' are presented in Table 4 above. Another relevant example is *Maintenel Automation* (see case study 37), a Latvian start-up active in predictive maintenance for a variety of industrial sectors. Maintenel's devices measure the workload of heavy equipment by counting the periods of time spent in different operation modes. On receiving this data, the Maintenel Cloud allows detailed labour analysis and enforces timely preventive maintenance, using predictive maintenance features.

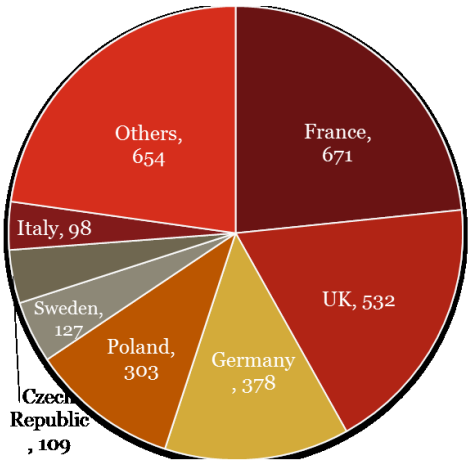
*Maintenel's portal*



*Source: Maintenel*

The trend of "Service innovation for smart industry" also encompasses a new approach to competencies development and recruitment, investigated under the case study on new demand-driven skills (case study 38). "New demand-driven skills" refer to a wide range of activities, tools and services aiming to directly improve educational outcomes of students and workers. The key difference of these innovative methods compared to traditional ones lies in the ability to better align learning materials and content to the industry's demand for skills. New demand-driven education models transform all stages of the value chain of the firms and education institutes for which they have been designed. The online education market is flourishing and the number of E-learning firms in the EU (Figure 13) has increased over the last few years.

**Figure 13: Number of E-learning firms in EU, by country**




*Source: Cedefop (IER estimates from StockMOD),2012*

A third case study under the trend of Service innovation for smart industry is the one on human-robot collaboration (see former chapter).

The main drivers and obstacles for the uptake of this innovative trend are presented in table 5. The fact that online connectivity is becoming ubiquitous is a major driver in each of the three case studies investigated.

**Table 5: Main drivers and obstacles for Service innovation for smart industry**

| | |
|---|---|
| **Drivers** | |
| New demand-driven skills | Exploding demand for education<br>Rise of cutting-edge digital learning technologies<br>Long-term cost savings enabled though online learning solutions |
| Cyber-physical systems in the 'value network' | Connectivity becoming ubiquitous<br>Policy initiatives such as '"Industrie 4.0'<br>Market opportunities stemming from the 'value network |
| Human-robot collaboration | Increased uptake of advanced manufacturing techniques<br>Demand for flexible production<br>Europe's strong position in robotics research |
| **Obstacles** | |
| New demand-driven skills | High up-front costs of online learning systems<br>Lack of MOOC recognition, certification and accreditation |
| Cyber-physical systems in the 'value network' | Security and privacy concerns<br>Interoperability challenges<br>Lack of consumer education<br>Difficulty to acquire pilot customers |
| Human-robot collaboration | Safety and risks related to the human workforce<br>Challenge of bringing R&D to the market<br>Competing in the global market place<br>Financing robotics startups/SMEs<br>Finding skills and talents in robotics |

## 2.3. Traceability across the value chain

Traceability across the value chain has become an increasingly important source for innovations that can make value chains smart by setting up a fully networked business environment. Advanced tracking systems can for instance identify and track items along the value chain through the use of data transfer with Radio Frequency Identification (RFID) and Near Field Communication (NFC).

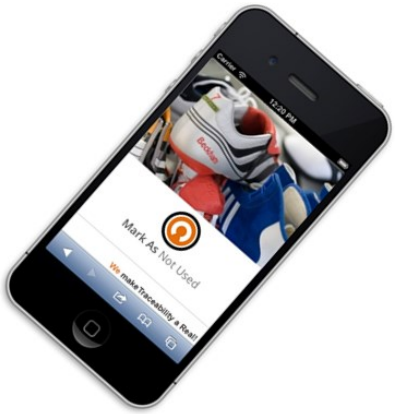
Some of the companies featured in the case studies under the trend of 'Traceability across the value chain' are presented in Table 6.

**Table 6: Examples for Traceability across the value chain**

| Company | Business innovation and success signals |
|---|---|
| Creative Systems (PT) | Automatic identification and traceability solutions. The company works with the largest fashion retailer Zara and has won several awards, including: Red Herring's Top 100 in 2013; Motorola's Best Mobile Applications Solutions Award 2013. |
| FractureCode (DK) | Sophisticated Track and Trace systems combined with highly secure self-authenticating technologies. The firm is winner of PISEC06, PISEC07, and EuroId 2007 award. It is also Accredited as Microsoft Silver Certified Partner. |
| Dipole (ES) | Smart ID technologies, RFID, NFC and Advanced Systems. Dipole is exporting to more than 30 countries and serves clients such as Smatrac, Motorola, Siemens and ArcelorMittal. |
| Alpha Fox Systems (UK) | Brand protection and identification tag system (Crystal Chip®). Finalist in Cambridge Wireless Discovering Startups competition in 2013; Finalist at the UKTI competition for funded participation at CeBIT 2014 |
| Is4it (DE) | Identity and access management solution that helps companies integrate their complex system environments in a way that generates increased usability and user-acceptance while increasing system efficiency. IS4IT was honoured by Bavarian Ministry of Economic Affairs, Infrastructure, Transport and Technology with the Bayern's Best 50 Preisträger 2013 |

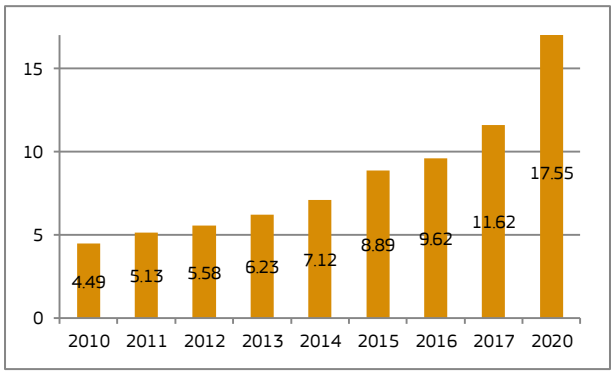
*Tracekey* is another illustrative example for this trend (see case study 40). The company brings track and trace solutions on the cloud in a cost-efficient manner, enabling SMEs to benefit today from tomorrow's digitalised value chain. *Tracekey* offers an end-to-end solution, while most providers offer databases with limited capabilities. Tracekey's solutions include data management (import and processing of large amounts of data in real time), representation and processing of product and packaging hierarchies. Additional benefits of *Tracekey's* solutions lie in the possibility of collaboration along the supply chain. Indeed, what proposed by the company is a Software-as-a-Service architecture. Thus, it enables full integration of suppliers and customers.

*TraceKey helps SMEs digitalise their value chain and it also offers mobile authentication capabilities*




Although the global economy has witnessed a severe slowdown, the market for advanced tracking systems has sustained strong growth. In 2014, the global RFID market was worth EUR 7 billion, following a strong and steady growth from EUR 6 billion in 2013 and EUR 5.6 billion in 2012. It is expected to rise to more than EUR 17 billion in 2020 (Figure 14).

**Figure 14: Projected size of the global market for RFID tags from 2010 to 2020 (in EUR billion)**




*Source: IDTechEx Ltd*

In 2014, governments were behind most advanced tracking systems orders, with the objective to improve safety (ID, passports, secure documents), efficiency (clickers, cards, smart tickets for passenger transport), and protect industries (identification of pets and livestock). However, in 2020, it is anticipated that the private sector will lead orders, mainly for retail and consumer goods purposes (pallets/cases, apparel, items).

The global NFC market was estimated at EUR 860 million in 2012. It is expected to reach a net worth of EUR 16 billion by 2018. A solid Compound Annual Growth Rate of 44% is anticipated for the forecast period.[18] NFC is now one of the basic technologies integrated in every smartphone and

[18] Transparency market research, "Near Field Communication (NFC) Market (By Products - Global Industry Analysis, Size, Share, Growth, Trends and Forecast, 2013 – 2019".

tablet, as a minimum specification. For instance, in 2013 more than 260 million NFC-enabled cellular handsets were distributed throughout the world.

