Industry 4.0 for the future of manufacturing in the EU

FINAL REPORT

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1.
Introduction: background information and methodology

EU manufacturing output stands for 15% of the overall Member States' GDP and EU[1] has declared that the goal is to increase this level by 20% by the year 2020. However, since 2008 over 3.4 million jobs have been lost in the metal industry and several studies threaten further losses in the next years. Contemporarily, new production paradigms are growing, especially those guided by new processes of digitization of manufacturing.

The most iconic one is the so-called Industry 4.0 paradigm, a new production system resulting from the application of the new Internet of Things (IoT) and Services to manufacturing. A paradigm born as a German economic policy but quickly spread around Europe and across countries such as the US and China. Industry 4.0 represents a game changer affecting all the activities linked to manufacturing, from planning to processes, from products to work organization and workers' skills. While the digital evolution of production represents an opportunity for the EU economy, as it implies the demand for new professional figures and new work schemes, the process will involve several challenges for the EU labour market, including a loss of low and middle qualified jobs and a lack of high-skilled workers. In order to deal with the skills mismatch arising from Industry 4.0, it is necessary to develop actions intended to link educational strategies with industrial and labour market policies, as the German experience well-demonstrates with examples of a dual education system. There is a strong conviction among academics and researchers that the bigger is the transition the

[1] See the Communication from the Commission, *Europe 2020. A European strategy for smart, sustainable and inclusive growth*, 3 March 2010, COM(2010)2020 final.

more all the actors need to be involved in it. According to the European Commission, one of the goals of the Europe 2020 strategy is "to promote the restructuring of sectors in difficulty towards future oriented activities, including through quick redeployment of skills to emerging high growth sectors and markets", thus fostering the Renaissance of industry in Europe[2]. Even though Industry 4.0 has still not been tackled by a joint action within the framework of the European social dialogue, EU social partners are currently demonstrating an increasing interest in this topic and the *European Pillar of Social Rights* is facing some of the challenges of this new paradigm in terms of working time, privacy, data security, etc.

Drawing on this background, this report intends to compare the results of three National Reports in order to show the different approaches at the challenges of Industry 4.0 and the actions of different actors in different social and economic contexts. This report also wants to compare the level of awareness of the companies in the countries about the impacts of technologies on production, work organization, skills and to inquire the level of development of such innovations.

To do so, a mapping exercise has been conducted through a desk research in a view of detecting main national initiatives developed by public authorities as well as unilateral and social dialogue activities performed by employers' associations in Germany, Italy and Slovenia, thus identifying their relevant characteristics. Moreover, a survey has been performed and addressed to 635 companies operating in the metal sector in Germany (54), Italy (527) and Slovenia (54), in order to better comprehend the degree of employers' awareness of this pervading phenomenon, the technologies already in use, their intentions about future investments as well as their concerns and actions with regard to workers' skills and work organization. Finally, 15 semi-structured interviews have been conducted with employers' associations (7), trade unions (6) and educational

[2] *Ibid.*

institutions (2) from Germany, Italy and Slovenia in an attempt to shed light on their views and perceptions about the incumbent digitalization of manufacturing.

The reason behind the choice to select Germany, Italy and Slovenia as case studies in this project lies on the different socio-economical contexts of the three countries. In Germany the paradigm of Industry 4.0 was launched in 2011 and so is still well developed, Italy one of the strongest manufacturing country in Europe hidden by the crisis that destroyed more than 500,000 jobs in the sector, Slovenia is one of the European country with the biggest growth in productivity in manufacturing starting to build processes of innovation and digitization. The comparison between these three countries can help in watching different steps of development of Industry 4.0.

It is worth stating that this report is the result of research activities carried out within the framework of a European project, named *INDUSTRY 4EU – Industry 4.0 for the future of manufacturing in the EU*. Co-funded by the DG Employment, Social Affairs and Inclusion of the European Commission, this project brings together employers' associations from Italy (Federmeccanica), Germany (Nordbildung), Slovenia (Gospodarska Zbornica Slovenije) and the European Union (CEEMET as associate organization), with the aim of identifying existing concrete actions and future rooms of manoeuvre for employers and their associations to successfully promote Industry 4.0 and cope with is related challenges and opportunities. *INDUSTRY 4EU* wants thus to be a stepping stone to put Industry 4.0 on the top of the EU social dialogue agenda. The main objective is to improve dialogue between employers' associations in order to create conditions for the spread of Industry 4.0 in the European countries, thus contributing to reconverting present factories and helping them to be more competitive.

This report is structured as follows: it will first provide a description of the employers' associations involved in this project and the main stakeholders

operating in their respective countries, as emerged from the mapping exercise conducted at the national level; it will then illustrate the main results of the mapping exercise, by shedding light on governmental initiatives as well as unilateral and social dialogue programs carried out by employers' associations involved in this project, especially as regards workers' skills, education and training in the light of the new Industry 4.0 paradigm; finally, it will analyzes and compares the results of the survey conducted with companies and the outcomes of the semi-structured interviews with social partners, thus describing both employers' and social partners' views on the process of digitalization of manufacturing.

The followings are the main findings of the report.

Social dialogue initiatives

The increasing awareness of employers' associations of the urgency to tackle Industry 4.0 is clearly demonstrated by a series of initiatives that have been recently implemented in all the three countries involved in *INDUSTRY 4EU* project.

About social dialogue and coordinated actions in this context, the mapping exercise has confirmed the crucial role that multilateral cooperation and social dialogue play: in Germany this dialogue covers all business-related questions on the (further) development of the industry and the safeguarding of its future, while in Italy the dialogue is conduct in the so called bilateral bodies.

Unilateral Programs for the Development of the required Technical Skills

On the unilateral programs side, most of the initiatives developed by employers' associations are not built directly on the framework of Industry 4.0 but they can be easily adaptable to it. These initiatives are mainly focused on: continuous

training; network initiatives; entrepreneurship education programs; and participation in regional, supra-regional and international projects.

The partners considerate the link between school and work an important way to facilitate the implantation of Industry 4.0: the employers' associations have already lunched, principally through networks with educational institutions and other partners, different initiatives to promote and valorise school-to-work transition in a 4.0 contest.

Employers' associations recognize that the skills gap could be a problem, so they are implementing tools for helping to fill those gaps and to facilitate the sharing of best practices among professional figures.

Awareness Survey

Even though Industry 4.0 paradigm was born in Germany, the majority of German companies does not assume their production processes have achieved a high degree of digitalization, while the Slovenian and Italian companies believe that their production processes have achieved a medium degree of digitalization. So is not strange if the Italian and Slovenian companies agree that new technologies can be implemented gradually with contained investments, even without radical changes, and that implementation doesn't require important investments, while the Germans ones, on the contrary, think that implementation of Industry 4.0 requires major investments, and that these will cost.

For the companies the main benefits attended by the implementation of Industry 4.0 are the improve of productivity, a deeper flexibility in product and service customization and the opportunity to optimise costs.

On the side of expectations about Industry 4.0, the companies deeply disagree that Industry 4.0 is a passing trend: for the majority of companies, so, the

implementation of new technologies will have real content and relevant economic effect.

For the surveyed companies, the greatest change carried by Industry 4.0 in relation to the soft skills will be in the fields of digital communication, team working, problem solving, autonomy, accountability, flexibility and proactivity, while the greatest change in the required technical skills will be on data analytics, managing IT infrastructures, programming and coding, robot management and prototyping and 3D production.

Stakeholders involvement

Between the Representatives of Employers' Associations and the Representatives of Trade Unions emerge some differences on planning and vision about the Industry 4.0 phenomenon, that depend also by the country they belong to. In a general way, the Employers' Associations are more enthusiastic about Industry 4.0 than the Trade Unions.

The partners think that Industry 4.0 will carry to new organizations of work, new business models and will have deep occupational implications. On this last point, fundamental seems the continuous training for workers and policies of requalification for unemployed people. Always on the educational and training side, central is the spread of digital competences and soft skills.

Industry 4.0 will have a strong impact on Industrial Relations because it influences directly the relations between human capital and company: it's believed that Industry 4.0 will be based on a model of communication and ideally common understanding rather than on a conflictual one, facilitate by a clime of good relations between trade unions and companies.

The partners recognize the need of specific interconfederal agreements that would make Industrial Relations adequate to potential changes. The increasing flexibility of companies and workers should be managed by national collective bargaining or by second level one. Moreover, is necessary that Trade Unions have a more International point of view on social and work problems to understand more deeply the great technological changes on a global scale. Finally, Industry 4.0 could be the opportunity for trade unions to renew their role, to increase the rate of unionization and the workers' consensus.

2.

The nature and network of *INDUSTRY 4EU* employers' associations in Germany, Italy and Slovenia

Germany

The German employers' association involved in *INDUSTRY 4EU* and its related research activities is Nordbildung (Northern Education), a network of seven education companies in the northern Germany economy. Its role in supporting the development of Industry 4.0 at the national level induces Nordbildung to frequently relate to many other organizations:

- AGV Nord and Nordmetall, which represent the metal and electrical industry in a large number of projects, networks, bodies and (education) policy committees either through a direct mandate or via regional or national umbrella organizations;
- Gesamtmetall, which is the umbrella organization of the regional employers' associations in the metal and electrical industry in northern Germany. This organization represents the common and general interests of M+E local companies at national level;
- the Federation of Business Associations in Hamburg and Schleswig-Holstein (UV Nord), which is the umbrella organization dealing with economic and social policy on behalf of north German business. The organization represents cross-sector business interests in Schleswig-Holstein and Hamburg to the government and the community and is a social partner representing the employers' interests in negotiations with the umbrella

organizations of trade unions;

- the Confederation of German Employers' Associations (BDA) (Deutscher Gewerkschaftsbund, DGB) which represents the umbrella organization dealing with employment and social policy on behalf of German business as a whole. Its headquarters are located in Berlin (in Cologne from 1951 to 1999). The BDA gathers the German employers' associations under one roof. Its members include 14 multidisciplinary national associations (joint associations for Berlin and Brandenburg and for Hamburg and Schleswig-Holstein), each including multidisciplinary regional associations, and 52 national umbrella trade associations, each including national and regional trade associations from the fields of industry, services, finance, trade, traffic, crafts and agriculture. Overall, around one million companies are direct members of the BDA;
- IG Metall (Industriegewerkschaft Metall). Is the largest metalworkers' union in Germany, the formal organization was founded in 1949. It represents workers from manufacturing and industrial production, machinists, printing industry both blue-collar and white collars.

Italy

The Italian employers' association taking part in *INDUSTRY 4EU* and providing a contribution in developing its main activities is Federmeccanica[3]. Federmeccanica represents the Italian companies working in the metalworking sector (MET). Federmeccanica leads almost 80 local industrial associations and belongs to Confindustria, the umbrella association that represents the manufacture and service companies in Italy. Federmeccanica usually relates to trade unions, notably to Federazione Impiegati Operai Metallurgici (Fiom), Federazione Italiana Metalmeccanici (Fim), and Unione Italiana Lavoratori Metalmeccanici

[3] Italian Federation of Metalworking Industries.

(Uilm), belonging to the respective trade union confederations Confederazione Italiana Generale del Lavoro (Cgil), Confederazione Italiana Sindacati Lavoratori (Cisl) and Unione Italiana del Lavoro (Uil). Federmeccanica and Fiom, Fim and Uilm are responsible for renewing the National Collective Labour Agreement (NCLA), which defines the rules for metalworking companies and workers. In the light of the potential spread of Industry 4.0 throughout the Italian territory, an important role may be played by the bilateral national committee for vocational training and apprenticeship established by the national contract of the metal sector in 2012. The committee is responsible for: reaching an agreement upon sectoral multiregional training plans; monitoring the training initiatives; identifying companies' needs in terms of skills; and coordinating the committees established at local and plant level. In firms with more than 300 workers, the unitary workplace union structure could appoint the 'Vocational Training Responsible', who has power of attorney for signing corporate training projects.

Slovenia

The Chamber of Commerce and Industry of Slovenia (CCIS) is the Slovenian employers' association co-applicant in *INDUSTRY 4EU*. It is a non-profit, non-governmental, independent business organization representing the interests of its members. With more than 160 years of tradition, it is the most influential business organization in Slovenia. Over 7,000 member companies of CCIS come from all sectors and all regions of Slovenia. CCIS unites 24 branch associations (e.g. metal and electro industry). CCIS operates within a network of 13 regional chambers in Slovenia. CCIS has the status of a representative Chamber of Commerce and is thus a partner of the government in the preparation of legislation and policy strategies. CCIS is also a member of numerous government bodies, boards and committees in various fields. CCIS is also a social partner organization and signatory party of more than 20 branch collective agreements, agreements on minimum pay and the Social agreements. CCIS is member of the Economic and

Social Council in Slovenia. As a member of Eurochambers (the European Association of Chambers of Commerce and Industry), the International Chamber of Commerce (ICC), as well as other international associations and organizations, CCIS is part of an extensive international network with innumerable contacts, as, for example, focused on the issues of Industry 4.0:

- Metal-Processing Industry Association (MPIA), which is an independent, professional branch association, organized within the framework of CCIS, representing the interests of companies in the metal sector in Slovenia. Its main mission is to take positions and propose policies relating to social dialogue (signatory party of collective agreement) and industrial relations, legislation and government institutions, assist its members by disseminating different sectoral information and data, provide various consultations, legislation questions, business opportunities, organize training, as well as represent and communicate their proposals. It provides a wide range of services for its members;
- Electronic and Electrical Industry Association (EEIA), which is a professional industry branch association organized within the framework of CCIS, representing the interest of companies in the electro and electronics industry of Slovenia. Its main mission is to take positions and propose policies relating to social dialogue (signatory party of collective agreement) and industrial relations, legislation and government institutions. EEIA supports its member companies with assistance and advice;
- Chamber of Construction and Building Materials Industry (CCBMIS), which is a professional industry branch association (private non-profit organization) organized within the framework of CCIS. Its main mission, in the best interest of the Association’s members, is to take positions and propose policies related to Slovenian social partners, public institutions as well as targeted to their domestic and international associations.

Finally, CCIS connects to two main trade unions. The first is the Trade Union of Metal and Electrical industry of Slovenia (SKEI), an independent and representative trade union of workers in the metal and electro industry and the largest and most powerful sectoral trade union in Slovenia, organized within the Association of Free Trade Unions of Slovenia (ZSSS). The second is the Federation of Workers' Trade Unions of Slovenia (SOLIDARNOST), an independent and democratic interest organization that represents, promotes and protects the interests of its members acting alone or in conjunction with other trade unions.

3.
Governmental strategies to boost Industry 4.0

There is an increasing awareness of the urgency to boost Industry 4.0 in all the three countries involve in the *INDUSTRY 4EU* project. The acknowledgement of the relevance of digitalization for economic competitiveness is proved by different initiatives (i.e. policy recommendations, the introduction of new goals in policy agendas, networks, official papers, etc.), which have been recently undertaken by public authorities in Germany, Italy and Slovenia.

Germany

In this regard, it is worth mentioning that the German Federal Ministry of Education and Research sponsored the *Recommendations for implementing the strategic initiative Industrie 4.0* thus paving the way for further governmental initiatives on this topic across Europe. The document was realised by a working group composed of the Industry-Science Research Alliance and Acatech (the National Academy of Science and Engineering)[4] and officially presented in April 2013. Nordbildung defines it as «probably the most complete institutional document about the digital manufacturing», since it reveals the main goal of the German strategy lying on the need to become a leading market and supplier by developing cyber-physical systems-related technologies and their marketing

[4] Established in 2008, it represents the interests of German technical sciences independently, at home and abroad. The name stands for the combination of *academia* and *technology*, thus revealing that its main purpose is to promote a strong link between science and business. It is located in Munich.

throughout Germany. As expressed by Nordbildung, besides launching the so-called *Industrie 4.0 Platform*[5], intended to coordinate the implementation process and initiatives in different economic sectors, the *Recommendations* clarify key actions to be performed in a view of ensuring the development of Industry 4.0. The reference is to: standardisation and open standards for a reference architecture, management of complex systems, creation of a comprehensive broadband infrastructure for industries, promotion of safety and security standards as critical factors for the success of Industry 4.0, design of work organisation models coherent with the digital industrial age, training and life-long learning, devising of a new regulatory framework. On the other hand, *Industrie 4.0* represents a pivotal topic in the Federal Government's Digital Agenda[6] which was approved on August 20, 2014 and whose development is in charge of the Federal Ministries of the Economic Affairs and Energy, Interior, Transport and Digital Infrastructure. By the way, the Federal Ministry for Economic Affairs and Energy published in April 2015 the report *Industrie 4.0 und Digitale Wirtschaft. Impulse für Wachstum, Beschäftigung und Innovation*. Finally, in Germany, the Federal Ministry of Labour and Social Affair started tackling the work-related implications of Industry 4.0 in a document entitled the *Green Paper – Work 4.0* which identifies main challenges for the German labour market and attempts to expand the scope of the concept of flexibility from the workplace to the labour market, by encompassing issues such as career development and training needs ('flexibility 4.0').

[5] For further information please see *www.plattform-i40.de*.

[6] Through its Digital Agenda 2014-2017, the Federal Government has drawn up a comprehensive strategy for guiding and shaping the ongoing process of digitization. The Digital Agenda is focused on three core aims: 1) to further explore and exploit the innovative capacity of Germany in order to enable further growth and employment; 2) to support the nationwide expansion of high-speed networks and enhance digital media literacy across all generations in order to improve access and public participation; 3) to improve the security and safety of IT systems and services in order to increase trust among the public and the business sector.

Italy

Unlike Germany, where the Ministry of Education played a leading role in proposing a strategy to boost Industry 4.0, in Italy, it was the Ministry of Economic Development, in coordination with the Government, that developed a national plan on *Industria 4.0*, which was presented in September 2016 and is grounded upon two main pillars: fiscal incentives to companies that choose to invest in material (i.e. machines) and immaterial (i.e. software) technological goods as well as in research and development; skills development through the creation of many *Competence Centres*, aimed at helping companies developing workers' skills and competences which are consistent with the technological investments. Nevertheless, it is important to mention that in 2012, the Italian Ministry of Education adopted the so-called *Clusters' policy*. The Clusters are conceived as aggregations of firms, universities, research institutions and other organisations operating in the field of innovation, which are supposed to contribute to the international competitiveness of the Italian economic system. Accordingly, Clusters can be established at the territorial or national level and as far as Industry 4.0 is concerned, the Cluster *Fabbrica Intelligente* (CFI) has been officially acknowledged by the Ministry of Education at the national level. Its aim is to develop and implement a research and innovation strategy oriented to the promotion of Italian competitiveness. Notably, it deals with seven thematic areas: systems for personalised production; strategies, methods and tools for industrial sustainability; factories for humans; high-efficiency production systems; innovative production processes; evolutionary and adaptive production systems; and strategies and management for next-generation production systems. The activity roadmap is explained in detail in the 2015 document *Research and Innovation Roadmap*. Furthermore, in 2014 the *Agenzia per l'Italia Digitale* (AgID) was established and according to Federmeccanica, it can be intended as the first step performed by Italy to comply with the European guidelines on digitalization. The AgID coordinates public administration activities (at different

levels) and monitors the public administration information system in an attempt to foster the adoption of infrastructures that could contain costs and improve the quality of services offered to citizens. Overall, AgID is supposed to promote innovation and economic, cultural and social growth by spreading the deployment of new technologies and pursuing the objectives set forth at the European level.

Slovenia

Like Germany and Italy, also Slovenian government has recently commit itself to the development of Industry 4.0. Notably, in 2015 it launched the so-called Smart Specialization Strategy (S4), which covers a broad range of policies primarily aimed at boosting innovation and more specifically focused on the promotion of research and development, industrial policy, entrepreneurship, skills' formation, rural development, and international relations. One of the defined S4 priority areas is Industry 4.0, conceived as a broad phenomenon encompassing key elements such as (distributed) production management and control, quality assurance, regulation and data processing, intra-logistics, automation, smart machines and equipment, mechatronic systems, actuators and smart sensors. Interestingly, with the specific aim of fostering companies' innovation and initiative in this field, it is worth mentioning that 16 programs have been developed thanks to an estimated investment of around EUR 950 million. The following are the main initiatives of S4:

- the *Smart efficient energy use and conversion and energy efficient systems* initiative, which involves 45 small, medium and large enterprises employing over 14,300 workers with sales revenues of more than EUR 2.3 billion and all relevant research organizations. The initiative incorporates only technological areas and product families where Slovenian companies already have an established global presence or those where Slovenian companies feature a realistic potential to achieve a global breakthrough. It

thus builds on established high quality products on one side while outlining the strategy to launch high quality high added value niche products on the other side;

- the *Integrated initiative on a wider area of process control technology*, that has been formulated within the framework of Technology Network Process Control Technology (TN PCT, TM TVP) and its Competence Centre for Advanced Control Technologies (CC ACT, KC STV). Consequently, it focuses on those technology fields and fields of application where members of the Technology network and/or partners of the Competence centre play a central role or represent integrative players. Moreover, it allows companies to prepare individual initiatives for Technology Fields or Fields of Application thereof in the frame of this integrative initiative;
- the *ACS4ICOMP INITIATIVE,* which is led by the Automotive Cluster of Slovenia and brings together the Slovenian companies and R&D institutions in a view of promoting the development of smart factories in the automotive industry. The initiative focuses on the highly successful results achieved by the Slovenian automotive sector in the past years, its economic and social significance for the country, its inclusion in the latest technological trends in the European automotive industry and its robust response to the last global economic crisis, which the Slovenian automotive industry overcame more successfully than any other significant Slovenian industrial branch;
- the *Smarttools Initiative*, which is focused on the tool-making and machine engineering technology field and covers the production field of smart mechatronics tools and control of production machines and processes;
- the *ROBO++*, which deals with Industry 4.0 connection with intelligent factories, existing national and international competences and results to introduce robot technologies for intelligent automation;
- the *Nanotechnology Initiative*, which put particular emphasis on high added value segments related to medical applications and on high-volume nanomaterials applications.

4.

Activities performed by employers' associations in Germany, Italy and Slovenia in the light of Industry 4.0

The increasing awareness of employers' associations of the urgency to tackle Industry 4.0 is clearly demonstrated by a series of initiatives that have been recently performed in all the three countries involved in *INDUSTRY 4EU* project.

About unilateral actions in this field, it is important to state that in Germany, the Confederation of Employers' Associations (BDA Die Arbeitgeber) and the Federation of Employers' Associations in the Metal and Electrical Engineering Industries (Gesamtmetall) have written the papers *Seize the opportunities of digitization* (2015) (BDA position on the digitization of business and the working world) and *Work 4.0 – Opportunities for the Future World of Work* (2015), respectively. The documents focus on the impact of Industry 4.0 on work organization, skills and industrial relations with a positive approach analyzing the opportunities of the new framework such as new tasks involving more soft skills, new schemes of work time, smart working, etc.

Similarly, in Italy, the Confederation of Italian Industry (Confindustria) has set up two working groups in 2016 with the aim of defining recommendations to institutions and enterprises, useful to promote the process towards Industry 4.0. The first one is composed of industrial association Directors and wants to elaborate an industrial policy document on Industry 4.0, whereas the second one brings together industrial association Presidents and is working on: *Manufacturing 4.0 – SMEs, Processes and platforms customer-centered, Infrastructures and system tools* and *Digital skills*. After the launch of the Italian

national strategy on *Industria 4.0* in September 2016, Confindustria was involved in the board of the plan, started to focus on the institution of *Digital Innovation Hubs* all around the Italian territory, especially built on a regional dimension. Furthermore, Confindustria has launched in 2016 the project *Education and Innovation*, in partnership with Confindustria SMEs, Fondirigenti, Intesa Sanpaolo, with the aim at understanding the advanced manufacturing skills. Conversely, Federmeccanica has set up in 2015 the task force *Liberare l'Ingegno*, involving companies, universities, research centres and other employers' associations. It aims at contributing to the development of Industry 4.0, promoting a 'holistic' approach (both institutional and entrepreneurial), intended to convey the correct information on the topic and share the best practices. Finally, in Slovenia, the Chamber of Commerce and Industry of Slovenia has launched in 2015 its own initiative for the advancement of the economy, which called *Slovenia 5.0*. Its mission is to raise awareness in different public spheres on the importance of industry and the necessity of its advancement based on development programs with the best chance of succeeding on the market. For this purpose, Slovenia 5.0 brings together stakeholders who know best how, where, and to whom new products, services, or technologies could most successfully be sold, which is also the goal of smart specialization strategy. To achieve its goals, the initiative focuses on five key areas: smart state, smart taxes, smart HR management, smart internationalization and smart development, which are presented in the CCIS's Industrial Policy Manifesto. The Metal Processing Industry Association, organized within the CCIS, is actively involved in the Industry 4.0 discussion on various levels, groups and events, such as the yearly ASM conference or the Association's Management Board. Another branch association of CCIS actively involved in Industry 4.0 discussion is the Electronic and Electrical Engineering Association (EEIA). They were involved in Slovenian Smart Specialization process from the very beginning and helped frame the basic Industry 4.0 idea into the Slovenian manufacturing base. Their current activities are aimed at raising the awareness of the digital transformation among Slovenian companies by organizing best practice exchange events, regulatory and legislation

workshops, digital academy for top management, and developing digital competence tools for carrier planners.

Overall, what emerges from the mapping exercise is the willing of employers' associations from different countries to support their constituents in the transition, by also attempting to provide guidelines and suggestions aimed at fostering a sustainable development process.

Regarding social dialogue and coordinated actions in this context, the mapping exercise has confirmed the crucial role that multilateral cooperation and social dialogue play in a coordinated market economy like Germany. Notably, as contended by Nordbildung, this dialogue covers all business-related questions on the (further) development of the industry and the safeguarding of its future. Within the framework of this dialogue, innovative structural model and modern careers were developed for the M+E industry and for the IT sector. These process-oriented, flexible job profiles also satisfy the requirements of the system orientation of Industry 4.0 across the sector and the associated value creation and networks. This is also the basis for a new initiative by the German social partners of the M+E industry, which led to the conclusion of a joint social partnership agreement that defines agile methods. Gesamtmetall, VDMA, ZVEI and IG Metall reviewed the Industry 4.0-related training occupations and the associated further training in the M+E sector in the light of changing requirements and new career prospects. The review included the expertise of company and education experts and researchers. As a result, the parties swiftly developed recommended actions for initial, advanced and further training in the M+E industry with specific proposals for further measures and initiatives. This action constitutes the basis for future negotiations with the process participants affected by the recommended actions.

Important actors in the industrial relations system in Italy are bilateral bodies, which are established jointly by trade unions and employers' associations in

several industries and funded by contributions from both workers and employers. They generally operate within the framework of workers' health and safety, training and lifelong learning, income support schemes and so on. Therefore, it is not by chance that Fondimpresa, a bilateral fund established by Confindustria and Cgil, Cisl and Uil, is described by Federmeccanica as an important player in face of the transition towards digital manufacturing. More specifically, Fondimpresa funds the sectoral multi-regional training plans through 'System Account' calls for proposals, which cover different items. Particularly, the development of the so-called skills 4.0 is promoted within the areas 'Competitiveness' and 'Technological Innovation'. For example, the call for proposals n. 1/2016 about company competitiveness has funded training measures directly related to qualification of production processes and products, organization innovation, digitalization of business processes, ecommerce, net contracts, internationalization. With specific regard to the metalworking sector, it is important to state that a crucial role is played by the joint Committees for vocational training and apprenticeship established at both national and local level. These Committees are responsible for analyzing and reaching agreements upon the training plans. Those plans, which are signed jointly by employers and workers' representatives, can be submitted to Fondimpresa and financed under its budget lines. Furthermore, the Committees monitor the metalworking training plans financed and share the related results. On March 17, 2016, Social Partners organized the Conference *Lifelong learning for Industry 4.0* in order to present the monitoring realized by some training centres on innovative plans developed under the Fondimpresa's call for proposals 4/2014.

4.1. A focus on skills

One of the main concern of the stakeholders about Industry 4.0 and the transition to the new production model is how to map, and then teach and learn the skills required for it. For this reason, a focus of the mapping exercise was devoted to

this topic. Most of the initiatives performed by employers' associations in this field are not built directly on the framework of Industry 4.0 but they can be easily adaptable to it. They can be summarized in three macro-groups: continuous training; network initiatives; entrepreneurship education programs; participation in regional, supra-regional and international projects. Not all these areas are tackled in all the three countries depending on national policies and attitudes, i.e. in Germany, the dual system in education already plays a prominent role in supporting school-to-work transition.

Continuous training

Fast and high quality school-work transition has been considered essential, and rightly so, in the Fourth Industrial Revolution. For this reason, Employers' Associations and Trade Unions from many European countries are trying to improve the relationship with educational actors, in order to fill that found gap between knowledge and practise competences into the labour market. More specifically, continuous training activities and much more initiatives have been developed.

In Italy, Federmeccanica is mapping the so-called 'Unilateral Programs' through a network with local Industrial Associations and to Metalworking Trade Unions, which are recording also entrepreneurship education programmes, partnerships with educational institutions and promotion of school-to-work transition initiatives.

The same mapping activity is made in Germany by Nordbildung Gmbh, the education network of metal and electric industry, organized by Nordmetall (Federation on the metal and electric industry), AVG Nord (Employers' Association in Northern Germany) and seven educational institutes. Unilateral programmes refer to all activities intended to inform the member companies about Industry 4.0 and Work 4.0 and forge links between them and with third parties.

Particular attention is given to events, networking and working groups because the content of these exchanges is centrally organised by the associations.

In Slovenia, instead, two different projects have been carried out: the so-called *SkillME* project and the *KnowME* project. About the latter, between 2012 and 2013, five European national sector organisations (CCIS-MPIA, CCISEEIA, MASOC, LINPRA, ZEP RS) from the Metal and Electro Industry (MEI) carried out a EU-funded project on future-oriented skills and knowledge management. The aim of *KnowME* project, that involves four countries (Slovenia, Latvia, Slovakia and Lithuania), is to improve the capacity of social partners in anticipating and managing change in their sector as well as strengthen their cooperation on the European level. For this purpose, the tool used for mapping the situation have been a survey and interviews with companies.

One of the most significant problem is the lack of highly skilled workers on the labour market besides the number of apprentices from VET institutions available that is considered not enough. Small and medium-sized companies (SMEs) have only limited capacity and personnel to provide the necessary trainings to respond to the newly upcoming qualification and skill requirements. The main result of this project was an increased awareness of the need for effective skills and knowledge management among SMEs in MEI. The involved social partners increased their capacity to support companies in anticipating, preparing for and managing industrial and demographical change.

The *SkillME* project instead is a 3-year (2014-2017) project co-funded by the Erasmus+ Programme of the European Union and led by CCIS-MPIA, aimed to identify the most pressing and widespread skill gaps in the industry of today and tomorrow and to design tools for helping to fill those gaps. This was only the first step, whereas the second one was to identify the areas of competencies that are going to be most sought-after in the future: the project fostered cooperation of

worlds of education and work by cooperation in CVs design between the industry and VET providers.

In all these different countries, some Association have developed a study about the aforementioned skill gap. In Italy both Employers' Associations and Trade Unions are developing some project to identify the new 'skills 4.0' in different sectors. In particular, the project *Education and Innovation* is developed by Confindustria, Fondirigenti, Intesa Sanpaolo and Confindustria SMEs with reference to the following sectors: Advanced Manufacturing, Aerospace, Biomedical, Fashion Industry. The long-term purpose is to identify useful tools to enhance companies' investment in training, which should become a real parameter that determines creditworthiness.

Local Confindustria, with the support of University and other training institutions, built up different programmes about digital knowledge to develop the new required skills. Confindustria Firenze, for example, worked on an executive programme in manufacturing big data, addressed to all the companies that want to implement the digital transformation of processes (COSEFI, Polytechnic University of Milan – Graduate School Of Business and University of Pisa are partners of the project): the program provides *ad hoc* training (50 hours of frontal lesson and about 15 hours of project work) about supply chain management, innovation culture, big data.

Similarly, Confindustria Bari, Polytechnic University of Bari and the Business School of *Il Sole 24 Ore* have developed the Master course *Innovation and Digital Transformation*, in order to foster the managerial and operational skills and to organise and supervise the processes of innovation and digital transformation within the companies.

Another example comes from Confindustria Bergamo, which has organised two different training programmes known as *Industria 4.0@Confindustria Bergamo*

and *Tips 4 Smart Manufacturing*, addressed to managers and young employees in order to share best innovative practices. On the other hand, the Trade Union Fim-Cisl, in collaboration with its local associations, employers' associations, training centres, inter-professional funds and training committees, has realized since 2009 the project *Rewind*, which wants to train Trade Unions delegates on the duties and responsibilities foreseen in the NCAL about vocational training. More than 2,300 delegates and 140 secretaries have been trained in 107 seminars, which are always more frequently focused on I4.0 implications.

Networking initiatives

In Germany the Unilateral Programs are developing much more in the networking through professional figures sharing best practices. Many are good examples:

1) the CoTP (Community of Training Practice), a networking service for all Nordmetall and AGV NORD member companies that brings together specialists and managers responsible for the organisation of product-related and process-related training content, formats and media;
2) the PEAK (Personnel Development Working Group), a networking service for all Nordmetall and AGV Nord member companies which invites HR experts for specialist discussions across corporate boundaries on current incentives and best-practice processes in personnel development. Industry 4.0, as an area of activity, was chosen as the heading for two PEAK meetings in 2016 and the companies involved explicitly requested the development of a set of questions to review their own specific structures and processes;
3) HR Networks for sharing HR-specific experience. The exchanges are based on a presentation on HR issues, the latest information about employment and social security law and current developments in wage policies. Training Networks in the M+E industry organised by Nordmetall and AGV Nord are

targeted at training managers or those responsible for training in the member companies;

4) Training Managers Conference, which usually takes place once a year to discuss an issue that is relevant to all four regional training networks. In 2016, for instance, the subject of the conference was *Training 4.0: Pipedream or Reality?* and delegates examined how digitalisation as a driving force behind technological development affected commercial and technical training in the M+E industry;
5) *Treffpunkt Nordbildung*, a joint project of the education network Nordbildung and the employers' associations Nordmetall and AGV Nord with two events in each year targeted at employers, managing directors, training managers and HR managers. Under the banner of *Sharing Knowledge – Cultivating Contacts* the aim is to hold cross-functional discussions, share experience and incorporate new ideas into operational practice;
6) Production Forum, organised once a year to provide managing directors, plant managers and production managers of the member companies with comprehensive and practical information about current issues and the latest developments in the metal and electrical industry. The Production Manager Meeting, aimed to ensure a high degree of practical relevance, is held at one of the participating companies, which can choose to give a practical illustration of the specific issue.

In Italy the most interesting example of partnership is represented by the Territorial Labs for the Employability, which are promoted by the Ministry of Education under the National Plan *Digital School* with 45 million financing. These are living labs addressed to students and NEETs, in which is possible to foster youth employability, promoting entrepreneurship activities and aligning skills with enterprises' shortages.

In this framework, the Labs are created with the cooperation among Municipalities, Educational Institutes, local Employers Association and firms in order to orient the schools to territorial needs and the training activities to strategic sectors of the local productive district. For example, LAB 4.0 is developed in Reggio Emilia by Unindustria, 8 secondary schools, 2 tertiary institutes, the Municipality, the Chamber of commerce, and other foundations (Bank foundations, the Foundation for industrial research and technology transfer, the local FabLab and training organisations). Also the Territorial Labs for the Employability *S.M.I.L.E.* and *SAIL – Smart Automation Innovative Laboratory*, developed, respectively, in Bergamo and Brescia, are 'totally connected' centres which deal with innovation and school-work interconnection.

Another important initiative of partnership is represented by the 'ITS', pathways of non-university tertiary education (level 5 EQF), characterized by higher technical specialization. Each course lasts for two years (1,800-2,000 hours) and foreseen a period of work-based learning (at least 30% of the duration) and can guarantee the title through an apprenticeship contract. The ITS offer training courses related with six technological areas considered as strategic for the Italian economic development and competitiveness, like Energy Efficiency, New technologies for the life and new technologies for the 'Made in Italy'.

School-work 'alternance' could considered as another example of partnership between educational and productive systems. In Italy the Law No. 107/2015 about the educational system, introduced 400 hours of on-the-job training during technical and VET education. *Traineeship*, is the alternance programme set up at national level by Federmeccanica and the Italian Ministry of Education: it involves 50 VET institutes, 5,000 students and more than 500 MET firms. The project is characterized by a strict collaboration between schools and firms, which should design and plan jointly both pathways (skills, working activities, performances, etc) and assessment criteria; furthermore it involves also joint training for internal and external tutors.

Other examples of school-work partnership are organized by local Confindustria to support teacher (for example Confindustria Bergamo with *Lean Production and Smart Manufacturing* or *Development of Strategic Skills for Learning Experts*, developed by Confidustria Padova with *Niuko*).

Entrepreneurship education programs

In terms of entrepreneurship education programs, in Italy Federmeccanica, in agreement with Ministry of Education and supported by local Employers Associations, developed a specific program called *Eureka! Funziona* to involve students of 3/4/5th years of primary school (11,000 students of 28 cities) in the theme of automation. Confindustria Padova instead focused on secondary schools with a project called '*Focus upon companies*, in which each class simulates a business activity and should invent, promote and sell an innovative product or service in order to solve a real problem or need emerged in the city. Furthermore, the students visit some companies, verifying how an idea could become reality. The aim of both programs is to introduce children to I4.0 and to stimulate young students to a new way of thinking about innovative business.

Through continuous innovation, this partnership is focused on create new specific and flexible professional profiles which can manage competences for Industry 4.0 such as Human-Machine Interfaces (HMI) designing, Data Analysis, Predictive maintenance systems designing, Visual Communication (tutorial, webinar, pitch), Team working, Process working, Autonomy, Self-entrepreneurship.

Participation in regional, supra-regional and international projects

In Germany, Nordmetall and AGV Nord participate, in part directly and in part via Nordbildung gGmbH, in a wide range of regional, national and international projects to actively support the developments of Industry 4.0 and Work 4.0 and to

help shape them in accordance with the objectives of the M+E industry in Northern Germany.

Two examples of regional projects are the *Airbus Factory for the Future – HR 4.0* and the *DigiNet – Air* application. Both projects deal with the design of sustainable processes and structures within the aviation cluster in Hamburg; apart from Airbus and Lufthansa Technik, the project partners also include universities, vocational schools, ministries, research institutes, trade unions and associations.

Regarding both projects, Nordmetall and AGV Nord consider it their responsibility to disseminate information and shape networks in order to identify best practices on the basis of the projects and apply it company-wide. During these events, the associations work together with the member companies to examine the question as to what impact the new developments are going to have on the future structure of employment.

Industry 4.0 should be regarded as an open socio-technical system. The associations are currently visiting businesses that have already gathered practical experience of the development and implementation of the issues relating to Industry 4.0.

In the light of the above, all the considered countries showed an important involvement in the theme of Industry 4.0 and on what is necessary to develop it in the best way. For sure Germany leads the others, Italy is growing in terms of awareness and Slovenia is starting to walk the path to evolution.

5.

The awareness of Industry 4.0 and its features

All the partners involved in *INDUSTRY 4EU – Industry 4.0 for the future of manufacturing in the EU* project have carried out a sample survey handing over to some organizations and to those related companies a questionnaire entitled *Industry 4.0 – A survey top build the future together*. The aim of the survey is to both track the real level of awareness of those surveyed companies with respect to the new 4.0 enabling technologies and to determine the effects of these technologies as well as the way they could affect human capital and the economic performances of corporations.

Enabling technologies:

Mechatronics

Robotics

Internet of Things

Big Data/Data mining

Cloud Computing

Cybersecurity

Additive Manufacturing

System of Virtual Simulation

Nanotechnologies

Smart materials

The analyzed enabling technologies are those mentioned within the literature review of national reports, namely:

1) Mechatronics;
2) Robotics;
3) IoT;
4) Big Data/Data Mining;
5) Cloud Computing;
6) Cyber-security;

7) Additive Manufacturing;
8) System of Virtual Simulation;
9) Nanotechnologies;
10) Smart materials.

Each surveyed company has answered to a questionnaire divided into six parts:

1) Company features;
2) Technological innovations;
3) skills and competences;
4) Job organization;
5) Attitude towards Industry 4.0;
6) Corporate culture.

If in Germany and in Slovenia the sample consisted of 54 companies, in Italy those surveyed companies were 527 companies revealing a marked difference compared to the other two States. Among those surveyed Italian companies it should be noticed a majority of small (53.7%) and medium-sized enterprises (32.4 %), whereas in Slovenia the production structure showed a greater homogeneity comprising a 33% of large companies, a 39% of medium-sized companies and a 28% of small ones. In Germany 63% of the companies of the survey are small and medium and the 37% big. For what concerns the productive activity typology, the Italian companies have largely positioned themselves in the market of industrial products, whereas the Slovenian companies have distributed their production more uniformly on the market of consumer goods, industrial products and those intermediate goods involved in the supply chain. The German companies are most in the fields of steel and metal processing and in mechanical and plant engineering.

Number of companies of the survey:

Italy: 527

Germany: 54

Slovenia: 54

Despite the fact that Industry 4.0 paradigm was born in Germany, the majority of German companies does not assume their production processes have achieved a high degree of digitalization, only 6% declare itself at a high level of digitalization, half of them (48%) medium and 13% low. Is also interesting the fact that 33% doesn't answer to the question or is not sure, showing that is not easy to have a clear awareness of this aspect. On the other hand, in Slovenia, 61.1% of companies admits that its production processes have achieved a medium degree of digitalization, whereas just 13% of the interviews answered to have only achieved a low degree. Roughly the same Slovenian figures have been registered also in Italy: among 62% of companies that have adopted 4.0 technologies, 28% of them assumes to have a high degree of digitalization, against 62% of them considers its degree of digitalization still medium; barely 9% of them thinks its degree of digitalization too low.