The increasing need for improving traceability across the value chain mainly relates to the need to address the growing globalisation and complexity, and to the need to improve supply chains with respect to speed and accuracy (Figure 15).

**Figure 15: Key drivers for improving visibility of what occurs within supply chains**


*Source: Aberdeen Group (case study 42)*

The drivers and obstacles for traceability which emerge specifically from the case studies developed under the trend are briefly presented in Table 7 and point to the importance of regulations and standards.

**Table 7: Main drivers and obstacles for traceability, per case study**

| | |
|---|---|
| **Drivers** | |
| Advanced tracking systems | Low cost of implementing advanced tracking systems now reached<br>Regulations pushing for adoption<br>Standards have allowed tracking systems to become almost fully interoperable today |
| New anti-counterfeiting methods | New distribution channels for counterfeiters (the Internet, free trade zones)<br>Directives have spurred the demand, especially in specific industries such as pharma or food |
| Standards and certifications as enablers of traceability | Ease to prove quick return on investment<br>International trade and globalisation of markets |
| **Obstacles** | |
| Advanced tracking systems | Security and privacy concerns due to legislation lagging behind<br>Lack of specialists to support the demand |
| New anti-counterfeiting methods | Anti-counterfeiting considered as a burden and additional cost by potential clients<br>Inadequacy of Horizon 2020 criteria for the anti-counterfeiting industry |
| Standards and certifications as enablers of traceability | Divergent, overlapping, or unclear regulations<br>Lobbying for inefficient standards<br>Lack of market and technology maturity |

## 2.4. Internet of Things

The 'Internet of Things' (IoT) can be described as the phenomenon in which not only computers, but all sorts of devices with embedded computing capacity are interconnected. The IoT builds out from today's internet by creating a pervasive and self-organising network of connected, identifiable and addressable physical objects enabling application development in and across key vertical sectors through the use of embedded chips, i.e. integrated circuits or microprocessors.[19]

The IoT increases the connectedness of people and things on a scale that was once unimaginable. People are entering an era of smart devices through elements such as self-driving cars, wearable devices, drones, smart sensors and connected homes, which are all part of the IoT trend. For both commercial enterprises and public sector organisations, this implies drastic changes for how consumers are reached, connected with, and engaged. Table 8 presents a selection of the companies featured in the case studies under the trend, with the indication of their innovative solution and the signals of their success.

**Table 8: Examples for the Internet of Things**

| Company | Business innovation and success signals |
|---|---|
| Veniam (PT) | Networking technologies that can turn vehicles into mobile hotspots for Internet access, bring car data to the cloud, and form a vehicle mesh network that can be used for business, leisure and safety applications, as well as Machine-to-machine (M2M) data delivery. Veniam has built and deployed the largest network of connected vehicles in the world, with more than 600 connected vehicles and 60,000 unique monthly users. First place at the 3rd Edition of Building Global Innovators. |

[19] Europe's policy options for a dynamic and trustworthy development of the Internet of Things. SMART 2012/0053. Schindler H.R. et al (2012).

| | |
|---|---|
| Withings (FR) | Smart devices and apps built around health. Broad product portfolio of smart devices that can connect to the internet, such as a wireless scale, a smart body analyser, and a blood pressure monitor.<br>In 2013 Withings received a EUR 25.8 million investment from Bpifrance, Idinvest Partners, 360 CapitalPartners, and Ventech. The company has recently won three innovation awards for its products |
| EOS Innovation (FR) | Robot for indoor surveillance of warehouses and industrial sites., which reduces the costs and risks associated with security and optimises indoor surveillance on monitored sites.<br>EOS innovation has already sold its first products to a logistics company. The firm has acquired a patent on parts of its invention. |
| Robotics Inventions (PL) | Robots which can improve the efficiency of service people active in routine jobs such as surveillance, cleaning and order picking. The company is currently expanding to Silicon Valley, from its initial location of Warsaw. |
| OpiFlex (SE) | Mobile robot platform which allows a robot cell that is typically fixed in its place to be moved in its entirety, either manually or by means of Autonomous Guided Vehicle (AGV) software. The platform provides the same high stability and precision operation as fixed robots, through its docking station. As one of the first companies in the world, OpiFlex has developed a solution that makes automation economically feasible for small series production (and in the future perhaps even handicraft). |
| Cloud Your Car (PL) | Fleet management system for small businesses. The application can collect data from vehicles, including start-up, shutdown, location, speed and fuel economy. The data can be used to e.g. minimise operating expenses. Start-up company with offices in San Francisco, Cork and Wroclaw. Secured seed funding worth 300 million USD. |

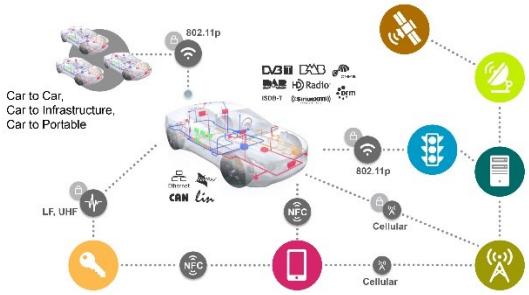
The case study on connected cars shows how cars get integrated into the Internet of Things. The global market for connected car components is estimated to equal EUR 32 billion in 2015 and it is expected to quadruple in size to EUR 115 billion by 2020.[20] This staggering increase is mostly driven by growth in the application areas of safety and autonomous driving. Significant growth is also foreseen in other market segments such as entertainment, mobility management and vehicle management systems, as illustrated in Figure 16 for the period 2015-2020.

**Figure 16: Global market of connected car components**


*Source: Strategy& (2014). Racing ahead – The Connected C@r 2014 study.*

*NXP* is an example of a company which is active in the connected car industry (See case study 43). NXP brings car-to-x communications, telematics, and in-vehicle networking into the car, as well as secure wireless technologies for vehicle access, NFC and multi-standard digital broadcast reception. NXP is also driving innovation in advanced technologies such as car radar. Furthermore, it develops integrated hardware and software solutions that tackle cyber-security concerns in the connected car market.

*NXP connects the car by providing integrated hardware solutions that enable connectivity and security in and around the car.*




*Source: NXP*

The drivers and obstacles which emerge from the case studies concerning the Internet of Things (Table 9) show that the uptake of this trend depends on the wider transformation of the systems (e.g. health or traffic system) in which the IoT applications are embedded, including changes in the legal framework and a cultural transformation.

[20] Strategy& (2014). Racing ahead – The Connected C@r 2014 study.

**Table 9: Main drivers and obstacles for the Internet of Things, per case study**

| | |
|---|---|
| | **Drivers** |
| Connected cars | Four general megatrends (energy efficiency, demand for security features and personalised health features, increasing number of connected devices)<br>Regulation in Europe (eCall)<br>Cooperation between different types of actors from different industries (universities, research groups, private entities) |
| Wearable technology | Market penetration of smartphones, which supports the rise of other complementary devices<br>Recent technological advancements of battery life and size |
| Smart machine tools | Cost savings and productivity gains<br>Recent technological progress (for instance in nano-electronics, photonics and data analytics) |
| Smart health | Technological developments in ICT, e-location technology, and connectivity<br>Ageing population<br>Maturity of on-site ICT infrastructure (which can allow for easier and earlier benefits, and similarly add barriers in certain cases) |
| | **Obstacles** |
| Connected cars | Privacy and data security as key concerns among potential customers<br>Regulation on liability of insurance and on applicability of telecom laws to providers of electronic communication devices<br>Embedded (wireless) communication technology (its absence limits the market for connected cars)<br>Large-scale investments in infrastructure required |
| Wearable technology | Struggle to find the right pricing strategy<br>Privacy as a major concern for consumers<br>Lack of standards for data |
| Smart machine tools | Lack of certification of for example robots with many moving parts (e.g. arms).<br>Lack of a proven track record of both the company and its technology.<br>Resistance to Smart Machines and Tools due to anxiety of job losses<br>Financial markets prefer investments in software-based companies |
| Smart health | Reluctance to change hospital culture<br>Public procurement processes, considered to be slow, complicated and inflexible.<br>Use of electronic health records by healthcare organisations as exception rather than the rule, due to formal legislation, the associated need for organisational change, and the steep investment costs required. |

# 3. Policy challenges

The findings of the case studies related to service innovation for smart industry, traceability across the value chain, and the Internet of Things highlighted a certain number of policy challenges. Among the policy and regulatory issues that most frequently affect these trends we can include data security and privacy; technology standards; and skill gaps. For each of these challenges, examples from the case studies and good practices of policies and regulation drawn from the literature will be discussed, with a conclusion on the main policy issues to be tackled for the future.