The fact that Germany considers its degree of economical digitalization still low, whereas in Italy and Slovenia it is thought to be in the average or high, is an interesting finding as Industry 4.0 paradigm was precisely conceived in Germany, whereas this concept has only recently spread in Italy and in Slovenia. Perhaps it shows that Italian and Slovenian companies have an overrated perception of their ongoing production processes or they understate the potential of new technologies, thus they assume their degree of digital progress well above the actual level of use. On the other hand, in Germany, where the manufacturing enterprises have now become familiar with the topics regarding Industry 4.0, the interviewees' perception is likely to have reached an awareness that comes close to the actual level of use of those new digital technologies.

Most known technologies:

Mechatronics

Robotics

Least known technologies:

Nanotechnologies

Big Data

Smart materials

It is no coincidence perhaps that in Italy, for instance, 93% of the interviewed companies has declared to know those technologies referring to cyber-security in contrast to a lower implementation of them (roughly 83%). Likewise, in the field of Robotics 85%, of companies has declared to know it, but just one in two companies employs it indeed. 49% of the companies has declared to know Nanotechnologies, but their actual use is accomplished in one in ten companies. Smart materials are almost known by 43% of the interviewees, whereas they are used by barely 1.5 in ten companies. As a matter of fact, the analysis of the survey shows that there is not a close correlation between the knowledge of a certain technology and the actual level of use and, above all, between the actual level of use and the degree of digitalization of corporate processes.

Specifically, in Germany, Italy and Slovenia the most known technologies are Mechatronics and Robotics, whereas the least known technologies are Nanotechnologies, Big Date as well as Smart Materials. In Germany and in Italy only one in two companies knows Internet of Thing (IoT), opposed to Slovenia where almost 87% of companies has become aware of the existence of that kind of technology. Cyber-securities rank first in Italy, whereas in Slovenia and Germany they are positioned fifth. Additive manufacturing is known by 74% of Italian companies, whereas barely half of Slovenian and German companies do not know what this kind of technology is.

Additionally, by comparing all replies, it can be outlined that Italian companies tend to mostly diversify the use of these technologies – through production and product development up to the commercialization processes and services. On the other hand, Slovenian companies are more likely to focus the use of digital technologies on the field of production, management and product development. For instance, in Slovenia companies tend to employ Mechatronics, IoT, Data Mining, Cloud computing, Additive manufacturing, Virtual Simulation System,

Nanotechnologies and Smart materials above all, or almost exclusively, in the field of production and product development.

Also in Italy the majority of these technologies are implemented in the fields of production and product development, although there are some exceptional cases as those of Cloud Computing where its implementation is limited to the field of Services. Conversely, IoT is approximately adopted in all fields: both in the production (34%) and in the product development (44%) fields, as well as in Commercialisation (35%) and in the field of Services (37%). Within the field of Services, Big Data are often used too, although a substantial employment is also registered in the fields of Production (48%) and Commercialisation (25%).

For what concerns investments in Industry 4.0, the survey reveals how Slovenian companies will make investments mainly in Robotics, Mechatronics and IoT. The investments in Robotics and Mechatronics will have a short-term planning – 53.7% of companies has replied that companies are going to invest in this kind of technology within next year, whereas the investments in IoT will have both a short-term (38.9%) as a medium long-term (24.1%) fallout. In Germany, the investments will be focused on, both along a short- and a long-term period, these four following enabling technologies:

1) Mechatronics;
2) Cyber-security;
3) Cloud Computing;
4) Robotics.

On the other hand, in Italy the economic resources of companies will basically focus on Nanotechnologies (84%), Smart Materials (77%), Additive Manufacturing (71%) and Big Data (69%).

After having been surveyed on the most remarkable features of novelty within corporate culture subsequently the introduction of Industry 4.0, Italian and German companies ranked life-long learning first, whereas, Slovenian companies ranked coordination and cooperation between enterprises within the value chain both at horizontal and vertical levels first. The reorganization of the company structure is ranked second by the Italian and Slovenian companies, whereas according to German companies the second enabling factor is innovation in the managerial culture. Conversely, according to Italian and Slovenian companies innovation within this latter field is ranked third, whereas according to German companies the restructuring of the corporate organizational models is ranked third.

To sum up, from the results of the survey carried out it can be noted that professional training is the most important enabling factor for Italian and German companies. This fact highlights the will of the management to bridge the gap skills that the introduction of the new 4.0 technologies will regularly determine in the matching between supply and demand in the labour market. On the other hand, Slovenian companies consider the vertical and horizontal coordination within the field of the value chain as the primary driver of implementation of Industry 4.0. This fact shows the need for the Slovenia economy to build up a system for the implementation of the new technological revolution with the objective of increasing above all the degree of competitiveness of industrial manufacturing in the global market.

In conclusion, the analysis of the national reports highlights broad consensus among interviewees for what concerns the fact that employer associations will have to support companies mainly, but not only, through the dissemination of information on available financial instruments at a national or European level (Slovenia, Italy) and on the initiatives at a local or/and regional level related to Industry 4.0 development. According to those interviewed companies, another driver for the efficient implementation of Industry 4.0 paradigm consists in the

dissemination of best practices related to a successful business case in the technological change towards the digitalization of production (Germany).

5.1. Benefits and expectations from Industry 4.0 adoption

It was asked to the companies which are benefits and the expectations that they think will derive from the adoption of the new technologies related to Industry 4.0. For the surveyed companies the most relevant benefits that the use of technological innovations will bring are, first of all, the improve of productivity, a deeper flexibility in product and service customization and the opportunity to optimise costs.

The main benefits attended by companies:

Improve productivity

Increase flexibility in product and services customization

Optimise costs

Italian and Slovenian companies also underlined that a relevant benefit would be the reduction in time-to-market processes. In generally companies think that with these new technologies they will optimise process: for the Germans ones there is the opportunity to reutilise or further utilise existing product, while for the Slovenian ones the introduction of new technologies will optimise energy consumption and raw materials and will orient the production towards a make-to-order production. The German companies also associated the use of new technologies with the possibility to create interfaces between real and virtual systems. Finally the Italian companies mention the possibility to supply new services to consumers and the increase of information related to production process as benefits linked to the adoption of new technologies.

On the side of expectations about Industry 4.0, the companies deeply disagree that Industry 4.0 is a passing trend: for the majority of companies, so, the

implementation of new technologies will have real content and relevant economic effect. Italian and Slovenian companies agree that new technologies can be implemented gradually with contained investments, even without radical changes, and that implementation doesn't requires important investments. Germans ones, on the contrary, think that implementation of Industry 4.0 requires major investments, and that these will cost. These considerations could be connected with the evidences reported in the previous paragraph about the self-consciousness of the level of digitalization: the German companies think that their level of digitalization is low – and so they require major investments –, while the Italian and Slovenian ones think that they are in an advanced state of digitalization – and so the investments could be done in a contained way.

Highest agree it's on the consideration that Industry 4.0 will allow customer-specific production that would increase competitiveness. The surveyed companies don't agree that Industry 4.0 is unsuitable for SME's, but, especially the Italian and Slovenian companies think that would be difficult that, thanks to the increase in efficiency and competitiveness that Industry 4.0 will bring, SME's can be a threat for big companies. At the same time, Italian and Slovenian companies agree that the greater agility given by these technologies to the big companies wouldn't be a threat for the SME's.

Questioned about the possession of the required skills for a proper implementation of these new technologies, the companies from the three nation are divided: the Italian ones said that they have the proper skills, the Slovenian ones were indecisive regarding this point, while the German ones think that they haven't acquired yet the proper skills.

There is high accordance on the consideration that the companies who fail to grasp the opportunities offered by Industry 4.0 are likely to be excluded from the market. The awareness on the fact that it's necessary to invest in these technologies is high. It could be said that benefits and expectations from Industry

4.0 adoption are more similar among the Italian and the Slovenian companies, rather than the Germans ones.

5.2. Skills, training and work organization for Industry 4.0

Researchers and practitioners agree on the fact that Industry 4.0 will deeply change the skills required to the workers and the job organization. So the third part of the survey was focused on asking about these dimensions. First of all, it was asked to the companies the average annual working hours/days pro capita dedicated to develop the skills through ad hoc training. Secondly it was surveyed to the companies if they found some change in the skills, especially the soft ones, following the introduction of the new technologies related to Industry 4.0. Then it was asked to the surveyed companies if they have already some specific skills useful for interact with these new technologies, and for which activity/process the mentioned skills were primarily used.

Finally it was asked to the companies about the changes that the new technologies could bring to the job organization, especially in relation to the new ways in which working-time and workplaces could change (smart working) and how these technology could impact on the sharing of knowledge.

As it was previously mentioned, it was asked to the companies the average annual working hours/days pro capita spent on skills development through training. There is a huge difference between the German case and the other two. Italian workers spend 29.7 hours per year on training and the Slovenian ones 24 hours per year, while the German ones well above these averages: they spend, indeed, 25 days per year on training.

With regard to the changing significance of specific soft skills following the introduction of new technologies, the greatest changes in all the companies surveyed were relate to digital communication, but also in team working, problem-solving, autonomy, accountability, flexibility and proactivity. In the Slovenian companies great changes were also in the interdisciplinary approach and the leadership approach. The smallest change instead was expected in the area of interpersonal relationships or empathy, and, for the Slovenians, in the area of emotional intelligence. These evidence underline that the changes carried by the new technologies don't affect the interpersonal rapports between the workers, but these affect the way which they approach the work itself.

Greatest change in soft skills in companies:

Digital communication

Team working

Problem solving

Autonomy

Accountability

Flexibility

Proactivity

On the side of what kind of specific skills the companies already hold, the most mentioned in every single report it's the data analytics, marking that the analysis of big data is one of most important consequences of Industry 4.0. Also the skills

to manage the IT infrastructure and to programming/coding are heavily mentioned (especially in the Italian and German report). The Slovenian report also evidence that among the held skills there are robot management and prototyping and 3D production, while product chain simulation was the last mentioned skill. As the Slovenian companies, the Germans ones lacking in skills in simulation of production, but also in prototyping and robot management.

Greatest change in technical skills in companies:

Data analytics

Managing IT infrastructures

Programming and coding

Robot management

Prototyping and 3D production

Data analytics skills are used primarily in reporting systems, decision making activities and (especially fort the Slovenian companies) quality control, while IT infrastructure management skills were most used in relation at IT security management and cloud, sensors and server management, but also, by the Slovenian companies, these skills were used for prevention and the solution of anomalies.

On the field of job organization, it was asked to the companies about the effects of the new technologies on the implementation of new working-time and workplace models (smart working) and the impact of the new technologies on the networking and sharing of knowledge (knowledge sharing). In every national report is underlined the big impact that these technologies have on knowledge sharing, while only the Italian and the Slovenian ones, especially the latest, mentioned an influence of the new technologies in the field of smart working. For the German companies there won't be major changes on this aspect.

In this paragraph the similarity between Italian and Slovenian companies is less strong; it's probably because the required skills to use a machine or to manage a determined situation are always the same, independently from the country where the worker works.

In the field of the project *INDUSTRY 4EU* some stakeholders have been involved – members of Trade Unions and Employers' Associations of countries belonging to the project – in particular as subjects of an interview that aims to identify the position, in general terms, of their organizations about the phenomenon Industry 4.0, the impact detected in occupational terms, the organization of work, the consequences on Industrial Relations, the proposed changes in competences and training and finally the possible obstacles to a development and role of social partners.

6.
Position of the stakeholders about Industry 4.0 and world of work

During the three national roundtables of the project interviews were taken with select stakeholders from employer's associations, trade unions and education institutions with questions about the impacts of Industry 4.0 on work, skills and industrial relations (*Annex. Survey draft for interviews with stakeholders*). About the vision of Industry 4.0 and the general position about the concept emerged firstly some differences on the phenomenon, depend by the kind of institution and also by the country they belong to. About Italy, the Representative of Unindustria Reggio Emilia affirms that the Industry 4.0 phenomenon represents a "developing process, a reality with a potential not yet developed and this must be the aim of companies". For Confindustria Bari, on the contrary, it is an actual topic, even though the Italian Industry, especially in the South, is not aware about Industry 4.0, risking that this phenomenon would be only a principle.

Some differences can be seen also among different Representatives of Trade Unions Associations involved in the project. For some of them (Uilm-Uil) the phenomenon is (for the moment) just a slogan, a trend, but they don't reject the existence of changes that come from technological innovations. The same Representative thinks also that these phenomena (revolutions) must be studied later, so now is difficult to give an opinion or take a well-defined position. For the Representative of Fiom-Cgil, on the contrary, "is necessary that Industry 4.0. would be recognized as a complex process of integration of digital technologies in manufacturing production", to be seen as an opportunity for workers that – so not to cope with it – should be protagonists and this can happen only through

continuous training that in Italy needs to be more qualified. For Fim-Cisl Industry 4.0 is an opportunity that workers and companies can't ignore, it is the only way today to securing a future of manufacturing sector, and it something already happening in the modern companies. The Trade Union of Metal and Electro Industries of Slovenia (SKEI) affirms that "the process is in an early stage so far, and would need more time to reach a complete development" and the employer association Metal Processing Industry Association claims that it is an acronym that includes an evolutionary process that involves most advanced companies and especially the ones that belong already to realities of global supply chain and for this reason are obliged to adapt to technologic changes and social process that come in succession. Interesting is how is underlined that Industry 4.0 is a process that is changing deeply the general world of business, the productive processes and even the mentality of consumers that are very important if we think how this phenomenon would bring a greater integration between goods production and the distribution of services linked to them.

As regards Germany, is interesting the fact that in this country, despite it was the first one to analyze the Industry 4.0 phenomenon both Trade Unions and Employers' Associations agree that the paradigm of Industry 4.0 is a successful one in many companies, even if it is in an experimental early stage and not so spread: "Even if it's something concrete, especially in Germany, in reality few companies have started this process" (Nordbildung). About this point they say that it's important the dimension of the company: small and medium enterprises are not so developed to implement this process because they need a focused support and models to invest correctly on technological innovation that is the essence of Industry 4.0. For IG Metall we are in front of a transformation more than an evolution, and the transformation changes the nature of companies that are a mix between manufacturing and services providers.

6.1. Impact of Industry 4.0 on employment and work organization

One of the profile of interest related to the phenomenon of Industry 4.0. and its connections and consequences with different productive realities of each country of the project is for sure the organization of work and company and its occupational implications. The common data emerged in the interviews is represented by the fact that, even talking about the facts on 'pilot cases' (Unindustria Reggio Emilia) where this phenomenon is more developed, emerges how the progressive commitment of new technologies in a context of IoT (a new way to use the capacity of systems based on web connections that guarantee the possibility to make parts of the physical world interact between them through the net) can generate new businesses for enterprises but only changing the organization of work.

In other terms, is underlined the need to have work organization models less top-down and characterized by an increasing cohesion between different tasks in the company (in particular Unindustria), in order to guarantee a correct circulation of information and a horizontal collaboration with the necessary autonomy.

UCIMU (Italian machine tools robots and automation manufacturers' association) underlines how the organization must change, as it has happened in the last 50 years, so what is needed is sort of continuous evolution of interaction between man and machine. A 'collaboration' that is already happening and that other people interviewed have already mentioned (especially the representative of Uilm-Uil). He highlights, differently from the others, how Industry 4.0 doesn't have a relation with the collaborative model between man and machine because "robots would continue to automate everything possible, while workers would do what remains, activities more intellectual and with more added value". All the interviewed people considered the Industry 4.0 phenomenon both an advantage and a threat for the workers: the result will depend by the level of professional qualification and requalification, that must be incentivize through a continuous

training. About this issue, the Representatives of German Trade Unions underline how there would be more opportunities than risks for workers, especially for high-skilled and qualified people. There is the need to act on two levels: on the first one, it must be given continuous training for workers and, on the second one, it must be implemented policies of requalification for unemployed people (Fiom-Cgil). SKEI underlines the need of a training focused on digitalization, the implementation of lifelong learning systems in order to manage the fast-changing productive processes, lifelong learning systems that must be projected together with other parts involved. Fim-Cisl sees training as the fundamental right of the workers in the scenario of digitization because skills are necessary in a fast changing world of work and a real protection for workers.

On this topic is also necessary to take on consideration the discourse about the productivity of work. As affirms the Representative of Confindustria Bari, the exchange of data between machines and between machines and men can bring more productivity, not just in the company, but also at systemic level; on the contrary UCIMU affirms that would be difficult to manage all these data that are evolving (big data), and that could bring to a paradoxical consequence of a loss of productivity.

Talking about consequences of work organization, is important to note how IG Metall highlight the need of flexibility for new productive processes integrated with new and more advanced technologies for a quick answer to demands of the different costumers. This allows to put attention on a specific aspect of Industry 4.0 that is a new dynamic of integration between the production of goods, the supply of integrated services and the customer care service, that must be guaranteed with fast interventions, often from remote, that is made possible by the interconnection with suppliers and customers and from the exchange of big data.

6.2. Consequences on Industrial Relations

Innovations introduced by Industry 4.0 seems to have a strong impact on Industrial Relations because they influence directly relations between human capital and company. On the issue, as explained by the representative of Unindustria Reggio Emilia, the direct consequence of the change of paradigm of Industry 4.0 regards an increase in productivity that is possible thank to the exchange of information among social parts and the ability of companies to acquire more data. This mechanism can guarantee more collaboration in Industrial Relations, a collaboration based on a participative model and good relations between trade unions and companies. To face future challenges is necessary that all the stakeholders can adapt to the specific case, without adopting predetermined models. Very important is the social dialogue that would be in Europe, through specific guidelines for Member States and social parts, as a way to face the potential social and work problems. Confindustria Bari affirms that there is the need of new tools to improve the model of Industrial Relations in Industry 4.0, in the specific, should be an interconfederal agreement on Industrial Relations and on bargaining that would make Industrial Relations adequate to the potential changes. The increasing flexibility of companies and workers will be managed by national collective bargaining or by second level one, while the so called high-skilled worker would have more individual contractual power. More important would be the bonus payment, in a single agreement or in a collective one (because of the increasing autonomy of workers). In the Slovenian case, people don't consider positive the introduction of new tools of Industrial Relations (joint committees, new intermediate bodies, 'new obstacles') because in the past these experiences didn't succeed. They agree only on the need of training of Trade Union Representatives on the global trends. From the point of view of SKEI the role of Trade Unions is still linked to a national dimension, while industries have been now considered economic global actors, and, with problems that are usually transnational ones, Trade Unions should be more international to adapt to the supranational dimension of markets. So, is now necessary for the Trade Unions to

have a more International point of view on social and work problems to understand more deeply the great technological changes on a global scale. The training of Trade Unions Representatives should be linked to a global dimension of work problems, great social changes caused by automatization, digitalization and robotization. Fim-Cisl see the development of new schemes and practices of workers' participation as a premise of Industry 4.0 because a new form of work organization, new responsibilities of workers and more autonomy requires a new model of industrial relations. For IG Metall the German "model of social partnership, employee participation, industrial performance are a good basis to shape the change".

6.3. Challenges for skills and training

The paradigm of Industry 4.0. is linked to the promotion of the workers in the productive processes: this approach requires the development of new competences and specific abilities. For this reason, is necessary to invest in educational systems and in the training of workers through tools such as turnover and apprenticeship. There is the need to build educational programs to acquire specific competences. In this process a fundamental role is performed by the different levels of education (first, second, third grade) that must help the spread of specific digital competences and to form the future labour force in scientific, technologic, mathematical and engineering subjects. The interviewed expressed that the digital abilities in Italy, at school and university level, are not enough to face the changes in the labour market. Unindustria Reggio Emilia considers the project *Turnover school-work* a fundamental way to evolve the school system, to help students to enter in labour market. On the contrary, apprenticeship, as a tool of integration in the labour world, is not considered good enough for the companies that prefer specialized students, as in the case of Slovenia: even if it is considered important, here the contract of apprenticeship is not quite spread. Moreover, about school education, the general opinion (except for Uilm that doesn't agree on the

existence of a mismatch between competences and offered/requested profiles, and that underlines that if enterprises think that there's a problem is just because they are too much demanding) is that the existent educational offer is insufficient if compared to company's needs. For example, the German system shows an insufficient use of IT tools that came also from a not qualified staff in education. To solve this problem and reduce the quantitative gap expressed by the companies in terms of output of educational programs, is fundamental an intervention on the qualification of the people that act as mediators between supply and demand, to make them able to help the match; is interesting how in the Slovenian system, employers interested in investing in training of human resources in the engineering sector, because of the competition of globalization, have tried to predict formative needs of companies and then they have communicated them informally to educational institutions at regional level. Germans stakeholders expressed the necessity of technical skills but also of the so called soft skills. The first category is about mainly the IT skills, while the second one is about mainly the communication skills (the most important soft skill): to forge proper communication skills is important the direct experiences that should be make, first of all, at school as privileged places for the development and implementation of these skills. Moreover, training workers already present in labour market could be a longer and more difficult process. On this topic, Trade Unions have always had an educative function for the workers because the training of workers is a strategic issue for the labour market. The interviewed affirmed that they should provide an active support promoting the training that should be seen not as an obligation but as an opportunity and reducing the gap between the educational system and companies needs. An interesting tool is the *Open Curriculum*, a project that aims to create new forms of CV in line with European standards. Through the help of Trade Unions, Companies, Institutions and Bilateral Authorities, the idea is to intervene on two levels: training for workers (continuous training) but also for unemployed people (requalification). However, there are cases, as the Slovenian one, in which resources to support educational programs are not enough and, moreover, entrepreneurs don't want to invest in this topic.