## 3.1. Data security and privacy

### Background

Data protection and related issues, including privacy, data liability and data transfer, are one of the most important aspects affecting business innovation. They influence the adoption of innovations in ICT, telecommunication and internet services. Particularly sensitive to data protection issues are the three trends investigated in this report, i.e. service innovation for smart industry, traceability across the value chain and the Internet of Things. Effective policies concerning data protection can play an important role in the development of smart value chains around new technologies, as they create security and certainty that facilitate operations and cooperation by the actors.

### Data protection and data privacy

Privacy of personal data is a matter of concern for most citizens. While disclosure of personal data is accepted as part of normal use of internet services, there is a concern that large volumes of data are collected every day without users knowing about it. Many Europeans feel they are not in control of their data and that they are not properly informed of what happens to their personal information, to whom it is transmitted, and for what purposes[21].

The issue of data security is related to the property of and the regulation of the use of technical data in advanced manufacturing processes, such as those linked to robotic systems and the Internet of Things. Data security involves the definition of: the consent to use information; the specific "purpose" the data can be used for; and the responsibility of the service provider for ensuring the protection of the data that it has been entrusted with.[22]

### European Regulatory Framework

EU legislation on data protection is currently under revision, notably in the context of the Europe 2020 flagship initiative on the European Digital Agenda. The new communication "A Digital Single Market Strategy for Europe"[23] sets out three pillars to be delivered by the end of 2016:

- Ensuring a better access for consumers and businesses to online goods and services across Europe;
- Creating the right conditions for digital networks and services to flourish;
- Maximising the growth potential of the European Digital Economy.

Under the second pillar focusing on creating the right conditions, an important priority concerns the reinforcement of trust and security in digital services and the handling of personal data. For this purpose, the Commission Communication proposes the creation of a "Public-Private Partnership on cybersecurity in the area of technologies and solutions for online network security".

The EU is committed to the highest standards of protection regarding personal data and privacy. Following the adoption of the General Data Protection Regulation, which is foreseen by the end 2015, the Commission will review the ePrivacy Directive to ensure "a high level of protection for data subjects and a level playing field for all market players".[24]

The new General Data Protection Regulation is currently under final discussion and should enter into force in 2017. In particular, it includes provisions concerning Privacy by Design and by Default (Article 23) which require that data protection is designed into the development of business processes for products and services. The revised ePrivacy Directive[25] requires telecoms operators and Internet service providers to keep personal data confidential and secure. It also establishes common rules concerning the handling of cases of personal data breach.

[21] See Special Eurobarometer 359 – Attitudes on Data Protection and Electronic Identity in the European Union, June 2011, p. 23.
[22] Schindler H.R. et al (2012) Europe's policy options for a dynamic and trustworthy development of the Internet of Things. SMART 2012/0053.

[23] http://ec.europa.eu/priorities/digital-single-market/docs/dsm-communication_en.pdf
[24] Ibid.
[25] Revised ePrivacy Directive (2009/136/EC)

The ongoing EU data protection reform and the proposed measures related to cyber security[26] are mostly based on aspects of consumer data protection as well as their privacy and security. They should lead to a reinforcement of individual rights and facilitate the future implementation of the Digital Single Market.

In the area of big data, the 2014 Communication concerning data-driven economy[27] set out to address some of the framework conditions related to data protection measures. In particular, the Commission pledged to make sure that the relevant legal framework and policies are data-friendly. More specifically, it proposed new rules on "data ownership" and liability of data provision for data related to the Internet of Things.[28] This focus was reinforced in the communication "A Digital Single Market Strategy for Europe"[29], which underscores the intent to build a data economy in Europe.

## Examples from the case studies

The case studies of the current semester have highlighted how issues of data protection and data privacy can affect, and sometimes constitute barriers to, the effective deployment of new innovations. Indeed, data storage, data privacy and liability are key areas of concern for the development of wearable technologies, connected cars, cyber-physical systems, and Smart Health.

Security aspects of Cyber-Physical Systems (CPS), namely data security, security of data flows, as well as the protection of intellectual property rights, represent the biggest barrier to the uptake of remote service solutions. This challenge is very clear for the companies showcased in the case study on CPS who stated that tackling these aspects should be a priority at the policy level.

The implementation of technology solutions based on RFID and NFC technologies also raises concerns about security and privacy for traceability across the value chain. In particular, risks are related to legitimate readers obtaining data from illegitimate tags, while privacy concerns are related to illegitimate readers obtaining data from legitimate tags.

No specific legislation, regulation or directives related to Advanced Tracking Systems have been enacted in Europe. However, initial work has been carried out by the European Data Protection Supervisor, which includes recommendation of legislation[30].

The evidence gathered in the case studies under the trend of the Internet of Things indicates that clear regulation and legislation for privacy protection still constitute policy challenges in the sector. Clear rules need to be set as privacy constitutes a major concern for potential users of these new technologies.

## Policy models

In Europe, national laws have been aligned with the provisions of the EU Data Protection Directive. The EU's approach to data protection is considered horizontal, as it potentially covers all sectors and is based on protection of individual rights. It is distinct from the US more sectoral-based approach, which is influenced by jurisprudence and where data protection is also counterbalanced by the importance of freedom of speech.[31] The resulting difference is that in Europe legal provisions may apply to various means of collecting and handling personal data and that data protection is less likely to be challenged by private interest.

The German Industrie 4.0 initiative also addresses issues related to data protection. In particular, the final report on its implementation noted that the disruptive nature of new technologies and their impact on legal issues (notably as regards sensitive employee data protection, corporate data, liability, trade restrictions, use of cryptography, transfer of data, etc.) create a new set of potential legal problems that may not be addressed by the existing legislation.[32]

## Conclusions and main policy issues to be tackled in the future

Data protection constitutes a horizontal regulatory issue for business innovation, where Europe has a role to play and clearly adds value. The case studies and other sources indicate that this issue is crucial for effective smart value chains to be deployed.

The existing legal framework and the proposed one address mainly telecommunication and internet services. In the context of the study on improving data protection in Europe, notably for the Digital Single Market, attention should be paid not just to the handling of personal data protection but also to matters related to industrial data protection. This means setting clear rules and regulations for the various elements of the new smart value chains (workers, robots, smart tools, Cyber-Physical Systems, connected cars, and

[26] Commission Proposal for a Directive concerning measures to ensure a high common level of network and information security across the Union, COM(2013) 48 final, aims at establishing an high degree of Network Information Security (NIS) and combat cybercrime

[27] COM(2014) 442 final.

[28] Commission urges governments to embrace potential of Big Data, Press release IP/14/769, 2 July 2014,

[29] http://ec.europa.eu/priorities/digital-single-market/docs/dsm-communication_en.pdf

[30] EDPS exercise a consultative role on proposals for new EU legislation, and other policy instruments (e.g. communications) that affect personal data protection in the EU.

[31] Donald C. Dowling, Jr., International Data Protection and Privacy Law, White & Case, 2009.

[32] Industrie 4.0 Working Group (2013)

advanced tracking systems) to gather and exchange data and information safely and effectively.

Establishing a comprehensive and dedicated legal framework of rules and regulations on data protection, privacy and security is also an important prerequisite to establish a viable and comprehensive e-health system.

## 3.2. Technology standards

### Background

Several case studies and the existing literature emphasise the role that policies and regulations related to the introduction of standards can have in supporting innovation, and in particular the development of innovative value chains.[33]

The development of standards is considered one of the main components of demand-side policies to support innovation, together with innovation-oriented public procurement, innovation-oriented regulations, and demand side measures targeting consumers (or user behaviour).[34]

In principle, regulations can set performance requirements, that often can be met only by innovative technologies, products and services specified in a standard. Enterprises can meet these requirements either by adhering to a standard or through other equivalent solutions.

The main advantages of successful standardisation for driving innovation and facilitating the functioning of value chains can be listed as follows: standards can facilitate interoperability between the different elements and actors involved; they constitute a codification of common terminology, development methods and measurement techniques; they ease the diffusion of information about technology, notably in the case of quality certification and consumer safety rules that are important in shaping demand; they can reduce risks and transactions costs for producers and consumers.[35]

Standardisation can play an effective role in the development of new markets by focusing demand on specific technical solutions. It can also help create a critical mass of users (e.g. the introduction of the GSM standard of communication helped Europe to develop its mobile phone market).[36]

Certification is a process that determines to what extent a product or service meets the standard, code or criteria developed for that product or service. Certification helps therefore to create confidence and predictability in the value chains by indicating a common reference for the form and quality of a product or a service.

Besides promoting the diffusion and up-take of existing innovations, innovation-oriented regulation and standards can also serve to spur and trigger the development of new innovations. In particular, governments can use standards and regulations to establish performances to be attained and/or specific technologies to be employed.

More specifically, technology-based regulations and standards set out the specific characteristics of a product, process or production method, such as its size, shape and design. They affect innovation by setting technical specifications for ensuring interoperability, securing minimum safety and quality, achieving variety reduction and providing common information and measurement. The standardisation of technical specifications for converging technologies is key to the acceleration of their successful deployment.[37]

Policies based on Metrology, Standards, Testing and Quality (MSTQ) should aim to support the constructive use of standards for establishing technical certainty and predictability, which promote the diffusion of innovations and can have a positive role in the development of smart value chains. Indeed, such MSTQ systems ease communication and transactions between the involved parties, transforming value chains from being captive to relational and promoting digitized interactions. MSTQ policies can also support SME suppliers in building up skills and dynamic innovation capacities, hence reducing their dependence from large value chain leaders. Finally, MSTQ organisations have a role to play in supporting SMEs in clusters and value chains by increasing the level of codification, and easing communication and transaction among companies.

### European Regulatory Framework

The Strategic Priorities for European Standardisation are set out annually by the EU, in line with the Industrial Policy Communication, on a number of sectors that include Key Enabling Technologies (KETs) and other elements related to the Digital Agenda for Europe, such as e-health, the Internet of Things, and RFID. The Strategic Priorities for European Standardisation contribute to improving the regulatory framework, stimulating investment in innovation and new technologies, and supporting SMEs, hence helping to establish viable value chains.[38]

[33] Pietrobelli and Rabellotti (2011)
[34] Ibid.
[35] Swann (2000)
[36] OECD (2014)
[37] Ibid.
[38] European Commission, 2014, The annual Union work programme for European standardisation for 2015

The new Digital Single Market Strategy mentioned before also aims at accelerating the use of standards for ensuring interoperability for new technologies that are essential for Europe's competitiveness.[39] In particular the Commission will devise an integrated standardisation plan to identify and define key priorities for standardisation with a focus on the technologies and domains that are deemed to be critical to the Digital Single Market. The Commission will also revise and extend the European Interoperability Framework.[40]

Standardisation efforts are typically led by national or European standardisation organisations that, as part of the European Standardisation System, facilitate communication, collaboration and negotiation between companies on standards and certification efforts.

In Europe, the most important standardisation organisations include CEN, CENELEC and the European Telecommunications Standards Institute (ETSI).[41] An example of the role played by the ETSI relates to standards that have allowed tracking systems to become almost fully interoperable today. The standards were the first step in a unified market; they led to a wider confidence in the technology and ultimately to a price decrease.[42]

## Examples from the case studies

Regulations that are divergent, overlapping, redundant, inconsistent or unclear pose an obstacle to the uptake of solutions towards standards and certificates as enablers of traceability. Such regulations can prevent successful deployment of innovative solutions, as they hamper the user acceptance on which these solutions rely, and delay their integration in day-to-day work processes. Users may get frustrated in their efforts to adopt and adhere to standards and certifications, especially when frequent changes in information and document requirements regularly induce changes and updates in digital forms, documents and templates.[43]

For instance, standardisation of safety rules and mitigation of safety risks are certainly a crucial area for regulating Human-robot collaboration. The existing standard for collaborative robotics mandates that power and force limits need to be enacted in order to have a cage-free robot. Yet, there is no consensus on what is allowable power and allowable force. As long as no standard has emerged, the industry will continue to develop its own approaches to safety.[44]

For traceability in the value chain to be widely adopted, advanced tracking systems need to be able to work across companies, sectors and countries. Due to their impact across the whole value chain, developing international standards has been an essential prerequisite to create a market open for all. This includes communication protocols, but also format of data, air interfaces for RFID and NFC technologies.

The European Telecommunications Standards Institute has allowed the frequencies from 865.6 to 867.6 MHz. for RFID UHF band in Europe. This limitation is sometimes seen as hampering the development of European RFID, so the case study on traceability recommends increasing the spectrum of frequency which can be used by RFID in Europe.

Some improvements can still be introduced in standardisation policy by ensuring that SMEs are more involved in defining the standards. According to the companies interviewed in the case study on standards and certification, the standard definition process is currently mainly addressed to and engaged with large companies and public institutions, in spite of the dispositions of Regulation (EU) No 1025/2012[45]. One of the reasons is that a direct participation of SMEs in the process represents a high investment in terms of time and cost.[46]

The full implementation of Cyber-Physical Systems (CPS), the enabling technologies that lie at the heart of the radical transformation from a linear value chain to a non-linear value network, raises a number of technical challenges, such as broadband infrastructure and interoperability. To date, there is no software application that can manage the data from millions or more connected devices. In order to cope with the complexity of CPS it will be necessary to have such an overarching software infrastructure. Many aspects could be standardised across industries, for e.g. infrastructure, security and privacy, yet other domains will need to be tailored to the specific sector concerned. Interoperability is another potential area that will require collaboration by the industry. The automation industry has already developed many (voluntary) interoperability standards and thus should be in a good starting position for continuing to work on the

[39] European Commission, 2015, Long-Term Strategy for Building a Digital Single Market.
[40] Ibid.
[41] Case study 42 – Standards and certification as enablers of traceability
[42] European Commission, 2011, Press release: Commission for better standards to boost European competitiveness and promote consumers' interest
[43] Case study 42, standards and certification as enabler for traceability
[44] Case study 39, human-robot collaboration.
[45] Regulation (EU) No 1025/2012 is the legal basis for the Union to use European standards for products and for services in support of Union legislation and policies, to identify ICT technical specifications and to finance European standardisation. The Regulation also sets obligations to European standardisation organisations (CEN, CENELEC and ETSI) and national standardisation bodies on transparency of standardisation processes and on stakeholder participation in European and national standardisation activities. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:316:0012:0033:EN:PDF
[46] Case study 42 – standards and certification as enablers of traceability

basis of interoperable solutions.[47] This is an example where the industry in specific sectors may be better able to develop its own solutions on a voluntary basis. For smart machines and tools, lack of certification of, for example, robots with many moving parts (e.g. arms) can frustrate market introduction. There are already certificates for assembly robots, but for robots in the service sector certification is limited.[48]

## Policy models

Examples of key policy measures at various levels, where standardisation has played an important role in supporting the development of smart value chains, include: the e-health records programme in the US, the standardisation elements in the German Industrie 4.0 programme, the French programme to support participation of SMEs in standardisation activities, standardisation measures in the EU Lead Market Initiatives, and the European eCall system.

The HITECH Act (e-health record) in the US is a programme composed of different incentives and regulations designed to accelerate the adoption of health information technology (HIT) by the industry, healthcare providers, consumers, and patients.[49] The programme has been running since 2009 and is expected to end in 2017. The goal is to promote the adoption of electronic medical records (EMR) to enhance medical service delivery (improve quality, affordability, and outcomes) for all Americans. The overall programme targets the entire ecosystem from care providers and professionals to patients, including policy researchers and implementers. The eligible providers apply to the programme and their selection is subject to the use of certified EMR technology. They also must show "meaningful use" of the technology, which is defined as a baseline for the use of core measures such as maintaining an active medication list and "menu set" (i.e. objectives that can be chosen from a larger list) , and sending patient reminders (Stage 1). Two further stages are foreseen, and will focus on further expansion of the baseline. In addition, these providers must report clinical quality measures to be eligible for the incentives.

Among the issues identified in the US healthcare systems, the cost of delivery system has long been flagged, alongside the speed at which important medical information is shared. The policy is addressing these aspects via the promotion of interoperable systems and standards for information storage and dissemination. The HITECH Act can serve as an example for the integration of e-health in existing healthcare systems at European level. In particular, the following points can be considered as good practices: i) Addressing the ecosystem as a whole and not separately. This enables policymakers to address specific issues and needs as well as to organise a dialogue amongst all stakeholders; ii) Certification: HITECH fosters the market emergence of certified vendors and an impact on "industrial and service providers"; and iii) Promotion of interoperable systems and standards for information storage and delivery.