6.4. Barriers for the development and role of social partners

The stakeholders interviewed identified also some problems and barriers about the implementation of Industry 4.0 by the point of views of work and Industrial Relations. For example the workers' requalification brings the need of a renewal of the role of social partners. The greater obstacles to develop Industry 4.0, as confirmed by the interviewed, are the technological infrastructure that allow the transmission and the quality of data connection. The Representative of Unindustria Reggio Emilia retains that "at the moment they are not enough to support a so broader development". The second obstacle is the incapacity of small and medium enterprises to boost and support investments to buy specific equipment and to support the research in innovation with the aim of taking an advantage on digital and technological transformation.

As affirms the Representative of Confindustria Bari is "the model of innovative industry together with the collaboration of startup and reinforced industrial companies" that can allow the development of Industry 4.0. Is fundamental to ensure a collaboration between private and public entities that focus on a training more oriented to the labour market necessities, that at the moment is based on knowledge rather than competences.

Is necessary that companies should be organized and able to manage big data through elaboration systems. Fiom-Cgil confirms that obstacles to the development of Industry 4.0 in Italy are cultural ones: about 30-40% of Italian companies deny the utility of internet, as showed in some studies. Another barrier to the development of Industry 4.0 is the normative framework: labour law should pick and adapt to the changes that Industry 4.0 would bring on times, places and modality of service. On this issue, a first attempt to change the law in Italy is the approval of the law about the so called *lavoro agile* (smart working). Analyzing this law, a leading role would be given to the social parts: Employers'

Associations should create a flux of information, opportunity of meetings, communication and sharing of experiences between companies. Social dialogue can be a tool to put in contact and attract the interest of the public opinion on the needs of companies and workers, reducing, in this way, the collective conflicts on labour issues. It's important that Employers' Associations will spread information about the future perspectives of the markets, so, in this way, companies can take their decisions more consciously, without following passively what happens in the world. Companies must be informed of the availability of public funds for innovative project at regional and European level. Trade Unions in the Slovenian system need deep changes because they are still linked to "an old language of about XX century on Industrial Relations", using, according employers' associations, anachronistic tools to have the workers consensus and to increase the rate of unionization, that is decreasing constantly. Is interesting to note the consensus on the lack of awareness of Trade Unions on current changes, on their structural lack of preparation and, above all, on the lack of consciousness about the advantages linked to the new professional profiles and the new jobs that the digital transformation will create. For this reason, is needed a great training on these issues, on the benefits linked to the creation of these new positions, on the new professional profiles especially in the manufacturing sector. The fundamental role of a Trade Union is also to manage the change and is clear the example of Uilm with the agreement on smart working with Micron. Another issue underlined is that Trade Unions should be committed to increase the motivation of workers, considering that the commitment of workers depends firstly on the guarantee of fair wages and decent work.

Annex.

Survey draft for interviews with stakeholders

1) **Do you think Industry 4.0 is a buzzword or a real evolution already implemented in production systems? What is your position about it?**
   - Why do you think Industry 4.0 is a buzzword?
   - Why do you think this evolution is already implemented?

2) **Industry 4.0 is an opportunity for workers or a threat of technological unemployment?**
   - How you can accompany this opportunity?
   - Which professions are most at risk?

3) **What impacts will Industry 4.0 have on work organization?**
   - Can be developed collaborative model between robots and workers?
   - How you can give a boost to labour productivity?

4) **What impact will have Industry 4.0 on Industrial Relations?**
   - What role can have social dialogue?
   - What logics and tools are at the basis to a renewed system of industrial relations in Industry 4.0?

5) **What is the role of training for the development of Industry 4.0?**
   - Which are the technical skills required?
   - How to decrease the skills-mismatch that prevents the meeting between supply and demand of work?

6) What are the barriers for the development of Industry 4.0?

- Which innovations in educational institutions?
- Which innovations in labour law?

7) What are the roles and responsibilities for sustainable development of Industry 4.0?

2.
GERMANY

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1.
Introduction

The EU manufacturing output stands for 15% of the overall Member States' GDP and EU has declared that the goal is to increase this level by 20% by the year 2020. However, since 2008 over 3.4 million jobs have been lost in the metal industry. This data proves that a new phase of EU economic growth cannot come without the involvement of metal and mechanical industry. Industry 4.0 is a new production system resulting from the application of new technologies to manufacturing. Industry 4.0 represent a game changer affecting all the activities linked to manufacturing, from planning to processes, from products to work organisation. While the robotic evolution of production represents an opportunity for the EU economy, as it implies the demand for new professional figures, the process will involve several challenges for the EU labour market, including a loss of low qualified jobs and a lack of high-skilled workers[7].

This report is part of *INDUSTRY 4EU – Industry 4.0 for the future of manufacturing in the EU*, a project aimed at bringing together social partners and institutions from Italy (ADAPT; Federmeccanica), Germany (Nordbildung), Slovenia (Chamber of Commerce and Industry of Slovenia) and at the European level (CEEMET) in an effort to identify concrete actions to cope with challenges and opportunities of Industry 4.0. Particularly, *INDUSTRY 4EU* is intended to identify good practices and possibilities for employers to successfully support the

[7] See F. MCCRORY, G. WESTERMAN, Y. ALHAMMADI, E. BRYNJOLFSSON, *Racing With and Against the Machine: Changes in Occupational Skill Composition in an Era of Rapid Technological Advance*, Thirty Fifth International Conference on Information Systems, Auckland, 14-17 December 2014.

implementation of Industry 4.0, especially by the means of social dialogue at all levels, from firm to the European Union.

According to the European Commission, one of the goals of the Europe 2020 strategy is "to promote the restructuring of sectors in difficulty towards future oriented activities, including through quick redeployment of skills to emerging high growth sectors and markets"[8], thus fostering the Renaissance of industry in Europe. Even though Industry 4.0 has still not been tackled by a joint action within the framework of the European social dialogue, EU social partners are currently demonstrating an increasing interest in this topic. *INDUSTRY 4EU – Industry 4.0 for the future of manufacturing in the EU* wants to be a stepping stone to put Industry 4.0 on the top of the EU social dialogue agenda. The project is aimed at bringing together social partners and institutions in an effort to identify concrete actions to turn Industry 4.0 challenges into opportunities. The main objective is to improve dialogue between employers' associations in order to create conditions for the spread of Industry 4.0 in the European countries, thus contributing to reconverting present factories and helping them to be more competitive.

This national report is one of the outputs of the project, aimed to explore the current landscape of Industry 4.0 in Germany based on the results of a map of past and existing unilateral programmes, as well as social dialogue initiatives to deal with the skills mismatch arising from the digitalisation of production methods and developing the technical skills necessary for the implementation of Industry 4.0, a mapping exercise conducted by Nordbildung gGmbH and semi-structured interviews conducted by ADAPT.

[8] COM(2010)2020 final, cit., 17.

2.
Objectives and methods of analysis

The aim of this report is to provide the partners of the *INDUSTRY 4EU* project with an overview of the current approach taken by the metal and electrical industry in northern Germany to the issues relating to digitalisation, Industry 4.0 and Work 4.0, and a summary of the initiatives that have been launched:

a) to collect information;
b) to identify and analyse areas of activity;
c) to develop appropriate measures.

Besides technological aspects, which play an important role particularly in the metal and electrical industry in the light of increasing digitalisation, this report also deals with sociological determinants, or 'soft' factors, which describe the integration of human labour in technological processes. These face major challenges in terms of adapting to the wide-ranging change processes arising from Industry 4.0. In Germany, these aspects and their general conditions (e.g. employment law, workplace design, working time models, management culture, communication) are summarised under the heading 'Work 4.0' in the context of digitalisation.

The results of the report are based on research carried out by Nordbildung gGmbH, the education network of the metal and electrical industry. This network is managed and organised by:

- Nordmetall, the Federation of the Metal and Electrical Industry;

- AGV Nord, the Employers' Association in Northern Germany;
- seven educational institutes for industry and commerce in northern Germany.

A large part of the collected and analysed data comes from the associations' day-to-day activities in Hamburg, Bremen, Schleswig-Holstein, Mecklenburg-Western Pomerania and northwest Lower Saxony. This information is supplemented by the work results of the national umbrella organisations Gesamtmetall and BDA (the Confederation of German Employers' Associations) and by reports of the Federal Ministry of Labour and Social Affairs.

The following methods for data collection and analysis were used in the preparation of the report:

- the organisation of specialist and interdisciplinary working groups of the associations Nordmetall and AGV Nord and their member companies;
- the organisation and analysis of panel discussions and information events of the associations Nordmetall, AGV Nord, Gesamtmetall and BDA, including member companies and third parties (external experts);
- the study and application of publications by the relevant stakeholders in the M+E industry;
- the inclusion of information and interim results from the social partnership agreement that is currently being drafted;
- the organisation and analysis of online member surveys carried during the *INDUSTRY 4EU* project;
- bilateral discussions with selected decision-makers from the member companies of Nordmetall and AGV Nord.

The report provides a structured summary of the association activities of Nordmetall, AGV Nord and Nordbildung in the context of Industry 4.0 and Work 4.0 in order to support the achievement of the project objectives.

3.
Stakeholders' involvement

In the context of this report, the term stakeholders refers to the partners of the employers' associations Nordmetall, AGV Nord and Nordbildung who play an active role in Industry 4.0. Apart from the member companies of the associations, the stakeholders also include partner associations, social partners, education partners and other experts on specific practical issues.

The stakeholders mentioned below were directly or indirectly involved in the preparation of the report – largely through their day-to-day activities or through regular discussions in connection with Industry 4.0 and beyond. In addition, selected representatives of the stakeholders also took part in interviews conducted during *INDUSTRY 4EU* project.

3.1. Member companies

The member companies of AGV NORD and NORDMETALL are the main sources of information relevant to this report. Their day-to-day activities are behind the growth of the metal and electrical industry and its significance to the German and the global economy. They also provide the necessary information about the latest developments in the sector with regard to Industry 4.0.

Member companies in figures (total)

Nordmetall: 233 companies

AGV Nord: 417 companies

3.2. Partner associations

AGV Nord and Nordmetall represent the M+E industry in a large number of projects, networks, bodies and (education) policy committees either through a direct mandate or via regional or national umbrella organisations. The umbrella organisations and partner associations involved in this report are the followings.

Gesamtmetall (www.gesamtmetall.de)

The employers' association Gesamtmetall is the umbrella organisation of the regional employers' associations in the metal and electrical industry in Germany. The umbrella organisation represents the common and general interests of M+E companies at national level. Gesamtmetall is a member of the Confederation of German Employers' Associations (BDA) in Berlin.

The responsibilities of an employers' association mainly revolve around wage, social and education policy. Together with the regional employers' associations, Gesamtmetall plans and coordinates measures at national level and ensures that the metal and electrical industry speaks with one voice on the important common interests of the companies. The association lists as its members 13 collective bargaining associations and 8 associations not covered by collective bargaining.

BDA (www.arbeitgeber.de)

The Confederation of German Employers' Associations (BDA) is the umbrella organisation dealing with employment and social policy on behalf of German business as a whole at its headquarters in Berlin (in Cologne from 1951 to 1999). The BDA unites the German employers' associations under one roof. Its members include 14 multidisciplinary state associations (joint associations for Berlin and Brandenburg and for Hamburg and Schleswig-Holstein), each including

multidisciplinary regional associations, and 52 national umbrella trade associations, each including state and regional trade associations from the fields of industry, services, finance, trade, traffic, crafts and agriculture. Overall, some one million companies are direct members of the BDA. These companies employ about 70% of all employees.

At European level, there is Businesseurope (formerly Union des Confédérations de l'Industrie et des Employeurs d'Europe), and internationally, the BDA is also represented in the International Organisation of Employers.

UV Nord (www.uvnord.de)

The Federation of Business Associations in Hamburg and Schleswig-Holstein (UV Nord) is the umbrella organisation dealing with economic and social policy on behalf of north German business. The organisation represents cross-sector business interests in Schleswig-Holstein and Hamburg to the government and the community and is a social partner representing the employers' interests in negotiations with the umbrella organisations of the trade unions. UV Nord comprises 71 business and employer associations in Hamburg and Schleswig-Holstein. Apart from multidisciplinary regional associations, the federation also includes associations from the fields of industry, trade, banking, services and crafts. UV NORD represents the interests of about 34,000 companies with 1.4 million employees.

3.3. Social partners

In Germany, the term 'social partner' is used to refer to the parties to collective agreements, that is, trade unions on the one side and employers' associations on the other. A 'social partnership' describes the cooperation between them with

regard to formulating joint rules on wage and working conditions in collective agreements.

This report looks at the social partnership in the metal and electrical industry at two levels: at national level, where the term 'social partner' refers to IG Metall (*www.igmetall.de*) and the employers' association Gesamtmetall, and at regional level, where the social partnership is shaped by IG Metall Küste (*www.igmetall-kueste.de*) and Nordmetall.

In the context of the *INDUSTRY 4EU* project, the fact that IG Metall and Gesamtmetall entered into a **social partnership agreement** in April 2016 in cooperation with the associations VDMA [9] and ZVEI [10] deserves particular attention. The partners agreed to carry out a joint review of the training occupations relevant to Industry 4.0 and the associated further training in the metal and electrical industry with regard to changing requirements and new career prospects. The partners also plan to develop recommendations for action on jobs in the metal and electrical industry. This includes guidelines for on-the-job training and school education, changes to the curriculum or new job/further training profiles and specific information on interdisciplinary qualification profiles[11]. Some of the core elements of this social partnership agreement are presented further below. The agreement is still being drafted and the final version is expected to be published in summer 2017.

[9] The VDMA is based in Frankfurt am Main and has around 3,200 members, making it Europe's largest industry association. It represents the interests of the mostly medium-sized capital goods industry to political and social institutions, business, science, public authorities and the media.

[10] The ZVEI represents the economic, technological and environmental interests of the mostly medium-sized German electrical industry. According to its own information, ZVEI has 1,600 members. With 840,000 employees nationwide (at the end of 2012) and a total turnover of €175bn (at the end of 2012), the electrical industry is the third-largest industrial sector after mechanical engineering and IT.

[11] Cf. *M+E-Sozialpartner analysieren Qualifizierungsbedarf und Berufsbilder für Industrie 4.0*, in *www.gesamtmetall.de*, 20 April 2016.

3.4. Education partners

Together with the seven educational institutes for industry and commerce in northern Germany, AGV Nord and Nordmetall offer their member companies an extensive range of seminars and qualifications via the training association Nordbildung gGmbH (*www.nordbildung.de*), an organisational alliance that provides a comprehensive service of consistent quality for the member companies in Schleswig-Holstein, Mecklenburg-Western Pomerania, Hamburg, Bremen and northwest Lower Saxony. The seven educational institutes for industry and commerce in northern Germany are:

- Bildungswerk der Wirtschaft Hamburg e.V. (*www.bwh-hamburg.de*);
- Bildungswerk der Wirtschaft Mecklenburg-Vorpommern gGmbH (*www.bildungswerk-wirtschaft.de*);
- Technische Akademie Nord (*www.t-a-nord.de*);
- Bildungszentrum der Wirtschaft im Unterwesergebiet e.V. (*www.bwu-bremen.net*);
- Bildungswerk der Niedersächsischen Wirtschaft gGmbH (*www.bnw.de*);
- Bildungs- und Tagungszentrum Tannenfelde e.V. (*www.tannenfelde.de*);
- AFZ Aus- und Fortbildungszentrum Rostock GmbH (*www.afz-rostock.de*).

Alongside an extensive range of seminars, Nordbildung also organises regular networking events for the member companies of the associations and for the stakeholders of the education partners. The key issues dealt with at these networking events reflect the requirements of the seminar customers that are identified through personal discussions and specific surveys.

4.
Mapping exercise

Nordmetall and AGV Nord have been dealing explicitly with issues relating to Industry 4.0 and Work 4.0 since 2015. The main focus of their activities to date has been:

a) to inform their own member companies about the basics, developments and trends;
b) to forge links between the member companies and with third parties (e.g. with experts on specific issues).

Since the member companies vary greatly in terms of structures, processes, size, strategy and objectives, the work of the associations with regard to supporting the companies is intentionally based on the principle of 'helping others to help themselves'. This means that the associations provide the companies with a financial and organisational framework to establish contacts with experts, build cross-business networks and generate new momentum from 'outside'. The core objective is to ensure that the companies find individual solutions to their specific questions and problems. The associations act as a learning and development guide.

The following pages describe the associations' activities that contribute to achieving the aforementioned objectives in the context of Industry 4.0 and Work 4.0. They focus primarily on in-house working groups, networks and events, which are summarised under the heading '**unilateral programmes**' in the project report for *INDUSTRY 4EU*. These unilateral programmes are partially organised

by Nordbildung gGmbH, which implements its own event formats that also contribute to achieving the objectives of the associations.

The description of the '**social dialogue**' particularly refers to the aforementioned social partnership agreement, whose aim is to define the future qualification requirements for training (and personnel development) in the context of Industry 4.0. This specific focus is simply due to the fact that the resulting actions recommended by the social partners will be an important indicator for the M+E industry when it comes to effective qualification concepts that take account of increasing digitalisation.

The practical implementations during the *INDUSTRY 4EU* project (online survey and stakeholder interviews) and their results are included in the associations' action portfolio. The key results of the online survey are summarised in § 4.3. The content of the **stakeholder interviews** is presented as bullet points in this report, however, full details will be available in a separate paper to be published by the project partner ADAPT.

Nordmetall and AGV Nord are currently considering the formation of a steering committee, which would review and group together all association activities relating to Industry 4.0 and Work 4.0 along strategic lines and route them to the appropriate implementation and communication channels. The makeup of this committee has not been finalised, however, due to its potential significance it is described in a separate section below. The working title of the committee is ***Industrieclub Arbeit 4.0***.

4.1. Unilateral programmes of Nordmetall and AGV Nord

As mentioned briefly in the introduction to this section, unilateral programmes of the associations and of Nordbildung refer to all activities intended to inform the

member companies about Industry 4.0 and Work 4.0 and forge links between them and with third parties. Particular attention is given to events, networking and working groups because the content of these exchanges is centrally organised by the associations.

Community of Training Practice

The Community of Training Practice (CoTP) is a networking service for all Nordmetall and AGV Nord member companies. The community brings together specialists and managers responsible for the organisation of product-related and process-related training content, formats and media. The training programmes are targeted at in-house after-sales staff and at employees of the end customers who are familiar with the use of the product.

In the context of a traditional best-practice exchange, the main question is how learning content should be prepared and conveyed effectively to ensure it has a long-term effect and a high ROI.

The CoTP takes place 3 times a year over a long afternoon. It is held on a rotational basis at one of the member companies that participate in the community. As a result, one of the collateral benefits of the exchange is that the companies are able to meet 'live' at the event and discuss specific practical implementation issues.

The associations chose 'Industry 4.0' as the heading for the next three events. The host companies can choose their own topics within the confines of this heading. The following CoTP meetings will be held in 2017:

- Host 1: HellermannTyton, 7 March 2017;
- Host 2: AIRBUS, 13 June 2017;
- Host 3: WEINMANN Emergency Medical Technology, 14 November 2017.

Personnel Development Working Group

The Personnel Development Working Group (PEAK) is a networking service for all Nordmetall and AGV Nord member companies. PEAK invites HR experts for specialist discussions across corporate boundaries on current incentives and best-practice processes in personnel development. The subjects at the centre of the discussions include evaluation exercises, such as the implementation of integrated personnel development concepts, or the support and anchoring of HR projects on specific issues.

Like CoTP, PEAK also takes place up to 3 times a year on a rotational basis with meetings being held at one the member companies involved. The host company is largely responsible for the choice and structure of the content.

Industry 4.0, as an area of activity, was chosen as the heading for two PEAK meetings in 2016. The meetings were hosted by STILL GmbH and NIT (Northern Institute of Technology Management). The companies involved explicitly requested the development of a set of questions to review their own specific structures and processes[12]. The work results of PEAK (key questions) generated in the context of Industry 4.0 are listed in *Annex 1* (*Work results of PEAK*) to this report.