In the context of the German Industrie 4.0 programme,[50] establishing standardisation and open standards for a reference architecture is considered a key priority. Standardisation efforts will need to focus on stipulating the cooperation mechanisms and the information that is to be exchanged. The complete technical description and implementation is called the reference architecture. This reference architecture establishes a common basic terminology, integrates existing standards (e.g. in the field of automation, industrial communication, engineering, modelling, IT security, device integration, digital factories), and maps them. The standardisation efforts aim to establish the reference architecture as a general model in the shape of software applications and software services, which can then be used by several companies (with very different business models) that compose the value network. For this purpose a standardisation road map has been created.[51]

SME participation in standardisation activities has been identified as problematic and a potential barrier to the uptake of standards as well as to the involvement of all actors within the value chains. To address this issue, at European and international level, the Small Business Standards (SBS), a European non-profit association established with EU support, represents European SMEs in the standard making process. In particular, SBS experts participate in 50 technical committees of the three ESOs (CEN, CENELEC and ETSI), as well as in some specific cases in the technical committees of the International Organisation for Standardisation (ISO), to represent the interests of EU SMEs in the standard making process, to monitor that standards are SME-friendly and to promote a better adaptation of standards to SME needs.[52]

At national level, similar initiatives have been undertaken to support participation of experts representing SME organisation in standardization committees at a European and International level, such as for instance the SME standardisation initiative in France. In place since 2007, this support measure provides direct co-financing (50%) to cover financial support to experts representing sectoral SME

[47] Case study 37 – Cyber-physical systems

[48] Case study 45 – IoT Smart Machines and Tools

[49] Health Information Technology for Economic and Clinical Health (HITECH) Act http://www.healthit.gov/; OECD (2011). Demand-side Innovation Policies. OECD Publishing. ERAWATCH, Health Information Technology for Economic and Clinical Health (HITECH) http://erawatch.jrc.ec.europa.eu/erawatch/opencms/information/country_pages/us/supportmeasure/support_mig_0006

50 Securing the future of German manufacturing industry, Recommendations for implementing the strategic initiative INDUSTRIE 4.0, Final report of the Industrie 4.0 Working Group. 2013

[51] Industrie 4.0 standardisation road map at CEN: http://www.dke.de/de/std/documents/rm%20industrie%204-0_en.pdf

[52] SBS Annual Report, http://sbs-sme.eu/sites/default/files/publications/SBS%20Annual%20Report%202014_3.pdf

organisations in standardization committees. The eligible expenditures include travel costs and experts' fees. This approach allows policymakers to target a large number of SMEs at sectoral level and with a reasonable budget. It also meets the SME's expectations, as many of them cannot or do not wish to participate directly in standardisation processes, but need to be aware of their evolution to maintain and increase their competitive advantage.[53]

The EU lead market initiative consisted of actions to lower barriers to the uptake of new products and services. It included several operational measures across six important sectors of economic activity with a high potential for innovation and great impact, namely: 1) Health, 2) Sustainable construction, 3) Personal protective textiles, 4) Bio-based products, 5) Recycling, and 6) Renewable energies. The operational measures encompassed standardisation, labelling and certification, general legislation, use of public procurement, and a host of complementary actions. [54]

Europe's eCall system is an integrated telecommunication solution helping in case of serious accidents. If a serious accident with a vehicle occurs, the system will automatically transmit an alert to the nearest emergency centre. Market research has suggested that the eCall regulations will drive growth significantly in this sector between 2015 and 2020.[55] In april 2015, the European Parliament adopted rules that will make it mandatory for all cars and light vans to be fitted with automatic emergency calling device as of April 2018.[56]

### Conclusions and main policy issues to be tackled in the future

The successful deployment of innovative solutions such as digital and online education models, advanced tracking systems, and the Internet of Things is highly dependent on the adoption of standards that will have positive influence on their uptake and adoption by the market. All efforts should therefore be encouraged in a coordinated and coherent way to support broad, systemic approaches for the introduction of standards in the context of smart value chains, through concerted processes which involve all players, in particular SMEs. The usefulness of systemic approaches is demonstrated notably by the examples of the US eHealth system and the German Industrie 4.0.

[53] DG RTD Demand and Supply Side Innovation Policies, 2015; ETSI White Paper No. 6, Participation of SMEs in Standardisation, http://www.etsi.org/images/files/ETSIWhitePapers/WP_No_6_SME_FINAL.pd;

[54] http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/index_en.htm

[55] Allied Market Research (2014). Global Connected Cars Market (Technology, Connectivity Solutions, Application, Products & Services and Geography) -Size, Share, Global Trends, Company Profiles, Demand, Insights, Analysis, Research, Report, Opportunities, Segmentation and Forecast, 2013 – 2020. Case study 43 on connected cars.

[56] EP press release, 29 April 2015.

## 3.3. Skills gaps and qualification mismatches

### Background

Digital skills in Europe are lagging behind in terms of population IT literacy as well as of the specialised ICT competence of the skilled workforce.[57] This situation is a barrier for the development of a digital society and of a Digital Single Market as well as for the capacity to fuel innovation in the European economy. Addressing the paradox of simultaneous skills shortages, increased levels of "over qualification" in the workforce, and rising unemployment rates has become vital in securing long-term economic growth and prosperity in Europe.

The demand for ICT practitioners, with a growth of around 4% a year, is outstripping supply resulting in 509,000 unfilled jobs in 2015 compared to 274,000 in 2014. The deficit of skilled ICT professionals is forecast to reach 900,000 by 2020.[58] This shortage is caused by a lack of relevant e-skills. The largest bottlenecks are in the UK, Germany, and Italy - which together are set to account for 60% of all vacancies in Europe.[59]

Furthermore, the skill gap and qualification mismatches issue is not only limited to the specific lack of ICT specialists. In the context of smart value chains, actors must be able to understand other disciplines: for instance, humanities and science should be brought together and more diversity in teams should be pursued. Hence, today the element of multidisciplinary is prominent in the skillset required by employers. This ends up creating a gap between the expectations of the private sector and what the education system provides.

### European Regulatory Framework

In September 2007 the European Commission adopted a Communication on "e-Skills for the 21st Century: Fostering Competitiveness, Growth and Jobs", which includes a long-term EU e-skills agenda for Europe.[60] On this basis, Member States have committed themselves to the development of long-term national e-skills strategies. The Commission, in line with this approach, has systematically addressed and launched a series of well-defined and targeted actions.[61] E-skills activities have been included in the "Digital Agenda for Europe" and are monitored in the context of the European Semester as part of the Europe 2020 strategy.[62]

[57] 47% of the EU population has insufficient digital skills, 23% has none at all. Digital inclusion and skills in the EU, 2014.

[58] Digital Agenda Scoreboard 2014 – Digital Inclusion and Skills.

[59] DigitalEurope.org

[60] COM(2007) 496 final

[61] Evaluation of the Communication of the European Commission e-skills for the 21st century, 2010. Empirica GmbH.

[62] Pillar VI: Enhancing digital literacy, skills and inclusion

In the 2012 Communication "Towards a Job-rich Recovery"[63] key actions were presented for the promotion of ICT employment and e-skills. The Commission has launched several studies to better understand the nature and scope of the problem and its implications for education, as well as several projects and initiatives that aim to mitigate the identified digital skills problem and raise civil and political awareness of the topic.

The Grand Coalition for Digital Jobs, launched in March 2013, is a partnership bringing together stakeholders from the education and employment world with the ICT industry, in order to tackle the lack of digital skills in Europe and the several hundred thousand unfilled ICT-related vacancies.[64]

Other relevant EU initiatives include "Opening up education"[65], the eSkills Campaign[66], the European Coding Initiative[67], the Startup Europe Roadshow, and the EU Code Week.[68] In addition, the EC encourages the use of Massive Open Online Courses (MOOCs)[69] focused on web skills by establishing the creation of a network of universities and business schools in Europe interested in developing MOOCs for web talent.