HR Networks

AGV Nord and Nordmetall have for many years been inviting the HR managers (managing directors, personnel managers) of the member companies at least 3

[12] Note: the principle of helping others to help themselves usually also applies to the working groups of AGV Nord and Nordmetall. Therefore, the content of the discussions often consists of questions, which each company can reflect in its own structures and processes after the discussions.

times a year to exchange HR-specific experience. The exchanges are based on a presentation on HR issues, the latest information about employment and social security law and current developments in wage policies.

In order to give the HR managers more time and space to share ideas among colleagues, the associations have adapted the format of the meetings as of 2017 and included more interactive elements. The next meeting, for instance, will open with a joint breakfast accompanied by a keynote speech.

Training Networks

The Training Networks in the M+E industry organised by Nordmetall and AGV Nord are targeted at training managers or those responsible for training in the member companies. The networks focus on sharing experience and information relating to training issues and are brought to life by the experience and the expectations of the participants.

The issues dealt with at the networks are either suggested by a participant or by an external speaker and discussed at network meetings. This allows the participants to network and learn from each other. The specific key issue is always accompanied by an open exchange of experience covering recent successes and challenges in training.

The network meetings take place at regional level in four areas: Bremen/northwest Lower Saxony, Hamburg, Mecklenburg-Western Pomerania and Schleswig-Holstein. They are usually held twice a year in each region and take the form of a half-day event with one member company acting as host.

The issues surrounding Training 4.0 are currently not explicitly on the agenda of the Training Networks, partly because of their local structure. However, many issues, such as the use and integration of digital media in training, are covered

automatically. Major recurring themes that are relevant to the entire training programme in the M+E industry are deferred to the annual Training Managers Conference (cf. § *Training Managers Conference*).

Training Managers Conference

The Training Managers Conference usually takes place once a year to discuss an issue that is relevant to all four regional training networks. The conference is therefore set up at supra-regional level.

In 2016 the subject of the conference was *Training 4.0: Pipedream or Reality?* and delegates examined how digitalisation as a driving force behind technological development affected commercial and technical training in the M+E industry. Speakers included scientific, economic and political experts who provided plenty of background information and the opportunity to discuss practical implementation. The presentations were followed by workshops to answer individual questions raised by the participants.

Treffpunkt Nordbildung

The networking format *Treffpunkt Nordbildung* is a joint project of the education network Nordbildung and the employers' associations Nordmetall and AGV Nord with two events in each year targeted at employers, managing directors, training managers and HR managers. Under the banner of *Sharing Knowledge – Cultivating Contacts* the aim is to hold cross-functional discussions, share experience and incorporate new ideas into operational practice.

The issues discussed at *Treffpunkt Nordbildung* originate from the pool of subjects developed by Nordbildung or its partners (cf. § 3.4, *Education partners*). In other words, the education institutions and associations decide which areas of activity should be given more emphasis on the basis of their customers' current

requirements. The organisation and structure of a *Treffpunkt Nordbildung* is guided by the given subject. For example, a networking afternoon under the heading *Utilising In-house Knowledge across Generations* was held in the form of an open bar camp, and an event on *Intercultural Competence from A-Z* was set up as a subject-specific workshop.

The first *Treffpunkt Nordbildung* in 2017 will take place in Hamburg on 6 April under the heading *Learning and Communicating in Work 4.0 – a Networking Afternoon by Practitioners for Practitioners*. As the heading implies, the core idea is to introduce participants to best-practice experience gained from corporate practice. The meeting focuses on proven digital learning content and learning techniques in terms of a continuous improvement process (personnel development/organisational development). Experts and managers from the member companies and external experts from the learning environment provide inspiration derived from practical applications[13].

Production Forum

The associations organise an annual Production Forum to provide managing directors, plant managers and production managers of the member companies with comprehensive and practical information about current issues and the latest developments in the metal and electrical industry. This is supported by renowned speakers with a scientific and practical background who report on the relevant key issue.

[13] Inspiration at Treffpunkt Nordbildung on 6 April 2017 will be provided by Prof. Peter Dehnbostel (DUW Institute for Professional Studies), Dietrich Weidmann (Siemens Germany, Process Industries and Drives Service Operation), Josef Buschbacher (Corporate Learning & Change GmbH), Daniela Peeters-Bendix (Beiersdorf AG).

In 2016, the Production Forum devoted itself entirely to the subject of Industry 4.0. The meeting focused on the umbrella theme of *Change Management and Leadership* and dealt with the following subthemes:

- *Increasing Corporate Success through Transformational Leadership*;
- *SMEs Successfully Forging ahead towards Excellence*;
- *Mastering Organisational Development successfully – a Challenge for a Medium-sized Company*;
- *Shaping and Securing Change Processes in a Sustainable Manner*;
- *Involving Employees Successfully on the Road to Change*;
- *Increasing Agility in Organisations*.

The following presentations rounded off the event:

- *Work in the Digitalised World – the Industry 4.0 Challenge to a Medium-sized Company and its Organisation*;
- *Changes in a Small Trade Business – What do We Need to Continue Operating Successfully in 2025?*;
- *Changes in Production: Work 4.0 – How Does This Concern Me?*;
- *The Significance of Transformational Leadership for Corporate Success, Particularly in Rapidly Changing Environments*;
- *Collaborative Productivity, Opportunities for a Global Network*.

Production Manager Meeting

As part of the Production Manager Working Group, which deals with various practical issues, Nordmetall and AGV Nord organise a Production Manager Meeting once a year. In order to ensure a high degree of practical relevance, the meeting is held at one of the participating companies, which can choose to give a practical illustration of the specific issue.

In 2016, the Production Manager Meeting took place under the motto *Industry 4.0 – More Than a Buzzword?* The purpose of the event was to explain the important

facts relating to Industry 4.0 to the participants and let them develop ideas for their own companies. The introductory talk and the subsequent workshop looked at the following issues:

- *Industry 4.0 – Classification of the Various Terms*;
- *Industry 4.0 – Results of Current Research Project*s;
- *Industry 4.0 – Opportunities and Challenges for Operational Practice*.

The company organising the event then demonstrated how the automation of production was implemented in the context of Industry 4.0 at its plant. Participants were able to ask questions about technical aspects and about the challenges during the planning and implementation of the solution presented.

Participation in regional, supra-regional and international projects

Nordmetall and AGV Nord participate, in part directly and in part via Nordbildung gGmbH, in a wide range of regional, national and international projects to actively support the developments of Industry 4.0 and Work 4.0 and to help shape them in accordance with the objectives of the M+E industry in northern Germany.

Two examples of **regional projects** worth mentioning at this point are the *Airbus Factory for the Future – HR 4.0* and the *DigiNet – Air* application. Both projects deal with the design of sustainable processes and structures within the aviation cluster in Hamburg in the context of Industry 4.0 and Work 4.0. Apart from the two companies from the aviation industry in Hamburg (Airbus and Lufthansa Technik), the project partners also include universities, vocational schools, ministries, research institutes, trade unions and associations[14]. With regard to both

[14] Here specifically: HAW (Hamburg University of Applied Sciences), TUHH (Hamburg University of Technology), Gewerbeschule Fertigungs- und Flugzeugtechnik (G15), Hamburg

projects, Nordmetall and AGV Nord consider it their responsibility to disseminate information and shape networks in order to indentify best practice on the basis of the projects and apply it company-wide. This is mostly for the benefit of the affected supply chains of the above-mentioned companies since they generally have fewer resources to fully develop concepts such as Industry 4.0. In addition, Nordmetall and AGV Nord also see themselves as main contacts responsible for initiating the social dialogue from the employers' perspective in both cases[15].

The EU initiative *INDUSTRY 4EU* is an example of the associations' **international project activities** that deserves attention at this point. The relevant contents and work results will be described in more detail below.

Nordbildung gGmbH and its partners support many, albeit not all, regional and supra-regional projects as education and qualification experts for the member companies of the associations. They make extensive use of the opportunities offered by a comprehensive service of consistent quality in Hamburg, Mecklenburg-Western Pomerania, Schleswig-Holstein, Bremen and northwest Lower Saxony.

Evaluation of current research projects

There are research institutes that present practical implementation measures under laboratory conditions in several regions of Germany. Staff from the work organisation division of Nordmetall and AGV Nord have been visiting the main research institutes since 2015. This largely work science-based focus is aimed at informing the member companies about current technical research results and the latest developments relating to Industry 4.0 and defining key issues for future

Authority for Economy, Transport and Innovation, Acatech – National Academy of Science and Engineering, IG-Metall and IG-Metall-Küste.

[15] For reasons of data protection no detailed information on the regional projects mentioned may be published in this report. If you have any queries, please contact Nordbildung gGmbH.

events on the basis of this. During these events, the associations work together with the member companies to examine the question as to what impact the new developments are going to have on the future structure of employment.

Evaluation of best practice examples from practical applications

Nordmetall and AGV Nord share the prevailing view of the research community that people are at the centre of Industry 4.0 and that Industry 4.0 should be regarded as an open socio-technical system.

In order to gain an insight into the associated opportunities and risks for the companies, the associations are currently visiting businesses that have already gathered practical experience of the development and implementation of the issues relating to Industry 4.0. The focus is on the challenges inherent in the development and implementation of Industry 4.0 together with the employees and, in particular, on the requirement for occupational competence. The associations also asked the companies which solution strategies turned out to be useful when dealing with the (new) requirements.

The following similarities between the companies have already been identified on the basis of the current findings from the surveys (extract).

From the employees' perspective:

- essentially, there is an increasing need for interdisciplinary skills. This particularly applies to IT skills;
- there is a significant lack of skills among employees;
- the qualification of key skills should begin at an early stage.

From the organisation's perspective:

- there is a high degree of acceptance of Industry 4.0 among staff at all levels in companies that have previously dealt with lean management methods;
- high practical relevance, joint experimenting and the creation of small successes increase the acceptance of further experiments;
- flat hierarchies and a management culture based on trust and anticipation are regarded as prerequisites for the implementation of Industry 4.0;
- showing how Industry 4.0 works at normative level and granting relevant freedoms is regarded as another prerequisite.

On the basis of best-practice examples and the findings from science and research, Nordmetall and AGV Nord develop recommended actions for the implementation of Industry 4.0 from a socio-technical perspective. In collaboration with interested companies, the practical implementation of specific applications, for instance, as part of *Industrieclub Arbeit 4.0* (cf. § 4.4, *Industrieclub Arbeit 4.0*), is scheduled to start in 2017.

4.2. Social partner dialogue

A continuous social dialogue takes place between employer and employee representatives in the M+E industry in Germany. This dialogue covers all business-related questions on the (further) development of the industry and the safeguarding of its future. During this process, an innovative structural model and modern careers were developed for the M+E industry and for the IT sector. These process-oriented, flexible job profiles also satisfy the requirements of the system orientation of Industry 4.0 across the sector and the associated value creation and networks.

This is also the basis for a new initiative by the German social partners of the M+E industry, which led to the conclusion of a **joint social partnership agreement** that defines agile methods (cf. *Annex 2, Figure showing the agile methods agreed between the social partners*). Gesamtmetall, VDMA, ZVEI and IG Metall reviewed the Industry 4.0-related training occupations and the associated further training in the M+E sector with regard to changing requirements and new career prospects. The review included the expertise of company and education experts and researchers.

As a result, the parties to the agreement swiftly developed recommended actions for initial, advanced and further training in the M+E industry with specific proposals for further measures and initiatives. This forms the basis for future negotiations with the process participants affected by the recommended actions.

Since the wording of this social partnership agreement is still being drafted it cannot be published in this report. The document is to be finalised by summer/autumn 2017. It will be available from Nordbildung gGmbH on request in due time.

4.3. *INDUSTRY 4EU* – online survey and stakeholder interviews

The following briefly summarises the results of the **online survey**, which was carried out as part of the *INDUSTRY 4EU* project.

The project-related **stakeholder interviews** and their evaluations – both conducted and supported by ADAPT – were not available at the time the country reports were being prepared. They will be made available by ADAPT after they have been finalised and added to the country reports as a separate annex.

Online survey – key results[16]

A total of 54 companies took part in the online survey on the *INDUSTRY 4EU* project between 20 July 2016 and 11 August 2016 (inclusive).

Asked about **their own assessment of the level of digitalisation** in their own company, the participants showed great uncertainty: one third of all companies felt unsure or unable to assess their own level of digitalisation. Among the remaining participants, 13% regarded their own level of digitalisation as low and almost half of those surveyed rated it as 'medium'. Only a small minority of 6% of all survey participants rated the level of digitalisation in their company as 'high'. Smaller companies tended to rank their level of digitalisation much lower than larger companies.

Mechatronics was by far the **most widely known technology**. Robotics followed in second place. Cloud computing and cyber-security took third and fourth place. Virtual reality (VR), nanotechnology and big data/data mining were in the mid-range in terms of familiarity. Near the bottom of the list was the IoT, with only just over half of the companies stating that they were aware of this technology. Rapid prototyping, as used in 3D printing, took last but one place. And finally, in last place were smart materials, which not even half of the companies were familiar with.

The surveyed companies in the metal and electrical industry were the greatest users of mechatronics. Cyber-security was in second place. The IoT was already being used by exactly half of the companies. Cloud computing, big data analysis or data mining and robotics ranked in the mid-range of applied technologies.

[16] Management Summery of the *Industry 4EU Study Report on the Online Survey conducted for Nordbildung gGmbH*, 5-7, conducted by IW Consult GmbH, author: Dr Thomas Schleiermacher.

Rapid prototyping, virtual reality, smart materials and nanotechnology brought up the rear.

Mechatronics took first place among the technologies in which the surveyed companies planned to invest in the short, medium and long term. Cyber-security, cloud computing and robotics followed in second to fourth place. By contrast, a relatively small number of the surveyed companies intended to invest in big data/data mining, the IoT, rapid prototyping and virtual reality in future. Only a minority of companies would consider potentially investing in nanotechnology and smart materials.

With regard to the **benefits the application of new technologies would create for the companies**, most of the businesses surveyed expected increased productivity within their own company. Greater flexibility with more customer-orientated products and services and the opportunity to optimise costs followed in second and third place. Relatively few companies associated the use of new technologies with an opportunity to reutilise or further utilise existing products and services and create interfaces between real and virtual systems.

On average the employees of the companies surveyed spent about **25 days per year on further training**. With 29 days, employees of SMEs spent more of their time on further and advanced training than those in companies employing more than 250 people (24 days). Companies that rated their own level of digitalisation as high trained their employees on only 15 days per year. In companies with a medium level of digitalisation, the figure was 29 days and rose to a far above average 44 days in companies with a low level of digitalisation. Companies that had already established research partnerships with universities and external institutions spent 22 days per employee on further training, however, companies without such partnerships spent 28 days a year per employee.

With regard to the **changing significance of specific soft skills** following the introduction of new technologies, the greatest changes relate to digital communication or the handling of digital media. The survey participants expected the smallest changes to be in the area of interpersonal relationships or empathy.

Asked about which **know-how components** had already been established in the company, the majority of the companies surveyed mentioned knowledge relating to IT infrastructure management. Data analysis followed in second place and general programming skills ranked in third place. Prototype development, automation management, process control using machines and the simulation of production processes brought up the rear.

When the companies were asked how strong the **effects of the new technologies on the implementation of new working-time and workplace models** (smart working) are, a not very dynamic picture emerged. Only 2% of the survey participants reported strong effects, while two thirds of the companies did not expect any, or only minor, effects as a result of the new technologies. The picture changed when the companies were asked to assess the impact of the new technologies on the networking and sharing of knowledge. In this case, almost one third of the survey participants expected strong or very strong effects.

During the survey, the companies were given **different statements** for evaluation. The statement that "Industry 4.0 allowed customer-specific production that would increase competitiveness" received the highest level of agreement. The companies surveyed seemed to be quite capable of assessing their own position on the road to Industry 4.0 in a self-critical manner ("Industry 4.0 is very important but requires know-how that we haven't acquired yet" – in third place) and did not expect to be able to implement the necessary adjustment process at zero cost ("Industry 4.0 requires major investment" – in fourth place). The statements in the bottom three places – "the preparations for Industry 4.0 require little investment", "Industry 4.0 offers no new opportunities for small companies in particular" and "the discussion

about Industry 4.0 is just a buzzword without any real content or relevant economic effect" – were met with very little agreement. The above average rejection of the last statement, which referred to the presumed irrelevance of Industry 4.0 for the German economy, confirmed that the M+E industry in Germany was aware of the forthcoming changes and would, and had to, actively take on the associated challenges.

Asked about the measures that their own company should take for the **successful implementation of Industry 4.0**, the survey participants ranked the promotion of lifelong learning among employees at the top of the list. The adjustment of the management culture to meet the requirements of Industry 4.0 took second place in terms of the most important measures. Synergy improvements in business processes to optimise regional networking and the reorganisation of the company to increase innovation activities followed in third and fourth place.

The **support measure most frequently requested of Nordbildung gGmbH by the companies** was an "assessment and support of regional or local initiatives relating to Industry 4.0". The development of a communication campaign or networks to identify and present best practice approaches and the compilation and preparation of information on national and European subsidies for Industry 4.0 followed in second and third place. Relatively few companies expected Nordbildung gGmbH to emphasise the significance of entrepreneurship more strongly than before.

Stakeholder interviews

The stakeholder interviews planned as part of the *INDUSTRY 4EU* project were organised and conducted by the project partner ADAPT. The same applies to the evaluation and summary of the results of the interviews. As soon as all the data has been submitted it will be made separately available by ADAPT.

4.4. *Industrieclub Arbeit 4.0*

AGV Nord and Nordmetall developed *Industrieclub Arbeit 4.0* as a proposal for the establishment of a central steering committee that would deal with all the activities of the associations relating to Industry 4.0 and Work 4.0 and route them to suitable communication and implementation channels. In addition, *Industrieclub Arbeit 4.0* could draft and develop central themes for the member companies. This option is regarded as beneficial particularly if areas of activity arise from the day-to-day work of the associations (e.g. as part of projects and working groups) that should be applied to the wider business context.

In summary, the *Industrieclub Arbeit 4.0* is meant to play a strategic function. The appointments to such a committee should, on the one hand, be of an interdisciplinary nature (i.e. across all departments of the association) and, on the other hand, include strategically important representatives from the member companies. At present, it would also be conceivable to appoint experts from the wider stakeholder group.

The *Industrieclub Arbeit 4.0* is expected to commence its work in 2017.

5.
Outcomes

As mentioned at the beginning of this report, the associations Nordmetall and AGV Nord and the education network Nordbildung have been addressing the issues surrounding Industry 4.0 and Work 4.0 since 2015. The organisation of information and networking events, the management of specialist and interdisciplinary working groups and the conduct of face-to-face interviews are the **most important sources of information from the member companies** and other stakeholders in this context.

With the exception of specific individual cases, both the associations and Nordbildung have so far reached the conclusion that the above-mentioned **topics have to be considered and processed under various aspects**. This conclusion is mainly based on the fact that the initial situations of the companies in the M+E industry vary greatly in the context of Industry 4.0, particularly with regard to the following points:

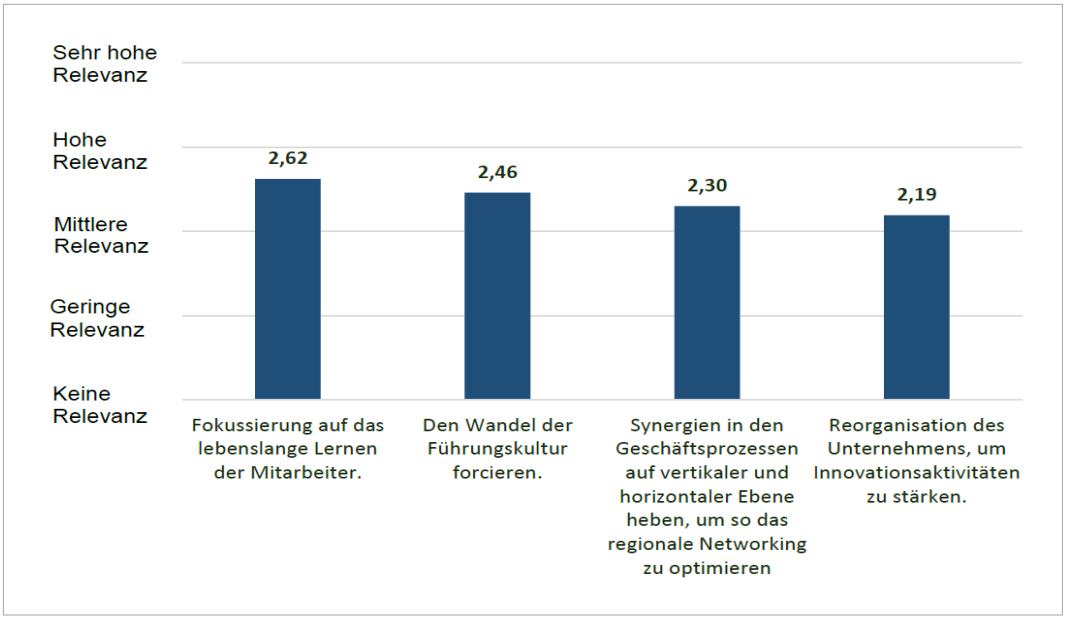
- the concept of the significance of the term ‘Industry 4.0’ and the associated formulation of expectations and consequences for their business activities;
- experience of the implementation of digitalisation and digital media in corporate structures and processes;
- thematic awareness among experts and managers to determine their company’s position and set objectives derived from it;
- the development and implementation of a substantive and organisational strategy for dealing with Industry 4.0;
- the maturity of the company’s management and communication culture;

- the provision of time, budget and personnel resources to develop and explore the issues relating to Industry 4.0 and Work 4.0;
- the size and role of the company in the value chain.

The results of the online survey provided Nordmetall, AGV Nord and Nordbildung with a good summary of the companies' self-assessment with regard to Industry 4.0.

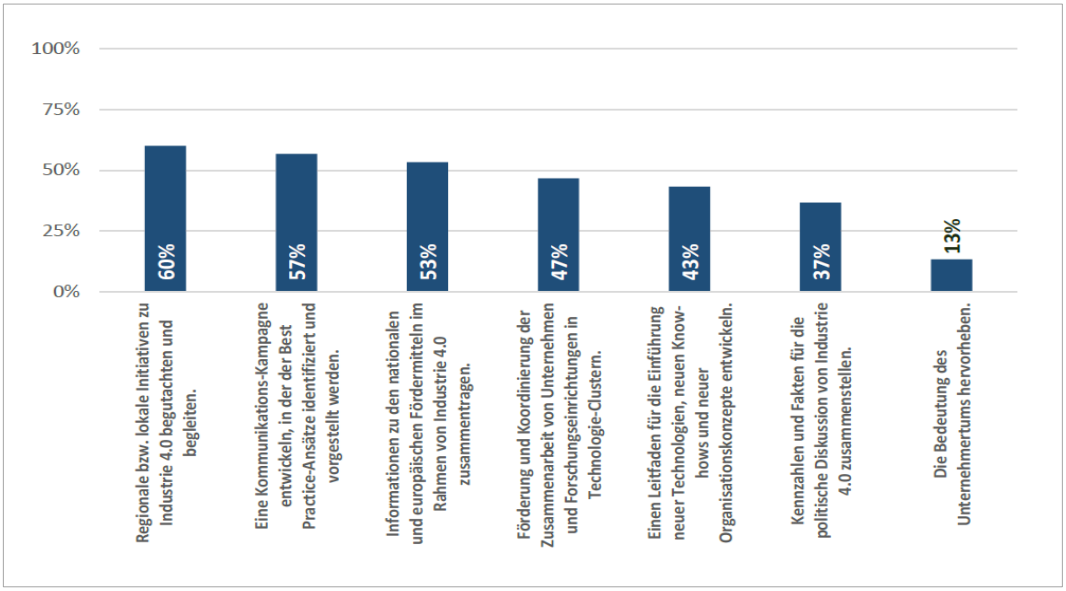
The future areas of activity and the expectations of the members *vis-à-vis* the association also became clear:

1) *Measures that from the companies' perspective have to be taken to successfully shape the changeover to Industry 4.0*[17]:



[17] *Ibid.*, 40.

2) *Activities with which Nordbildung and the associations can support the objectives of member companies in future*:



In this respect, the project results support Nordmetall and AGV Nord in the process of defining future actions and objectives in the context of Industry 4.0.

The stakeholders put forward many new ideas in terms of content and structure, which the associations and Nordbildung will take up and use in future. In this context, priority will be given to integrating the project content in day-to-day activities and using it in future agenda setting within the working groups, networks and other events. The planned *Industrieclub Arbeit 4.0* is likely to play a role in this (cf. page 76).

6.
Problems emerging within the mapping exercise

During the mapping exercise carried out in the course of the *INDUSTRY 4EU* project, no structural or procedural problems emerged among the German partners. The project-based surveys among the member companies of AGV Nord and Nordmetall were carried out as planned. The same applies to the planning and conduct of the discussions and networking events with the member companies and other stakeholders.

However, a look at the content of the *INDUSTRY 4EU* project or of the content relating to Industry 4.0 and Work 4.0 reveals that it was, and is, very difficult to identify and formulate a uniform starting point for the M+E industry.

On the one hand, the companies differ too much in their structures, processes and level of digitalisation (cf. Chapter 5, *Outcomes*) and on the other, the 4.0 issue is too complex horizontally and vertically for it to be readily broken down into brief, general key messages that focus on a single industry. This conclusion is also confirmed at operative level by the fact that current issues relating to Industry 4.0 cannot be easily transferred to a wider business context in a uniform format.

Specifically, this means:

Companies that have taken a deliberate in-depth approach to the issues surrounding digitalisation justifiably demand that they are supported by the activities of the associations with practicable, operative and strategic input (ideas for topics, contacts with experts, best practice in the application of models,

formats and materials). This means that AGV Nord and Nordmetall have to work in a specialist and detailed manner to satisfy this demand. Companies that have no or little prior knowledge of Industry 4.0 are asking for a general overview to enable them to orient themselves and establish basic networks. The companies generally regard too much detail as information overload and as 'too far removed'.

These diverging expectations also became clear at the German Round Table meeting in Hamburg on 17 January 2017 and during the conduct and evaluation of the online survey.

An extract from the feedback query, which the associations sent out after a Treffpunkt Nordbildung in 2016, illustrates this point perfectly[18]:

Asked about what expectations the companies had of the event and if these had been met, the companies provided the following qualitative feedback (extract):

- *(+) "I wanted to get an overview of the subject. The amount of information was just right"*
- *(-) "There was not enough time to get to grips with the expert opinions in the working groups"*
- *(-) "Specific, including legal, contributions would have been helpful"*
- *(+) "A comprehensive insight into intercultural partnership projects – excellent!"*
- *(+) "There was an interesting exchange of ideas during the coffee breaks"*
- *(-) "Some of the content was too superficial and the sessions were too short"*

[18] Feedback query as part of Treffpunkt Nordbildung on *Intercultural competence as an opportunity for personnel and organisation development*, 30 March 2016, in-house evaluation by Nordbildung by means of a participant questionnaire.

This feedback could give the impression that the participants visited different events.

To sum up, it can be said that the problems emerging during the mapping exercise are identical to the challenges that the associations have to face in their day-to-day activities. The associations have the duty to precisely define and organise the target groups within the member companies and the specific choice of subjects and methods for the exchange and information formats.

7.
Perspectives of analysis

Nordbildung states that the project objectives at the level of *INDUSTRY 4EU* have been met in addition to the contents described above.

The country representative involved in the project shared its contents on a continuous basis, mainly during round tables meetings and minute calls organised as part of the project. The interviews and network talks with national stakeholders also provided highly interesting practical insights into the current situations in other countries.

It remains to be seen whether the contacts made between countries during the project will be maintained after its completion, however, this would certainly be desirable, particularly in view of the fact that Industry 4.0 will continue to be relevant for the next few years or even decades. The cross-border sharing of best practice is going to be a particularly important element of the continuous improvement process within the EU structures.

AGV Nord and Nordmetall together with Nordbildung will process and organise the information acquired as part of the *INDUSTRY 4EU* project for the member companies and the extended stakeholder group. Initial talks have already taken place in existing project and network structures, e.g. in the core project team of *Airbus – Factory for the Future or in the Community of Training Practice*. The development of new communication and event formats that explicitly and successively deal with Industry 4.0 and Work 4.0 over a long period is also being considered.

The further application of the project information of *INDUSTRY 4EU* will primarily be based on the expectations of the member companies in terms of content (cf. Chapter 5, *Outcomes*). The associations are going to focus on an interdisciplinary approach, which could be supported by the establishment of a cross-sectoral working group.

8.
Final conclusions

Failure to shape the digital transformation for the benefit of Europe will lead to potential losses adding up to € 605bn (EU-17) by 2025, which corresponds to a loss far in excess of 10% of the industrial base. The declared EU aim of increasing the share of industry to 20% in Europe by 2020 would become unachievable because without digitalisation there is going to be no reindustrialisation. In the best-case scenario, there would be an additional value creation potential of € 425bn in Germany alone and of € 1.25tn in the industrial sector in Europe over the next ten years.

Against this background, the following recommended actions were developed.

1. Digital maturity

Top priority is given to creating greater awareness and initiating processes in companies because many of them regard digitalisation primarily as a means to improve efficiency. However, the digital economy not only forces companies to optimise existing business models but also promises new, previously untapped value creation potential. Companies have to raise their level of digital maturity to indentify and implement these opportunities. This involves greater penetration of digital trends and opportunities, a deep understanding of how the rules of competition change in the digital space to optimise existing and develop new business models and, lastly, the capacity to establish and expand the resources required to harness new opportunities.

2. Safeguarding Europe's interests during standardisation

The Industrial Internet Consortium (IIC) in the US has taken a pragmatic approach to promoting the setting of industrial standards. South Korea has a dedicated department for digital matters in the form of the Ministry of Science, ICT and Future Planning, and the Korea Industrial Technology Association (KOITA) represents the standardisation interests of the country's industry. The Chinese government is investing the equivalent of approximately € 700m in the roll-out of the IoT. Industry regulations will play a key role in translating industrial expertise into competitive advantages in future. German and European companies must not fall behind and therefore have to create appropriate platforms for sharing ideas, knowledge and experience.

3. Stimulating investment in the digital future

Investments in the digital future in Europe have so far been woefully inadequate. The US invests around € 17.5bn in venture capital every year while the figure for Europe as a whole is only € 3.5bn. Europe has to create the general conditions to make private investments in infrastructures and start-ups worthwhile. The public sector also has to take action to break through the existing investment backlog. Investment programmes, such as the *Juncker Plan*, must be rigorously oriented towards promoting the digital transformation. This could be a driver for comprehensive broadband expansion in Europe, the funding of digital start-ups and the development of new tools to mobilise private investment. Changes to the educational programmes for pupils, students and further staff training with the aim of acquiring, expanding and updating key skills for the digital future must also be given greater priority in future.

4. European-wide coordination

Success in the digital economy requires joint action. Clusters, partnerships and associations must be promoted by a European economic alliance and the skills scattered across Europe must be brought together in a virtual 'Digital Valley' as part of a coordinated EU-wide approach. This European counterpart to Silicon Valley would connect the developers and providers of digital solutions to each other, from start-ups to global players and from garages to high-tech laboratories, and so create the necessary density to encourage new developments and innovative business models[19].

[19] See ROLAND BERGER STRATEGY CONSULTANTS, *The digital transformation of industry. How important is it? Who are the winners? What must be done now?*, BDI, 2015.

Annexes

Annex 1. Work results of PEAK

First set of questions – fundamental issues

- "Who is going to produce which products in future (here: Google car)?"
- "Which new demand options are going to result from Industry 4.0 for different customer groups with regard to the determinants time, investment and supplier diversity?"
- "How are customers' demand profiles going to change?"
- "Which distribution channels and what types of customer approach will or must result from this?"
- "What key skills and what knowledge are actually going to be required at existing production plants in future?"

Second set of questions – support of corporate change processes at social level through personnel development

- "Is it possible to predict the social impact, and if so how?"
- "What type of support is required to infer and implement personnel development measures?"
- "What skills does the overall organisation require to adjust to new systems?"
- "How can we persuade a capable workforce to make sure that the 'core processor' of the company is running?"
- "What is going to distinguish a capable workforce with regard to personal, methodical, technical and social skills in future?"

- "How can we develop ideas from a personnel development perspective to encourage managers to question their existing thought patterns and direct them towards a completely new system?"
- "And how can personnel development encourage managers to learn things that they will not need to know until later?"

Third set of questions – networking

- "How can we implement and encourage a corporate networking culture that ensures that the necessary knowledge is passed on to the appropriate employee at the right time?"
- "How can we motivate employees to participate in the culture and share their knowledge? Perhaps through incentive schemes?"
- "What general infrastructure conditions have to be created to ensure that knowledge is and can be passed on as necessary?" (Catchphrase from the suggestion box to the tablet)
- "How can personnel development support and analyse these exchange and networking processes and assess their effectiveness and efficiency?"
- "How can personnel development monitor this large number of, in some cases highly complex, communication processes and draw suitable, that is, commercially target-oriented conclusions?"

Fourth set of questions – changes at the level of work organisation and human resource allocation

- "How is production going to take place in our company in future?"
- "Which jobs will be affected by a new production structure?"
- "What impact is this going to have on the current and future employee qualification profiles?"

- "What do these substantial changes mean in terms of research and development, that is, what and how are we going to carry out developments in future?"
- "To what extent are the current working-time models going to survive in future? Will they still be useful in their current format or will they have to be completely reassessed?"
- "Are the changes also going to affect the existing communication structures with the works council? How quickly and flexibly must it be possible to reach agreements in future in order not to lose competitiveness due to long coordination channels?"

Fifth set of questions – learning and acquisition of knowledge

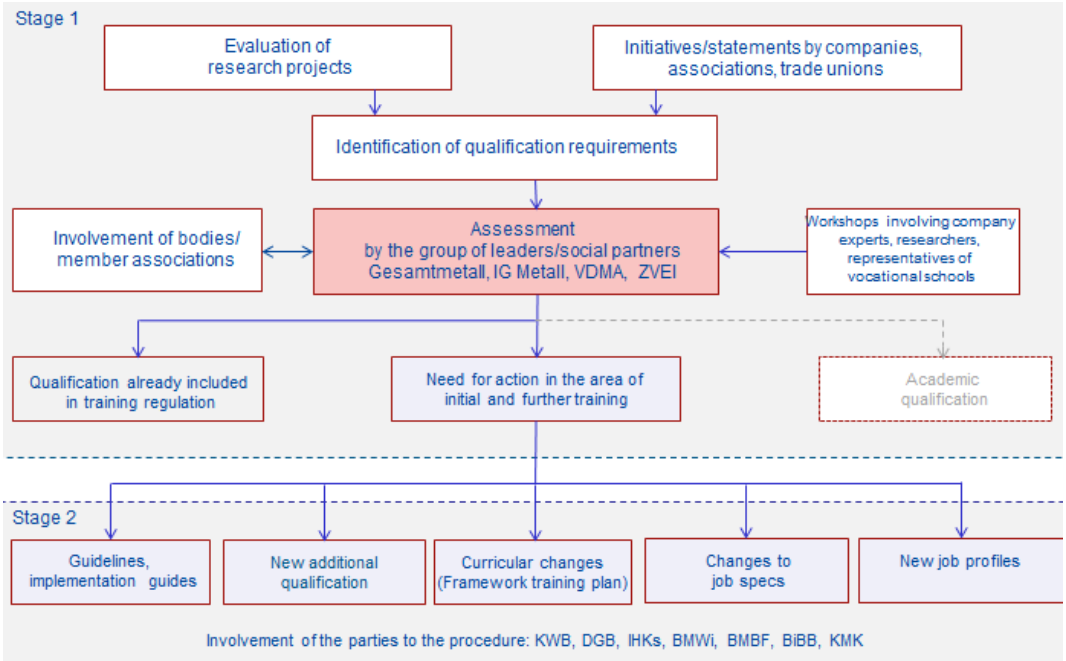
- "What could modern offices look like?"
- "How could cyber-physical systems be embedded in production and logistics and how could the internet of services be integrated into industrial processes?"
- "To what extent are the methods of knowledge transfer going to change in initial and further training?" The trend is moving toward 'fast vehicles' (technical training lasting 3 to 4 days) and 'continuous horizontals' (skills-based learning)
- "What consequences should we expect if the places of skills-based learning are going to be increasingly relocated to specially designed training factories in future?"
- "Is there going to be more classroom training and will this completely replace traditional forms of training?" (Question based on the McKinsey Capability Centre MCC)
- "How do companies, and hence personnel development, deal with the fact that knowledge transfer in companies is becoming increasingly individualised? How can it be integrated into the current exchange platforms

and proactively take advantage of them?" (cMOOCs, databases, LoD, ActiveMath, etc.)

- "How can personnel development encourage the creation of agile decision-making structures in companies and how will the social systems have to be advanced to sustainably support an agile network?"

Future dates for PEAK are still being planned and will be transferred to the HR network, as necessary (cf. § *HR Networks*).

Annex 2. Figure showing the agile methods agreed between the social partners[20]



[20] Internal working paper (not for publication): *Training and Qualification for Industry 4.0 – Successfully Shaping Change – Recommended Actions for Agile Methods*, 30 November 2016.

3.
ITALY

INDEX

1.
Introduction

The EU manufacturing output stands for 15% of the overall Member States' GDP and EU has declared that the goal is to increase this level by 20% by the year 2020. However, since 2008 over 3.4 million jobs have been lost in the metal industry. These data proves that a new phase of EU economic growth cannot come without the involvement of metal and mechanical industry. Industry 4.0 is a new production system resulting from the application of new technologies to manufacturing. Industry 4.0 represent a game changer affecting all the activities linked to manufacturing, from planning to processes, from products to work organisation. While the robotic evolution of production represents an opportunity for the EU economy, as it implies the demand for new professional figures, the process will involve several challenges for the EU labour market, including a loss of low qualified jobs and a lack of high-skilled workers[21].

This report is part of *INDUSTRY 4EU – Industry 4.0 for the future of manufacturing in the EU*, a project aimed at bringing together social partners and institutions from Italy (ADAPT; Federmeccanica), Germany (Nordbildung), Slovenia (Chamber of Commerce and Industry of Slovenia) and at the European level (CEEMET) in an effort to identify concrete actions to cope with challenges and opportunities of Industry 4.0. Particularly, *INDUSTRY 4EU* is intended to identify good practices and possibilities for employers to successfully support the implementation of Industry 4.0, especially by the means of social dialogue at all levels, from firm to the European Union. According to the European Commission,

[21] See F. MCCRORY, G. WESTERMAN, Y. ALHAMMADI, E. BRYNJOLFSSON, *op. cit.*

one of the goals of the Europe 2020 strategy is "to promote the restructuring of sectors in difficulty towards future oriented activities, including through quick redeployment of skills to emerging high growth sectors and markets"[22], thus fostering the Renaissance of industry in Europe.

Even though Industry 4.0 has still not been tackled by a joint action within the framework of the European social dialogue, EU social partners are currently demonstrating an increasing interest in this topic. *INDUSTRY 4EU – Industry 4.0 for the future of manufacturing in the EU* wants to be a stepping stone to put Industry 4.0 on the top of the EU social dialogue agenda. The project is aimed at bringing together social partners and institutions in an effort to identify concrete actions to turn Industry 4.0 challenges into opportunities. The main objective is to improve dialogue between employers' associations in order to create conditions for the spread of Industry 4.0 in the European countries, thus contributing to reconverting present factories and helping them to be more competitive.

This national report is one of the outputs of the project, aimed to explore the current landscape of Industry 4.0 in Italy based on the results of a map of past and existing unilateral programmes, as well as social dialogue initiatives to deal with the skills mismatch arising from the digitalisation of production methods and developing the technical skills necessary for the implementation of Industry 4.0, a mapping exercise conducted by Federmeccanica and semi-structured interviews conducted by ADAPT.

[22] COM(2010)2020 final, cit., 17.

2.
Objectives and methodology of analysis

The goal of this report is twofold. First to show the results of a mapping process in order identify all the initiatives already under way about the issues involved in the process of transition to Industry 4.0 in relation to work and social dialogue. In fact one of the risks of the approach to future issues and scenarios is not to act as a broader system of all the actors involved in the change, in this way, however, is very difficult to build a sufficient critical mass to face the challenges of the transition. Besides that, often businesses and the social partners are not aware of the initiatives already in place and the potential opportunities and funding related to them. The exercise of mapping exercise conducted and presented in this report wants to be a useful tool for all stakeholders of Italy to evolve their business models to the Industry paradigm 4.0. To this end we conducted a desk research by going to map all the institutional and social partners to sources involved in the innovation processes in Italy using websites, social media, institutional communication, institutional relationships.

The second objective of the survey is to map the level of business awareness both for the theme 4.0 Industry as a whole and in relation to the impacts on the labour market. For this reason we conducted a survey among companies partners of Federmeccanica asking them several questions designed to frame the issue in terms of knowledge of technology, adoption of technologies, expected impact of them, and the forecasts of purchase and investment. Attention then focused in asking what are the impacts on the labour market, particularly with regard to the skills required by the new Industry 4.0 and the impact on work organization. The aim of the survey is to have a complete and representative landscape of the situation of enterprises in Italy in order to then develop good transition practices built on the principles of social dialogue.

3.
Stakeholders' involvement

Federmeccanica represents the Italian companies working in the metalworking sector (MET) towards Industrial Relations with a special focus on Labour Law issues in accordance with the three branch Trade Unions, namely Fim, Fiom and Uilm.