Finally, the development of eSkills is considered a vital element for creating a Digital Single Market. In this context, reflection is ongoing about EU-wide synergies – in terms of best practices sharing, peer reviews, access to EU level funding, better cross-European recognition of digital/ICT qualifications (e.g. those obtained through MOOCs), support to mobility of ICT specialists within Europe, facilitated access of migrant ICT specialists to the EU, support for reforms in this area through the European Semester process, and the anticipation of skills needs.

Most of the competences and instruments in the area of education and labour concern Member States and regions.

[63] COM (2012) 173.

[64] Davos Declaration on the Grand Coalition for Digital Jobs. https://ec.europa.eu/digital-agenda/en/grand-coalition-digital-jobs

[65] eSkills campaign is an action plan to facilitate schools and universities to deliver high quality education through ICT and digital content, as well as the digital skills which 90% of jobs will require by 2020. The initiative focuses, inter alia, on ICT-based innovation in learning and teaching, underpinning the delivering of skills for the 21st century, including digital skills. It calls for better ICT infrastructure and connectivity in schools, including actions to connect every school, every classroom to high speed broadband services by 2020.

[66] Initiative based on the Communication 'e-Skills for the 21st Century'

[67] Initiative led by ICT-companies and European Schoolnet to bring coding skills to teachers, kids and adults.

[68] Other projects are e.g. the Open Knowledge Technologies - Mapping and validating knowledge, EP Pilot I and II; the Platform for Learning and Inclusion; the Safer Internet Programme; the Platform for ICT training & learning

[69] MOOCS for web talent network, final report of project "Support services to foster Web Talent in Europe by encouraging the use of Massive Open Online Courses focused on web skills", 2014. https://ec.europa.eu/digital-agenda/en/news/moocs-offer-accessible-and-flexible-way-learners-acquire-job-specific-web-skills.

Nevertheless, with the recognition of a digital skills shortage and mismatch affecting Europe, several private and public initiatives have been implemented at European level.

Public institutions are now placing a greater emphasis on private sector skills needs and industry-academia collaborations. For this reason, public authorities are striving to reinvigorate existing programmes to better address the needs of employers. As a result, more public-funded programmes and training courses tend to be driven by employment demand, with content varying across industries and often being tailored to the specific needs of firms.[70]

## Examples from the case studies

The evidence gathered in the case study on new demand-driven skills highlighted the importance to foster industry-academia collaborations. In this context it is argued that from the business standpoint project managers must ensure the alignment of these collaborations with the firm's long-term research and development strategy. Such a strategic vision guarantees the ability of the project to address the real needs of the company and the consequent capability to have a positive impact on its products and processes.

From the university perspective, industry-academia collaborations are essential as they provide students with tangible hands-on experience and help increase the employability of new graduates participating in such projects. Indeed, students learn to solve practical business issues by carrying out tasks which apply a combination of essential skills highly demanded by the market. This point is illustrated by the MEKTORY programme, where the employment of young graduates participating in the collaborative projects with companies has increased. The fundamental objective of these industry-academia collaborations is therefore to better align research activities with real industry interests while equipping students with the skills they need to adapt to the jobs of today and tomorrow.[71]

There are numerous other issues that complicate the further development of eSkills and of digital strategies responding to the educational crisis. Indeed, the alignment of skill supply and demand is still a long-term process requiring multi-sectoral and participatory efforts. In addition to this, the future success of MOOCs relies on accreditation and certification by universities and recognition by employers. In the US, an ever-growing number of universities are already providing for-credit courses. In Europe, "MOOCs for ECTS credits" is a growing concern among students and MOOC providers. Academia stakeholders could take advantage of the Bologna process to widen the accreditation of MOOCs if more partner universities of MOOC platforms would agree to

[70] Case study 38, new demand driven skills

[71] Case study 38, new demand driven skills

include MOOCs as part of their accredited programmes.[72] The barriers to MOOC recognition include the lack of information about content providers, the lack of transparency as regards to institutional procedures, pedagogy and assessment, and the lack of trust in institutional quality of MOOCs.

## Model policies

Examples of interesting good practices of policy measures are related to national actions and include the Irish Webigate and the German PELIT. These are strategies and projects which have been funded by Structural Funds, in particular the European Social Fund.

WebActivate enlisted the support of 400 SMEs in hiring 200 trainees to set up Internet sites for them for free. This gave the trainees much-needed work experience and helped SMEs create a larger potential client base and develop online services. Within three months of the traineeship, 56% of the participants had found jobs. In addition, the programme has brought together a pool of former unemployed people in the three cities where it was delivered, which has boosted social inclusion in the Galway region of Ireland.[73]

The PELIT project created a demand-oriented training platform for the Schleswig-Holstein sector of information and communication technology and media. The content of the learning modules was agreed jointly to ensure that all project partners would benefit from it. Since the start of the project, more than 100 employees from the IT industry have expanded their IT skills through this training course , which was tailored to their needs.[74]

Other good practices include Digital skills private and public initiatives such as the UK Government Digital Inclusion Strategy and Ecomunicate in Romania.

The UK Government Digital Inclusion Strategy establishes a set of actions to be carried out by various government services to implement digital inclusion in all relevant aspects of public policy, by coordinating public programmes in this area and training public servants, establishing common definitions and standards and developing partnerships with the private sector through a dedicated platform (GO ON UK).[75]

Ecomunicate is a Knowledge-Based Economy Project that establishes an extensive Public-Private Partnership (PPP) programme designed to ensure access to ICT and improve Digital Literacy in 'Knowledge-Disadvantaged Communities'. Its objectives include offering access to modern ICTs and training citizens in using computers.[76]

## Conclusions and main policy issues to be tackled in the future

In conclusion, bridging the growing eSkills gap constitutes a significant challenge for Europe both at EU and Member States level. To address this, numerous initiatives have been put in place; however, the scope of European initiatives is limited and the activities of Member States are very diverse and dispersed.

The existence of a highly trained workforce and a wide digitally literate consumer base are two important framework conditions for the development of innovative technologies in Europe. The rise and success of smart value chains require skilled workers, and the market uptake of new technological products is based on consumers that have the digital skills to make use of them.

This implies a need to invest more on this subject at EU level, possibly through the innovation angle of the research programmes, and to encourage Member States to devote additional resources, possibly with the support of Structural Funds, in an effective and coherent way.

In particular, industry-academy collaboration should be encouraged and supported in all possible ways, notably through the replication of successful programmes like the Estonian MEKTORY or the Irish Webigate, or through the creation of dedicated platforms like the German PELIT or the British GO ON UK. It is important to connect business people with scientists and technical experts who are computer literate. There should be more room for trying and failing and second chances, since many skills are acquired by "doing". This type of practical education should be brought to all aspects of people's lives, not only in schools.

Finally, there is also a need to recognise MOOCs as an effective way of teaching that contribute to the development of specialised skills. Therefore, MOOCs should be included in universities' accredited programmes or in the context of lifelong learning programmes of the relevant national authorities. At European level, efforts should be made to encourage this process and provide an information platform, possibly on the basis of the experience of the educationeurope.org portal and of other Opening up Education initiatives.[77]

[72] Ibid.

[73] http://ec.europa.eu/esf/main.jsp?catId=46&langId=en&projectId=274

[74] http://ec.europa.eu/esf/main.jsp?catId=46&langId=en&projectId=447

[75] Cabinet Office, Policy paper, Government Digital Inclusion Strategy, 2014, Available at: https://www.gov.uk/government/publications/government-digital-inclusion-strategy/government-digital-inclusion-strategy#actions. http://www.go-on.co.uk/

[76] http://www.ecomunitate.ro, https://ec.europa.eu/growth/tools-databases/dem/sites/default/files/Countryfiche_Romania.pdf

[77] Opening up Education: Innovative teaching and learning for all through new Technologies and Open Educational Resources (COM(2013) 0654 final)

# 4. Policy recommendations

This concluding chapter frames the main policy recommendations drawn from the case studies, literature, interesting policy practices and the outcome of the first conference of the Business Innovation Observatory which took place on 16 April 2015 in Brussels.

## Develop a smart regulation approach based on open and collaborative innovation ecosystems

Policy makers should intervene to:

- Remove existing barriers to the uptake of innovative products (like the regulatory fragmentation that limits market integration);
- Ensure favourable framework conditions (including education, funding and networking opportunities), tailored to the needs of the different actors;
- Promote the development of open innovation ecosystems, which do not function autonomously but need new management processes and a new role of orchestrators to address complex problems and be successful;
- Encourage networks that foster collaboration between EU SMEs and ensure openness, neutrality and fairness in value chains.