Federmeccanica leads almost 80 Local Industrial Associations and belongs to Confindustria, the association that represents the manufacture and service companies in Italy; at the same time, Fim, Fiom and Uilm belong to the Trade Union Confederations Cisl, Cgil and Uil, respectively.

Social Parteners (Federmeccanica, Fim, Fiom and Uilm) are responsible for renewing the National Collective Agreement of Labour (NCAL), which defines the rules for metalworking companies and workers.

The NCAL disciplines the key items aimed at tackling the skills mismatch and settles special tools aimed at developing the required competences, such as the continuous vocational training, the workers' right to the education and the apprenticeship contract.

In particular, with the renewal of NCAL signed in November 2016, the Social Partners introduced a new individual right to continuous training accounting for 24 hours (on a 3-year base), in order to "update, improve or develop knowledge and professional skills linked to technological and organizational innovation of productive and working process". The metalworking one is the first NCAL that introduces in Italy such right for workers, enabling both the employability and the enterprise competiveness. The competences pointed out in this rule are digital,

linguistic, soft or managerial. Furthermore, the Social Partners agreed upon the launching of a national campaign aimed at filling the digital skills gap.

The Bilateral National Committee for vocational training and apprenticeship is responsible for: reaching an agreement upon sectoral multiregional training plans; monitoring the training initiatives; identifying companies' needs in terms of skills and coordinating the committees established at local and plant level. In firms with more than 300 workers, the plant level union structure could appoint the Vocational Training Responsible, who has power of attorney for signing corporate training projects.

In Italy continuous vocational training programmes are financed by inter-professional funds with 0.30% of contribution coming from companies. Fondimpresa is the fund constituted by Confindustria, Cgil, Cisl and Uil and manages the resources in three different accounts. Each company could use its 'training account' (*conto formazione*) in order to train workers, on the basis of training plans agreed with trade unions representatives. The SMEs could use its training account participating to 'additional contribution' (*contributo aggiuntivo*) calls for proposals. Alternatively there is 'system account' (*conto sistema*), which funds sectoral multiregional projects.

4.
Mapping exercise

The Mapping Exercise is made up of two sections.

In the first one there are the results of the questionnaire distributed to the MET firms about Industry 4.0 technological innovations and the consecutive changes in terms of skills. In the second part there are the analysed initiatives, set up either unilaterally or jointly by social partners, aimed at developing 4.0 skills, such as continuous training, entrepreneurship education programmes, partnerships with educational institutions, promotion of school-to-work transition.

4.1. Survey on the degree of Industry 4.0 technological innovations adoption and successive changes in terms of skills

The present questionnaire has been elaborated by the *INDUSTRY 4EU* partners and disseminated among the Italian metalworking firms. It is called *Industry 4.0 – A survey top build the future together* and is focused on the real knowledge and implementation of 10 enabling technologies which have emerged by the literature review, namely mechatronics, robotics, IoT, big data/data mining, cloud computing, cyber-security, additive manufacturing, systems of virtual simulation, nanotechnologies and smart materials.

The questionnaire also aims at figuring out how skills and competences are changing towards Industry 4.0 and how Federmeccanica and Institutions alike can support the labour market of the upcoming future facing new challenges linked to brand new skills. Taking together those aspects, along with the job organization,

we have been able to portrait a general framework to share with our Project Partners.

The purpose is to create the right conditions for the spread of Industry 4.0 in the European countries, thus contributing to reconverting present factories and helping them to be more competitive.

Further to this, the aforesaid survey is divided as follows:

- 1st Section – Company features;
- 2nd Section – Technological innovations;
- 3rd Section – Skills and competences;
- 4th Section – Job organization;
- 5th Section – Attitude towards Industry 4.0;
- 6th Section – Corporate culture.

The present study is based on a 527-company sample of replying enterprises to the aforesaid survey. 64% of those firms (which we have renamed adopters) have declared they actually use at least one of the 10 above-mentioned technologies, while the 36% of them has not implemented any.

43.7% stands for small enterprises (employing from 10 to 49 people), followed by medium (32.4%) large (13.4%) and micro businesses (10%).

Most of the replying companies, stated that their business activity deals with the manufacture of fabricated metal products, except for machinery and equipment (98 out of 527, Nace code n. C25) and 79 out of the total is a machinery and equipment n.e.c. manufacturer (Nace code C28).

33% of companies produces finished products for industrial customers, 19% for the market and the 21% supplies parts or components.

28% of the 64% of the adopter companies perceives to own a high level of digitalization, while the remaining percentage is divided into a 62% of medium and 9% of low level of digitalization. Furthermore, the adopters show a higher percentage of graduated in tertiary education employees (19% vs. 12%) and cooperate more than the non-adopters with research entities and Universities (59.1% vs. 26%), even though 53.5% of the total has declared they do not cooperate with the aforesaid institutions.

Among the 10 technologies, at least 50% of the involved companies have declared to be aware of the following (in decreasing order): cyber-security (93%), robotics (85%), mechatronics (76%), additive manufacturing (75%), cloud computing (72%), simulation (71%) and IoT (55%).

However, the real use of such technological innovations is not directly linked to their level of acquaintance. For instance, cyber-security is actually implemented in 83% of cases. Robotics is adopted just in 5 firms out of 10. 49% of entrepreneurs said they know nanotechnologies, but in practice just 1 company out of 10 uses them, as for the Smart Materials known by 43% of companies but used by 1.5 firms out of 10.

Nonetheless, what is interesting too is to understand in which area companies use 4.0 technologies.

For example, in 66% of cases, cyber-security is used in the production/management compartment, while seldom is it employed in the commercialisation one (37%).

The same for robotics, which is the most used technology among all the 10 in the production/management area, accounting for 80%, but for 8% in the commercialisation. Mechatronics is employed in 50% of companies, 69% for

production/management procedures, while additive manufacturing seems to be important during the product development phase (76%) but neither for the commercialisation nor the service department (4% in both cases).

In the end, cloud computing is more used in the service area (55%), while simulation and IoT are employed the most in the product development compartment (73% and 44% respectively).

The latter, seem to have a balanced use among all the areas, accounting for the 37%, 35% and 34% in service, commercialisation and management departments respectively.

The same for Big Data which is used in the respective areas for the following percentages: 48% production/management, 33% product development, 25% commercialisation and 34% service.

Table 1

9. Where do you use these technological innovations?						
	I don't use it	Production/ Management	Product Development	Commercialisation	Service	Level of adoption
Mechatronics	50	69	43	12	11	50
Robotics	49	80	22	8	9	51
IoT	73	34	44	35	37	27
Big Data/Data mining	76	48	33	25	34	24
Cloud computing	58	44	29	20	55	42
Cyber-security	17	66	39	37	56	83
Additive manufacturing	68	35	76	4	4	32

Systems of virtual simulation	47	42	73	15	22	53
Nanotechnologies	89	35	78	9	7	11
Smart materials	85	43	68	8	7	15

45% of the analyzed firms are planning to invest in cyber-security, in the short term; for the same lapse of time, simulation, cloud computing and robotics are more likely to be the next investments (with a percentage of 26%, 21% and 20%, respectively).

In the mid-term, robotics and cloud computing are the most relevant investments (19% each), followed by simulation (18%) and mechatronics, IoT and big data (14% equally).

Lastly, companies give more importance to smart materials in the long term (7%), nanotechnologies (6%) and, with equal merit (4%), simulation, additive manufacturing, robotics and IoT.

Unfortunately, it seems that the non-adopters enterprises are not planning significant investments for the coming years; this would lead to an ever deeper gap between them and the adopters if the former group does not plan any make up for delay.

Table 2

	Total				**Non-adopters**				**Adopters**			
Tech. Innovations	**Short term**	**Mid term**	**Long term**	**Any investments**	**Short term**	**Mid term**	**Long term**	**Any investments**	**Short term**	**Mid term**	**Long term**	**Any Investments**
Mechatronics	19%	14%	3%	64%	5%	9%	3%	84%	28%	18%	3%	52%
Robotics	20%	19%	4%	57%	8%	11%	4%	77%	28%	23%	5%	44%

IoT	17%	14%	4%	65%	4%	7%	4%	85%	25%	19%	4%	53%
Big data	14%	14%	3%	69%	4%	6%	3%	88%	20%	19%	3%	58%
Cloud comp.	21%	19%	3%	57%	5%	11%	5%	79%	30%	24%	2%	44%
Cyber-security	45%	16%	2%	37%	24%	16%	3%	57%	58%	17%	1%	25%
Add. manufact.	11%	13%	4%	71%	5%	5%	3%	88%	16%	18%	5%	61%
Simulation	26%	18%	4%	51%	7%	11%	4%	78%	38%	23%	5%	34%
Nanotech.	6%	5%	6%	84%	1%	2%	3%	94%	8%	6%	8%	78%
Smart mater.	8%	8%	7%	77%	3%	4%	6%	88%	12%	11%	7%	70%

Surprisingly, more than 52% of the participating companies do not plan to take part in public funding projects about Industry 4.0 for R&D.

Among the adopters, the improvement of the productivity is the most significant effect due to the implementation of the technological innovations at issue. Secondly, a deeper flexibility in product and service customization is another important consequence followed by (in decreasing order) supply of new services to customers, reduction in time-to-market processes, cost optimization and increased information relating to production processes.

The third part of the survey is focused on skills.

First of all, our features show that the average annual working hours pro capita dedicated to skills development through training (referring to managers, employees and workers then), is about 30 hours (29.7 to be more exact).

More specifically, adopters declared they have remarked some kind of change in people soft skills outcomes following the introduction of new digital technologies.

For instance, on a scale base ranking from 0 (= no change) up to 4 (= greatest degree of change) autonomy, accountability, flexibility and proactivity scored 2.3 points, followed by problem solving and team working (2.2) and digital communication (2.1).

The following question regards what kind of specific skills the adopters companies hold among their personnel; IT infrastructure management accounted for the 80%, followed by coding (63%) and data analytics (61%). This latter and the first one, seem to have specific implementations; IT infrastructure management is very relevant for the IT security management (88%) and cloud, sensors and server management (83%), while data analytics is judge to be important in reporting systems (80%) and decision making activities (69%).

Another fundamental aspect of the present research, is the impact such technological innovations have on job organization.

We have focused our attention on two specific aspects, namely smart working and knowledge sharing.

On an average basis structured as in the case of the change of soft skills, the replying companies scored a 2.37 points in knowledge sharing and 2.05 in smart working.

We have used the same question format to introduce the 5th part of the survey, regarding the expectations linked to Industry 4.0.

The following Table shows the general sentiment of our companies towards Industry 4.0

Table 3 – Industry 4.0 expectations

18. Do you think: [0 = total disagreement; 4 = total agreement]	
Industry 4.0 can also be implemented gradually with contained investments, even without radical changes in the basic technology normally used	3,07
Industry 4.0 is unsuitable for SME's	1,6
Industry 4.0 requires important investments	1,8

Industry 4.0 allows big companies to be more agile and therefore 'threaten' SMEs	1,9
Industry 4.0 allows SMEs to be more efficient and competitive in the market, Thus 'threatening' big companies	1,9
Industry 4.0 enables product customisation which can amplify competitive strength	2,3
Industry 4.0 is a passing trend	0,9
Industry 4.0 is important, but it requires skills that we don't have	0,8
Those who fail to grasp the opportunities offered by these innovations are likely to be excluded from the market	2,2

The last part of the survey is focused on companies corporate culture.

We asked our firms what actions should they undertake in order to facilitate the change towards Industry 4.0.

It seems that the staff lifelong learning is the most relevant factor to work on (2.8 out of 4), followed by the reorganization of the company structure (2.7) and a brand new managerial culture (2.5).

Finally, what firms require to Federmeccanica is more awareness of both National and European financial instruments (60.53%) as well as a communication strategy in order to spread best practice examples and attract the entrepreneurs interest and awareness (59.39%).

4.2. Social dialogue initiatives aimed at developing the skills necessary for the development of Industry 4.0

As touched upon, Fondimpresa funds the sectoral multi-regional training plans through system account calls for proposals, which cover different items. In particular, it's possible to develop the skills 4.0 under the areas 'Competitiveness' and 'Technological Innovation'.

For example, the call for proposals n. 1/2016 about company competitiveness has funded training measures directly related to qualification of production processes and products, organisation innovation, digitalization of business processes, e-commerce, net contracts, internationalisation.

In the metalworking sector, the most important social dialogue initiatives in this field are linked to the activities set up at national and local level by joint Committees for vocational training and apprenticeship.

These Committees are responsible for analyzing and reaching an agreement upon the training plans: only the most innovative ones could be signed jointly by Social Partners this way giving them the chance to participate to the calls for proposals.

Furthermore, the Committees monitor the metalworking training plans financed and share the results. On March 17th 2016, National Social Partners organized the Conference *Lifelong learning for Industry 4.0* in order to present the monitoring realized by some training centres on innovative plans developed under the call for proposals 4/2014.

4.3. Unilateral programmes aimed at developing the skills necessary for the development of Industry 4.0

Employers' Associations and Trade Unions are aware that fast and high quality school-work transition is fundamental in the fourth industrial revolution. For this reason, Social Partners are improving the relationship with educational actors, from primary schools to VET providers and Universities.

In order to map these unilateral programmes, Federmeccanica has sent a sheet to its local Industrial Associations and to Metalworking Trade Unions, which has been filled with continuous training activities, entrepreneurship education

programmes, partnerships with educational institutions, promotion of school-to-work transition initiatives. Each programme has been described, with a focus on promoters, objectives and target groups.

Continuous Training

The approach of this section is to deal with continuous training in a wide perspective. For this reason several initiatives will be described, even not strictly related with the training of workers.

The project *Education and Innovation* is developed by Confindustria, Fondirigenti, Intesa Sanpaolo and Confindustria SMEs with the aim at identifying new skills for Industry 4.0 in the sectors Advanced Manufacturing, Aerospace, Biomedical, Fashion Industry. The long term purpose is to identify useful tools to enhance the enterprises investment in training, which should became a real parameter which determines creditworthiness.

Confindustria Firenze has built up an executive program in manufacturing big data, addressed to all the companies which want to implement the digital transformation of processes. COSEFI, Polytechnic University of Milan (Graduate School Of Business) and University of Pisa are partners of the project.

The program provides ad hoc training about supply chain management, innovation culture, big data. There are 50 hours of frontal lesson, 8 hours through FAD and 15 hours of project work.

Similarly Confindustria Bari, Polytechnic University of Bari and the Business School of *Il Sole 24 Ore* have developed the Master course *Innovation and Digital Transformation*, in order to foster the managerial and operational skills and, at the same time, to organize and supervise the processes of innovation and digital transformation in the companies. The Master course is divided into three modules,

namely *Digital Strategy & Innovation*, *Digital Strategy and Business Impact*, *Digital Technologies and Solutions for Digital Transformation*. Its target groups are managers, entrepreneurs and professionals who want to improve their ability in understanding and managing innovation projects also on the basis of new digital technologies.

Confindustria Bergamo has organised two different training programmes known as *Industry 4.0 @ Confindustria Bergamo* and *Tips 4 Smart Manufacturing*, addressed to managers and young employees, respectively. The first one was developed in 2015 with FORMA – Sistemi Formativi Aziendali (training school), Intellimech (Consortium for the mechatronics), Fraunhofer IAO, Fraunhofer IEC and wanted to get the companies aware about Industry 4.0 in order to implement smart manufacturing projects. The training pathway involved 40 managers and was structured in:

- face-to-face training meetings (12 hours);
- tour in Stuttgart at the 'Mini-factory' created by Fraunhofer IAO;
- inter-enterprise working groups with the aim at developing project ideas;
- final conference with results and agenda with next objectives.

At the same time, *Tips 4 Smart Manufacturing* was a training initiative for young employers in order to share best innovative practices. Six meetings were carried out in 2016 including a visit in the high technological enterprise ABB.

On the Trade Union hand, Fim-Cisl, in collaboration with its local associations, employers' associations, training centres, inter-professional funds and training committees, has realized since 2009 the project *Rewind*, which wants to train trade unions delegates on the duties and responsibilities foreseen in the NCAL about vocational training. The project deals with all the training cycle, from skills need survey to supervision, monitoring, and effectiveness analysis of the action.

More than 2,300 delegates and 140 secretaries have been trained in 107 seminars, which are always more frequently focused on Industry 4.0 implications. In line with this, the workshop held in Terni on November 15th 2016 was about *Vocational training and qualification in Industry 4.0*.

Entrepreneurship Education Programmes

Eureka! Funziona! is the entrepreneurship programme developed by Federmeccanica, in agreement with the Ministry of Education and the support of Local Employers Associations, addressed to students of 3rd, 4th, 5th years of primary education. The project wants to create entrepreneurs of the future, orienting children towards scientific and technical education. Federmeccanica supplies schools with some kits composed by generic materials (such as wood, paper, rubber and so on) and the students have to create a toy which applies a physical principle such as pneumatics, mechanics or magnetism. The main topic of the fourth edition has been the automation, in order to introduce children to Industry 4.0. With *Eureka! Funziona!* 4.0 have been supplied 2,200 kit, involving 11,000 students from 28 cities.

Local Employers Associations promote entrepreneurship education programmes also for the students of secondary education. For example the young employers of Confindustria Padova develop *Focus upon companies* with the aim at developing knowledge about creating innovative business.

In the project, each class simulates a business activity and should invent, promote and sell an innovative product or service in order to solve a real problem or need emerged in the city of Padova. Furthermore, the students visit some companies, verifying how an idea could become reality.

Students learn both technical (such as swot analysis) and soft skills (team working, public speaking, time management, activity planning).

Partnerships with Educational Institutions

Social Partners and Educational Institutions are working hardly in order to build strong, efficient and long-lasting partnerships which can allow to align the supply and demand in terms of skills of young people.

The most interesting example of partnership is represented by the Territorial Labs for the Employability, which are promoted by the Ministry of Education under the National Plan *Digital School* with 45 millions funding.

These are living labs addressed to students and NEETs, in which is possible to: foster youth employability and guidance, promote entrepreneurship activities, align students' skills with enterprises' shortages, develop digital skills for Industry 4.0 and computational thinking, spread school-work alternance and apprenticeship.

In this framework the Labs are created with the cooperation among Municipalities, Educational Institutes, local Employers Association and firms in order to orient the schools to territorial needs and the training activities to strategic sectors of the local productive district.

For example, LAB 4.0 is developed in Reggio Emilia by Unindustria, 8 secondary schools, 2 tertiary institutes, the Municipality, the Chamber of commerce, Bank foundations, the Foundation for industrial research and technology transfer, the local FabLab and training organisations. This centre is deeply focused on continuous innovation, in order to create new specific and flexible professional profiles which can manage competences for Industry 4.0 such as:

- Human-Machine Interfaces (HMI) designing;
- HW and SW prototyping;

- Data Analysis;
- Predictive maintenance systems designing;
- 3D production chain simulation;
- Visual Communication (tutorial, webinar, pitch);
- Team working;
- Process working;
- Autonomy;
- Self entrepreneurship.

Also the Territorial Labs for the Employability *S.M.I.L.E.* and *SAIL – Smart Automation Innovative Laboratory*, developed, respectively, in Bergamo[23] and Brescia[24], are 'totally connected' centres which deal with innovation and school-work interconnection. Under *S.M.I.L.E.* project there have been created 3 different labs (at secondary schools 'Paleocapa' and 'Natta' and at Scientific Park Kilometro Rosso) in order to provide specific training for Industry 4.0 and to tackle early school leaving. Likewise *SAIL* wants to create the skills 4.0, fostering youth employability and 'Made in Italy' sectors, such as automotive, electrical components, industrial automation, precision engineering and metal processing, which are fundamental for the manufacturing base of Brescia.

Another important initiative of partnership is represented by the 'ITS', pathways of non-university tertiary education (Level 5 EQF), characterized by higher technical specialization. Its organizational model is the Foundation, composed by

[23] The partnership is composed by: Confindustria Bergamo, Education institutes 'Paleocapa' and 'Natta', Kilometro Rosso, Firms, Cluster Fabbrica Intelligente Lombardia, University of Bergamo, Consortium Intellimech, Association BergamoScienza, Municipality of Bergamo.

[24] The partnership is composed by: Employers Associations of Brescia (AIB, Apindustria, CNA), 8 Secondary Schools, 2 Universities, Municipality of Lonato, 4 Temporary work agencies, Companies (Camozzi; Feralpi; TiesseRobot; System Technology; Officine Meccaniche Rezzatesi; Automazioni Industriali).

the collaboration among enterprises, universities, scientific and technological research centres, local authorities, the education and training institutes.

Each course lasts for two years (1,800-2,000 hours) and foreseen a period of work-based learning (at least 30% of the duration). It's possible to reach this title through an apprenticeship contract.

The ITS offer training courses related with six technological areas considered as strategic for the Italian economic development and competitiveness, namely: Energy Efficiency, Sustainable Mobility, New technologies for the life, New technologies for the 'Made in Italy', Innovative technologies for the cultural activities – Tourism, Technologies for the Information and Communication.