Since Europe hardly benefits from exporting patents, technology development should not be considered as the final objective, but as one of the elements that help to develop smart value chains. Innovative business models and shared values concerning economic, social and environmentally friendly progress should also be taken into account.

The role of policy makers should be to ensure that value creation is open, and that the benefits are shared in a fair way between all participants within the innovation network or system. For this purpose, attention should be paid in particular to setting goals in terms of societal benefits, employment and sustainable growth; defining protocols for interoperability; creating trust; and ensuring that technology platforms continue to play an effective role in supporting innovation. In doing so, policy makers should keep in mind that public research organisations and private companies have different needs.

## Develop an integrated and systemic approach to standardisation in order to ensure a higher degree of certainty and clarity for the introduction of innovative services and products

The uptake and successful deployment of solutions towards standards and certificates as enablers of traceability is hampered by rules and regulations that are divergent. To prevent possible overlaps and redundancies, as well as to encourage users to adopt standards for traceability, governments and public bodies responsible for the design and implementation of information and documentation requirements related to standards and certification should deliver clearer, more straightforward requirements that do not change too often, and that maximise the possibilities offered by ICT.

Regarding in particular human-robot collaboration, the standardisation of safety rules is considered a crucial area for policymaking, as an equal-level playing field needs to be defined in order to allow human-robot collaboration to further develop. The needs of workers and industry have to be taken into account with a view to ensuring maximum safety on the one hand and technology advances on the other hand.

Concerns and costs related to residual safety risks constitute a barrier to the uptake of human-robot collaboration, especially if dealing with SMEs and first-time robot users. Policy action could be explored in particular to support the introduction of schemes for the mitigation of residual risks, such as mandatory insurance or similar arrangements that could also include forms of co-financing or guarantee to reduce costs and burdens for businesses, especially SMEs. On the other hand, industry must be committed to heavily invest in safety as well as in the education of consumers on how to behave safely around a co-bot.

Regarding connected cars, the absence of EU-wide rules for self-driving functionality will complicate the introduction of semi-autonomous (level 3) and fully autonomous (level 4) vehicles in Europe. By quickly developing a harmonised European legal framework that addresses this issue as well as concerns on liability, Europe can gain a competitive edge over other regions where such a framework is not yet in place (e.g. the US).

## Establish a regulatory framework for wearable technology

Cloud computing is a strong enabler for the wearable technology market. The data collected by wearable devices will become part of a human cloud system that will analyse customer patterns to improve the services offered. As personal wearable technology devices start proliferating, the regulation of data storage, privacy and processing will become a key area of concern. However, at the moment the laws regulating data protection are considered out-dated and too restrictive compared to the capacities of the new technologies in this sector. Therefore, discussions on big data and cloud computing should take into account the positive role that regulation can play in fostering the emerging sector of wearable technologies.

Driver distraction is a major cause of the increase in preventable accidents, with the growing use of technology while driving, in particular smartphones. Although wearable devices may be hands-free, distractions decrease a driver's attention needed to react in unsafe situations on the road. For this reason new or revised regulatory frameworks will be required to address the increasing problem of combining wearable technology with driving a vehicle. The European policy orientations on road safety 2011-2020[78] may have to be reviewed to assess to what extent further restrictions should be enacted by Member States on the use of smartphones while driving, following the examples of rules that have been adopted by US and Canada[79], as well as on the use of wearables.

## Establish a solid cyber-security strategy

Security for industrial data is even more critical than in banking, because insurance schemes cannot cover the losses that are generated through hacking or copying patented technology. As a result, the threshold for acceptance must be reduced to virtually zero. Policymakers and specialists need to conceive an overarching cyber-security infrastructure that is up to this task, both in terms of prevention and enforcement (policing). Only with a strong and coordinated cyber-security policy will Europe be part of the industrial Internet. Today's efforts are not sufficient and lack integration among the Member States. These aspects should be taken into account in the definition of an EU cybersecurity strategy which aims at establishing a high degree of Network Information Security (NIS) and combat cybercrime.

[78] Towards a European road safety area: policy orientations on road safety 2011-2020 COM(2010) 389 final

[79] http://www.distraction.gov/get-the-facts/state-laws.html;http://distracteddriving.caa.ca/education/distracted-driving-laws-in-canada.php

## Develop a systemic approach and methodology on industrial data protection to facilitate the introduction of innovations in smart value chains

In the context of the German Industrie 4.0 initiative, it has been suggested that regulatory analysis of new technologies should begin as early as possible during the R&D phase rather than being left until they are already in use. The main aspects that would need to be addressed in this context include: status of data, protection of corporate data, liability for protection of such data, handling of personal data of employees involved in the processes, and possible trade restrictions related to the use of encryption technologies.

## Harmonise and specify European regulations on minimum requirements for privacy provisions in new technologies such as connected cars, connected devices, advanced tracking systems

One way to address privacy concerns is to further explore the need for a harmonised European regulatory action. By setting clear regulations on minimum requirements for privacy provisions in connected cars (and connected devices as a whole), the market is forced to come up with solutions that will benefit end users. As a starting point it could be considered to what extent the current ePrivacy Directive (Directive 2002/58/EC) is sufficient for maintaining the privacy of end users of connected cars.

Concerning advanced tracking systems, there is currently no specific legislation in Europe. Some initial work has been carried out by the European Data Protection Supervisor, which includes legal recommendations. Still, it is important to reassure consumers that their data will be protected. In particular, advanced tracking tags and readers must take into account the risk of eavesdropping or information leakages. They should be designed to mitigate this risk with the introduction of security measures. There is a possibility that the market fails to address these risks and therefore room for policymakers to take actions.

## Carefully harmonise electronic health records initiatives while addressing privacy considerations

Smart Health solution providers consider electronic health records as a crucial prerequisite to the uptake and implementation of Smart Health innovation. However, the European healthcare sector's fragmented and diversified approach to electronic health records makes it difficult for Smart Health entrepreneurs to deliver the benefits of their innovations. Smart Health innovation may benefit from a harmonised approach to electronic health records in terms of technological standards, implications for organisational structures and processes, and legislation related to privacy. The experience of the US eHealth system could be taken into account, notably for addressing the ecosystem as a whole, involving stakeholders and creating a market of accredited service providers.

## Solving concrete business and engineering challenges in multi-disciplinary teams of students should be part of education

Industry-academia collaboration in solving concrete business and engineering challenges is an important tool to promote new, demand driven, problem-solving oriented, and entrepreneurial skill sets. Smart value chain constellations imply new and more diverse skill requirements, which should be acquired through a process of learning by doing (trying and failing). Through such industry-academia collaboration students would learn to cooperate in solving problems and gain entrepreneurial skills and at the same time curricula would better reflect the needs of industry.

## Favour the accreditation of MOOCs

MOOCs constitute a form of "direct-to-students" education placing skills at the heart of the learning pathway. The further development of blended learning (the combination of face-to-face and online learning) is a first step to higher recognition of MOOCs by both education institutions and employers. There are many ways to include MOOCs in universities accredited programmes. They can form part of a structured degree programme as a replacement course, an integrated course, a background course, or as an enrichment of a "traditional" course. Students can demonstrate their achievements and confirm their mastery of skills by earning a certificate or a "MOOC badge". As these certifications are also taken into account for professional education credits, MOOCs represent a cost-effective enabler of lifelong learning. However, the accreditation and higher recognition of MOOCs is linked to the ability of MOOC providers to improve exam proctoring and verification, and to ensure more transparency in their internal procedures as well as in the learning outcomes.

## Foster access to market and uptake of innovative solutions through increased support for pilots and demonstration programmes

Policies and programmes in Europe should aim at further stimulating the demand of innovative products and solutions. The case studies investigated have highlighted the need to intervene in support of commercialisation of R&D results, including via pilot and demonstration schemes.

For instance, robotic companies need support in their efforts of bringing innovative ideas to market in order for collaborative robotics to get off the ground.

Also the market uptake of connected cars calls for additional pilot demonstrators. Similarly, investments in public infrastructure can drive the growth in vehicle-to-infrastructure applications.

For smart machine and tools, the barrier for companies to enter the market is the substantial investment levels required for developing and commercialising their technology. To alleviate this, policy makers could act as launching customer and provide more concentrated and more systemic funding possibilities linking R&D and commercial activities.

Overall, best practices show that, in order to gain public acceptance, it is essential to widely demonstrate and show-case disruptive innovations. Attention through, but not limited to, dedicated funding should be given to demonstration, experimentation and co-development mechanisms and infrastructures, such as arenas, showrooms, playgrounds, living labs, test beds, etc.

## Encourage the creation of "smart financing chains" in line with smart value chains.

Policy makers should consider new models of financing for innovation that would contribute to the creation of smart financing chains, involving public-private cooperation as much as possible. New integrated approaches to innovative financing would include:

- Coupling financial aid with advisory services, as offered by the EIF InnovFin fund[80];
- Increased use of soft-loans for private companies;
- Opening Venture Capital and equity funds markets to cross border investment. Considering the creation of an E-Zone for innovation investments[81] in the form of a pan-European capital market to overcome the legal and fiscal disparities that prevent the efficient allocation of funding; and
- Encourage the use of other emerging alternative financing mechanisms such as crowdfunding.

[80] http://www.eif.org/what_we_do/guarantees/single_eu_debt_instrument/innovfin-guarantee-facility/

[81] European Business Angel Association (2014), Creation of an e-zone for Europe, contribution to the debate on European Fund for Strategic Investments.

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# 6. Annexes

### Table A: Existing policies the companies benefitted from

| Trends | |
|---|---|
| **Service innovation for smart industry** | |
| Cyber-physical systems | Policy initiatives such as Industry 4.0 and high-level political attention in general. |
| New demand-driven skills | Increasing interest of learning institutions in e-learning solutions.<br>Industry-academia collaboration.<br>Review of existing learning programmes by public authorities.<br>Rising number of public-funded programmes and trainings linked with market demand. |
| Human-robot collaboration | Collaboration with a research / university institute.<br>EU funds for robotic research. |
| **Traceability across the value chain** | |
| Advanced tracking systems | Showcased companies benefited from EU Telecommunications Standards Institute through established international standards allowing tracking systems to become almost fully interoperable. The standards were the first step in a unified market, which led to a wider confidence in the technology, and ultimately a price decrease.<br>They also benefited from EU directives, i.e. the "track and trace" (EU food regulation 178/2002) or directives linked to animal identification or fishing by introducing a catch certification scheme. |
| New anti-counterfeiting methods | A new regulation 5129/2013/EC introduced early 2013 describes the procedures implemented by the customs against goods suspected of not respecting IPR. Clear identification methods are thus needed to support customs. |
| Standards and certifications as enablers of traceability | The companies did not benefit from specific existing policies. |
| **Internet of things** | |
| Connected cars | Seed funding from US-based companies for development of a fleet management system targeted at small businesses.<br>Companies have the opportunity to receive funding from the 'Investment Plan for Europe', a joint initiative from the European Commission and the European Investment Bank (EIB). Strategic infrastructure (digital, transport and energy investments in line with EU policies) is one of the key areas where funding is made available.<br>Strategic partnerships between industry and European cities can be developed within the 'European Innovation Partnership on Smart Cities and Communities (EIP-SCC)'. |
| Wearable technology | A company from Northern Ireland received governmental funding for their emotional response measurement technology. Funding was received from two funding organisations: the Northern Ireland Screen which is the government-backed lead agency in Northern Ireland for the film, television and digital content industry, and the Arts Council of Northern Ireland which is the Funding and Development Agency for The Arts in Northern Ireland.<br>An Italian company raised more than EUR 100,000 on crowdfunding on Indiegogo.com, an important global crowdfunding engine to fundraise online.<br>A French company received funding from Bpifrance, the French organisation for financing and business development, supporting in particular SMEs, medium-sized enterprises and innovation companies.<br>EU funding – EU Research and Innovation programme FP7 |
| Smart machines and tools | EU funding – EU Research and Innovation programme FP7<br>Funding from angel investors and venture capitalists |
| Smart health | EU funding – EU Research and Innovation programme FP7<br>Funding from business angels and venture capitalists<br>Innovation funding from health insurers |

## Table B: Recommendations

| Trends | |
|---|---|
| **Service innovation for smart industry** | |
| Cyber-physical systems | Implementing strong cyber security policy.<br>Creating appropriate framework conditions.<br>Supporting market entry and approaching the potential clients.<br>Public support facilitating the stage of 'death valley'.<br>Supporting ecosystems through the creation of infrastructure and adequate funding. |
| New demand-driven skills | Introduction of customised support in the form of one-stop-shop for SMEs.<br>Fostering industry-academia collaboration.<br>Supporting the accreditation of MOOCs.<br>Promoting participation of women and young people in ICT.<br>Increasing investments in lifelong training programmes.<br>Supporting mobility of European workers. |
| Human-robot collaboration | Standardisation of safety rules and introduction of risk mitigation schemes.<br>Supporting long-term investments, for example through tax incentives.<br>Promoting EU funding opportunities.<br>Facilitating market entry through Public-Private Partnerships (PPP).<br>Supporting academia-industry cooperation. |
| **Traceability across the value chain** | |
| Advanced tracking systems | Introduce security measures in the design of advanced tracking tags and readers to lower risks of information leakages and eavesdropping.<br>Develop High Technology Indicator tools to assess the progress of innovative trends, in particular advanced tracking systems and evaluate its macro-economic progress.<br>Introduce specific legislation or directives towards data protection for tracking systems.<br>Promote advanced tracking systems within IT sectors to attract more skilled workforce.<br>Accelerating the implementation of frequency spectrums. |
| New anti-counterfeiting methods | Create tools to better evaluate the impact of counterfeiting through a reporting system, which could provide accurate statistics on the efficiency of anti-counterfeiting methods.<br>Elaborate calculations methods to determine the appropriate fining.<br>Strengthen cooperation between companies and authorities, between countries of origin and end-use destinations.<br>Establish bilateral trade agreements to standardise international regulations.<br>Emphasise intra-EU collaboration within member states involving also the private/public sectors.<br>Further actions to enforce anti-counterfeit laws and protect Intellectual Properties.<br>Take necessary steps to educate end users on the issues related to counterfeiting (exposing the damaging outcomes and develop a culture against counterfeit) |
| Standards and certifications as enablers of traceability | Improve transparency and equitability of lobbying efforts. Strengthen the interaction between policymakers, legislators and representatives of specific standards and certifications solutions.<br>Harmonise standards. Regulation authorities responsible for the design and implementation of information and documentation requirements related to standards and certification could attempt to deliver clear, straightforward requirements that do not tend to change and that maximise on the possibilities that information and communication technology offer. |
| **Internet of things** | |
| Connected cars | Clarity to the current legislative and regulatory framework<br>Boost the uptake of technologies through Pilot demonstrations, which could be supported through Horizon 2020.<br>Invest in infrastructure that allows vehicle-to-infrastructure (v2i) communication and autonomous driving.<br>Harmonised European framework on minimum requirements for privacy concerns of end users. |
| Wearable technology | Introduce a new regulatory framework with a view to data storage and data privacy concerns.<br>Adopt a regulation of roaming costs in the EU and worldwide. This problem has already been engaged by the European Parliament that proposes to abolish end user roaming charges in the EU from 15 December 2015. At the current state of play it is not clear if the new regulation will come into force at the envisaged date.<br>Stimulate the adoption of health wearables, regulated medical devices to drive down health costs.<br>Implement quality monitoring by consumer authorities of health claims made by wearable providers or app developers. |
| Smart machines and tools | Stimulate education and appropriate training for jobs in sectors that are driving the technology (engineering, computing, and science).<br>Implement pilot projects through public bodies and make public authorities act as a launch customer.<br>Increase funding possibilities through public funding and by stimulating private investments, especially as regards the funding for hardware-based innovation.<br>Adapt tax relief measures to the need of the market players: make all or at least some R&D activities exempt from taxes to give start-ups/SMEs the possibility to simulate R&D work. |
| Smart health | Provide sustained support to technological development through grant schemes tailored to the sector's needs (e.g. favour small-scale consortia with focus on a single good idea, support introduction into the market and focus funding more on the final stages of innovative development).<br>Increase public sector investments and field demonstration opportunities.<br>Encourage public sector healthcare providers to streamline their purchase-to-pay processes.<br>Adopt a harmonised approach to electronic health records in terms of technological standards, implications to organisational structures and processes, and legislation related to privacy. |