Among the 'New technologies for the Made in Italy' Area, there are training pathways related with the mechanic/mechatronic system, which allow to achieve the professional profiles "high level technician for the process innovation and mechanic products" and "high level technician for automation and mechatronic systems". These profiles are deeply oriented to Industry 4.0 requirements and the young people graduated in this area are endowed with strong specialized skills and work experience.

There are other examples of school-work partnership, such as the training pathways for teachers.

For example the young employers of Confindustria Bergamo and the territorial School Office promote *Lean Production and Smart Manufacturing*, an initiative about Industry 4.0 principles addressed to teachers responsible for alternance programs, which takes into account traineeships too; likewise the project *Development of Strategic Skills for Learning Experts* is developed by Confidustria Padova with Niuko (training provider) with the aim at supporting teachers in the creation of school-company relationships.

Confindustria Padova organises, with the collaboration of Carraro S.p.A., the *Olympics of Machines And Mechanical Talents*, in order to share new production technologies with the schools.

The students of secondary education (IV and V class) work in team and take many tests on different areas: technology, lean, technical design, CNC programming, cyber-security, management, and so on.

Students also visit the production departments of Carraro S.p.A., meanwhile the teachers participate to training pathways about Industry 4.0. The initiative is realized also in Treviso and Vicenza.

Promotion of school-to-work transition

The agreement between Federmeccanica and the Ministry of the Education signed in July 2014 is deeply oriented towards the promotion of school-to-work transition.

On the basis of this agreement has been developed the project *Traineeship*, the first alternance programme set up at national level after the Law No. 107/2015 about the educational system, which strengthens the 'school-work alternance' introducing 400 hours of on-the-job training during technical and VET education.

The project objectives are disseminating and strengthening the school-work alternance, developing the laboratorial teaching, increasing the level of employability of young people, aligning their skills and competences to the needs of the labour market, also recognizing the equivalence between school-based and work-based training, promoting the school-enterprise cooperation, spreading best practices implemented at local level and leading them to system.

Traineeship, which involves 50 VET institutes, 5,000 students and more than 500 MET firms, was launched in March 2016 and will last until July 2017. The main characteristics of the project are the firm-school 'co-planning' of both activities and assessment criteria, along with a concrete on-the-job training for students, a joint training for both tutors and the certification of the acquired skills. In the project, many companies are testing a system of students rotation on the same working station: in this way also the SMEs can provide on-the-job training to a large number of young people.

The firm-school co-planning at issue is the pillar of the project because both internal and external tutors are responsible for pointing out the competences that the students will achieve during the years, describing each skill into different performances.

For these reasons, *Traineeship* triggers a real innovation process because it promotes a pattern of school-work alternance that supports a change of the teaching organization.

Also Indire, the National Institute for Innovation and Educational Research, cooperates on the project: it is responsible for the qualitative monitoring and has made available an online platform in which is possible to upload the documents (planning docs, school-firm agreements, training pathways, etc.) and organize webinars.

The promoters (Ministry of Education, Federmeccanica, Indire) are discussing the possibility of carrying on the second year of the project, in order to involve double VET institutes.

Another example of promotion of school-to-work transition is represented by the programme *Technical tests for business* developed by the Young Employers of Confindustria Padova towards the students of upper secondary education (III, IV

and V class). The project, in particular, wants to give to students the soft skills required in the labour market 4.0, as far as they are recognized more and more important to the companies. In the project, entrepreneurs and temporary staff agencies responsibles organize specific seminars with the aim at preparing students to take on the stage periods, teaching them all about the work environment, from the economic system and labour market 4.0 to the job profiles and competences of the future. These instruments are very important for young people, in order to speed the school-work transition.

5.
Outcomes

The deep analysis carried out through the mapping exercise is very important to understand the Industry 4.0 phenomenon in Italy.

Thanks to the questionnaire a landscape with lights and shadows has emerged, considering the deep differences between adopters and non-adopters.

The former group of companies perceives to have a higher level of digitalization, it shows a higher percentage of graduated employees and it cooperates more than the non-adopters with research entities and Universities.

Adopters who judge their firms to have a high digitalization level, give more importance to the output development as well as a quicker time-to-market procedure and to the use of the virtual systems for planning and prototypes. But, above all, the adopters are more willing to invest in new technologies. Unfortunately, it seems that the non-adopters enterprises are not planning significant investments for the upcoming years; this would lead to an ever deeper gap between them and the adopters if the former group does not plan any make up for delay.

However, as emerged from the expectations section, Italian companies are conscious that Industry 4.0 is not simply a buzzword, but a real challenge which should be deployed in order to amplify competitive strength. In spite of this, they think it is an evolutionary process, which can be implemented gradually.

In this process, skills will be playing the major role.

Autonomy, accountability, flexibility, decision making, problem solving, team working and digital communication are indicated as the most important soft skills for Industry 4.0. At the same time, the technological innovations will be concretely managed through data analytics, IT infrastructure management and coding skills.

Continuous staff training, as well as top management's (entrepreneurs and managers), will be crucial in order to manage the transition towards Industry 4.0.

For this reason Italian Social Partners (Federmeccanica, Fim, Fiom, Uilm) have introduced an individual right to be trained in the metalworking NCAL and are willing to launch a national campaign aimed at filling the digital skills gap.

Nevertheless, changes will affect all the learning cycle, thus influencing also the educational institutions. As described above, Employers Associations are strengthening the partnerships with these subjects, with the aim to develop school-work alternance projects, entrepreneurship education programmes, vocational guidance activities, training initiatives for students, NEETs, teachers, entrepreneurs and workers. Also in this context, we are dealing with an evolutionary process, which needs to be strongly fostered during the next years, in order to build a new educational model which could increase the competitiveness of the Italian industry and the Country in general.

6.
Problems emerged in the mapping exercise

The research contributes in understanding the state-of-the-art of Industry 4.0 and initiatives aimed at developing the skills 4.0 in the Italian metal-mechanic sector.

The major concerns are about the limited awareness and willingness to invest of the companies, the difficulties in creating school-firm partnerships and training pathways, the differences among regions and the limited number of social dialogue initiatives about the topic.

In particular the partnerships among productive and educational systems are well developed only in some places, in which the collaborations are structured from many years, also thanks to the role of Employers associations. In many places this system isn't structured and there are problems in aligning school and firm needs and planning the students' *curricula*.

However, the unilateral initiatives described before, represent best practices, which could be spread among all industrial associations and companies in order to give a successful model to all stakeholders which want to improve the relationships with the schools.

In spite of this, the research shows that social dialogue isn't a common practice in developing partnerships with educational institutions and alternance programmes.

As Social Dialogue is very important in providing high quality training for the staff, likewise it could be a useful tool in enabling Industry 4.0, as well as school-to-work transition. Employers associations and trade unions could boost Industry

4.0, designing and promoting new forms of participation and innovative training pathways pointed towards workers and students.

The fourth industrial revolution is creating new spaces for Social Dialogue and the Social Partners should work hard in order to increase the collaborations about these topics, thus strengthening it.

7.
Perspectives of analysis

We believe the *INDUSTRY 4EU – Industry 4.0 for the future of manufacturing in the EU* project, is leading to a deeper acquaintance of the skills that will be fundamental to the labour market of the upcoming future in the European framework.

All the stakeholders involved in the research have contributed to understand the phenomenon and the actions which need to be put in place in order foster Industry 4.0 in Italy.

Generally speaking, the Italian manufacturing companies appear to be slightly aware of the phenomenon at an initial stage. For this reason, Federmeccanica believes that two different approaches shall be planned; on the one hand, the adopters have to be helped glimpsing a 'common thread' to the technologies and the skills of the future as well as understanding how to develop new business models; on the other hand, the non-adopters should face their fears towards Industry 4.0 and realize that a step-by-step introduction is possible too.

For this reasons, Federmeccanica is willing to develop actions addressed to entrepreneurs, schools, Institutions. Hereby some examples:

1) webcasts: webinar created with the aim at spreading the awareness and the knowledge of entrepreneurs;
2) training measures for entrepreneurs: multimedial contents with literature reviews, business cases, financial instruments about technologies, skills, labour organization;

3) Continuous dialogue with schools: seminars with Traineeship schools about Industry 4.0 and strengthen partnerships with them;
4) Social dialogue: fostering the activities of national committee about continuous training and implementing the new individual right to be trained;
5) Lobby: continuing the lobby activities towards institutions.

As pointed out previously, Industry 4.0 is a process, which, day by day, is showing new interesting points of view.

In this context we believe that it's important to give value to the partnership established with this project, which should continue and broaden the research, examining new items and increasing the awareness about the topic.

8.
Final conclusions and remarks

As emerged from the survey, Industry 4.0 can be perceived as an evolutionary process, which can be implemented gradually. Nevertheless it will be disruptive with regards to technologies, production models, organization and skills.

The skills will change deeply and quickly. For this reason educational institutes should rethink their organization and should innovate training pathways and the knowledge-transmission model as soon as possible, enabling students to acquire digital and relational capabilities.

The only way to make Industry 4.0 suitable is to increase more and more the cooperation between education-training and work, creating labs for employability, supporting teachers experiencing on-the-job training, developing innovative alternance projects, betting on continuous training of the staff.

All the technological innovations should be managed by human resources, which will be crucial in the fourth industrial revolution. The success of the enterprises depends on the quality of the human factor, which is raising its importance in the new working model. Companies should invest on it, providing training to the staff, involving workers in strategic decisions, giving importance to the merit and paying it on the basis of the results, training and orienting young people, which will be the workers of tomorrow.

In summary, we state that enterprises, in order to catch all the opportunities of Industry 4.0, should create strong partnerships with educational institutes (VET schools, ITS, Universities) and give more and more importance to the human factor; at the same time it should start with a gradual digitalization process,

providing even small investments or employing already existing plants, in order to get the potential of innovations. As international competition strengthens, there will probably be a real gap on technologies, management and skills, which can be filled only with awareness about the topic, investments in technologies and workers, staff training, partnerships with the education system and collaboration with trade unions.

We need to start small from tomorrow, but think big.

4.
SLOVENIA

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1.
Introduction

The EU manufacturing output stands for 15% of the overall Member States' GDP and EU has declared that the goal is to increase this level by 20% by the year 2020. However, since 2008 over 3.4 million jobs have been lost in the metal industry. These data proves that a new phase of EU economic growth cannot come without the involvement of metal and mechanical industry. Industry 4.0 is a new production system resulting from the application of new technologies to manufacturing. Industry 4.0 represent a game changer affecting all the activities linked to manufacturing, from planning to processes, from products to work organisation. While the robotic evolution of production represents an opportunity for the EU economy, as it implies the demand for new professional figures, the process will involve several challenges for the EU labour market, including a loss of low qualified jobs and a lack of high-skilled workers[25].

This report is part of *INDUSTRY 4EU – Industry 4.0 for the future of manufacturing in the EU*, a project aimed at bringing together social partners and institutions from Italy (ADAPT; Federmeccanica), Germany (Nordbildung), Slovenia (Chamber of Commerce and Industry of Slovenia) and at the European level (CEEMET) in an effort to identify concrete actions to cope with challenges and opportunities of Industry 4.0. Particularly, *INDUSTRY 4EU* is intended to identify good practices and possibilities for employers to successfully support the implementation of Industry 4.0, especially by the means of social dialogue at all levels, from firm to the European Union. According to the European Commission, one of the goals of the Europe 2020 strategy is "to promote the restructuring of sectors in difficulty towards future oriented activities, including through quick

[25] See F. McCrory, G. Westerman, Y. Alhammadi, E. Brynjolfsson, *op. cit.*

redeployment of skills to emerging high growth sectors and markets"[26], thus fostering the Renaissance of industry in Europe.

Even though Industry 4.0 has still not been tackled by a joint action within the framework of the European social dialogue, EU social partners are currently demonstrating an increasing interest in this topic. *INDUSTRY 4EU – Industry 4.0 for the future of manufacturing in the EU* wants to be a stepping stone to put Industry 4.0 on the top of the EU social dialogue agenda. The project is aimed at bringing together social partners and institutions in an effort to identify concrete actions to turn Industry 4.0 challenges into opportunities. The main objective is to improve dialogue between employers' associations in order to create conditions for the spread of Industry 4.0 in the European countries, thus contributing to reconverting present factories and helping them to be more competitive.

This national report is one of the outputs of the project, aimed to explore the current landscape of Industry 4.0 in Slovenia based on the results of a map of past and existing unilateral programmes, as well as social dialogue initiatives to deal with the skills mismatch arising from the digitalisation of production methods and developing the technical skills necessary for the implementation of Industry 4.0, a mapping exercise conducted by CCIS-MPIA and semi-structured interviews conducted by ADAPT.

[26] COM(2010)2020 final, cit., 17.

2.
Objectives and methodology of analysis

The goal of this report is twofold. Firstly, to show the results of a mapping process in order identify all the initiatives already under way about the issues involved in the process of transition to Industry 4.0 in relation to work and social dialogue. In fact one of the risks of the approach to future issues and scenarios is not to act as a broader system of all the actors involved in the change, in this way, however, is very difficult to build a sufficient critical mass to face the challenges of the transition. Besides that, often businesses and the social partners are not aware of the initiatives already in place and the potential opportunities and fundings related to them. The exercise of mapping exercise conducted and presented in this report wants to be a useful tool for all stakeholders of Slovenia to evolve their business models to the Industry paradigm 4.0. To this end, we conducted a desk research by going to map all the institutional and social partners to sources involved in the innovation processes in Slovenia using websites, social media, institutional communication, and institutional relationships.

The second objective of the survey is to map the level of business awareness both for the theme 4.0 Industry as a whole and in relation to the impacts on the labour market. For this reason, we conducted a survey among companies partners of CCIS-Metal Processing Industry Association and CCIS-Electronic and Electric Industry Association, asking them several questions designed to frame the issue in terms of knowledge of technology, adoption of technologies, expected impact of them, and the forecasts of purchase and investment. Attention then focused in asking what are the impacts on the labour market, particularly with regard to the skills required by the new Industry 4.0 and the impact on work organization. The aim of the survey is to have a complete and representative landscape of the

situation of enterprises in Slovenia in order to then develop good transition practices built on the principles of social dialogue.

3.
Stakeholder's involvement

Chamber of Commerce and Industry of Slovenia

The **Chamber of Commerce and Industry of Slovenia** (CCIS) is a non-profit, non-governmental, independent business organization representing the interest of its members. With more than 160 years of tradition, it is the most influential business organization in Slovenia.

Over 7,000 member companies of CCIS come from all sectors and all regions of Slovenia. CCIS unites 24 branch associations (e.g. metal and electro industry). CCIS operates a network of 13 regional chambers in Slovenia.

CCIS has the status of a representative Chamber of Commerce and is thus a partner of the government in the preparation of legislation and policy strategies. CCIS is also a member of numerous government bodies, boards and committees in various fields. Supporting governmental bodies with the knowhow and expertise in these fields makes CCIS a key actor at a national level in the formation of national strategies and legislation.

CCIS is a social partner organization and signatory party of more than 20 branch collective agreements, agreements on minimum pay and the Social agreements. CCIS is member of the Economic and Social Council in Slovenia.

As a member of Eurochambres (the European Association of Chambers of Commerce and Industry), the International Chamber of Commerce (ICC), as well as other international associations and organisations, the CCIS is part of an extensive international network with innumerable contacts.

CCIS is involved in numerous national and international projects related to research and development, business and entrepreneurship, internationalization, social issues (equal opportunities, social dialogue, etc.) as well as training and education.

Metal-Processing Industry Association

The **Metal-Processing Industry Association** (MPIA) is an independent, professional branch association, organized within the framework of CCIS, representing the interests of companies in the metal sector in Slovenia. Its main mission is to take positions and propose policies relating to social dialogue (signatory party of collective agreement) and industrial relations, legislation and government institutions, assist its members by disseminating different sectoral information and data, provide various consultations, legislation questions, business opportunities, organise training, as well as represent and communicate their proposals. It provides a wide range of services for its members.

Electronic and Electrical Industry Association

The **Electronic and Electrical Industry Association** (EEIA) is a professional industry branch association organized within the framework of CCIS, representing the interest of companies in the electro and electronics industry of Slovenia. Its main mission is to take positions and propose policies relating to social dialogue (signatory party of collective agreement) and industrial relations, legislation and government institutions. EEIA supports its member companies with assistance and advice.

Chamber of Construction and Building Materials Industry

The **Chamber of Construction and Building Materials Industry** (CCBMIS) is a professional industry branch association (private non-profit organization) organised within the framework of CCIS. Its main mission, in the best interest of the Association's members, is to take positions and propose policies relating to the Slovenian social partners, legislative and government institutions as well as towards their domestic and international associations. The Association's tasks are performed within the system of statutory authorisations vested in the Chamber in accordance with the relevant legislation. The Association collects different statistical sectoral data and prepares different sectoral expert publications. CCBMIS takes positions and proposes policies relating to the position of the branch, to the sectoral social partners, to the legislative and government institutions as well as towards their domestic and international associations, promoting good sectoral practices.

Trade Union of Metal and Electrical industry of Slovenia

The **Trade Union of Metal and Electrical industry of Slovenia** (SKEI) is an independent and representative trade union of workers in the metal and electro industry of Slovenia and the largest and most powerful sectoral trade union in Slovenia.

It is organised within the **Association of Free Trade Unions of Slovenia** (ZSSS), a voluntary and democratic organisation founded in 1990. Its representativeness and efforts to establish a high level of social dialogue give ZSSS the leverage to negotiate the contents of collective agreements and participate in the Economic and Social Council where they, together with the government, coordinate law proposals and other documents affecting workers. Social and other agreements related to salaries and specific economic and social affairs are concluded in the framework of a tripartite partnership. ZSSS has representatives in all social

security institutions and three representatives in the national council. It is the only Slovenian full member of the European Trade Union Confederation.

School Centre Celje (SCC)

School Centre Celje (SCC) is a public educational institution with over 50 years of experience in the field of vocational education. It consists of:

- Secondary School of Chemistry, Electrical Engineering and Computer Science;
- Secondary School of Mechanical Engineering, Mechatronics and Media;
- Vocational College;
- Business training centre – MIC.

It has over 3,000 students of the secondary level each year, 800 students in higher education (tertiary level), and over 1,000 adults over the various programs of formal and informal education and training, over 300 employees, mostly highly qualified teachers in various professional fields.

Over the past ten years, SCC has experienced over 100 national and international projects with the budget of up to € 6.7 million as the leading or as a partner organization.

The secondary school for mechanical engineering, mechatronic and media is head of the Association of Secondary and Technical Schools of Mechatronics in Slovenia. The school has also organized or participated in a national Forum of mechatronic several times.

Among its 300 employees, SCC boasts several highly competent and educated experts in mechatronic, along with many other experts indirectly connected with

the profession of mechatronics (i.e. mechanical, electronic and informatics engineers).

Federation of Workers' Trade Unions of Slovenia – Solidarnost

Federation of Workers' Trade Unions of Slovenia – Solidarnost is an independent and democratic interest organization that represents, promotes and protects the interests of its members. It works on the principle of solidarity ('all for one and one for all'), reciprocity and independently from the political parties and authorities. The trade union Solidarnost is acting alone or in conjunction with other trade unions. Federation of Workers' Trade Unions of Slovenia – Solidarnost stands for respect of international principles of trade union freedom, which provides voluntary approach and the establishment of trade unions or exit from any union.

4.
Mapping exercise

4.1. Initiatives on a national level

On a national level, Slovenia as the third most industrial nation in the EU is engaging in Industry 4.0 in the framework of the **Slovenia's Smart Specialisation Strategy** (S4). S4 covers a broad range of development policies related to innovation, focusing on the promotion of research and innovation, industrial policy, entrepreneurship, education system, rural development, and international relations.

The strategic objectives of S4, with innovation being ranked at the top of political priorities, are:

1) developing and positioning Slovenia as an attractive innovative economy, with a focus on the development of medium and high-tech and comprehensive solutions for niche areas where Slovenia has key capacities and know-how to compete in the global market;
2) establishing dynamic, strategically guided, responsive, highly advanced, globally up-to-date and connected research, innovative and entrepreneurial ecosystem.

One of the defined S4 priority areas is **Industry 4.0**, focusing on (distributed) production management and control, quality assurance, regulation and data processing, intra-logistics, automation, smart machines and equipment, mechatronic systems, actuators and smart sensors.

Technologies to be used under Industry 4.0 priority area are cross-cutting and will be applied in selected Slovenian key economic sectors: **basic and fabricated metal products, electronic and electrical engineering industry, ICT, mechanical engineering, and automotive industry**.

During the entrepreneurial discovery process for Industry 4.0 priority area, 16 initiatives pertaining to the area of Factories of the Future were prepared with an estimated investment value of € 950 million. The following eight of them seem to be very promising.

The System Efficient Energy Use and Conversion and Energy Efficient Systems initiative

The *System Efficient Energy Use and Conversion and Energy Efficient Systems* initiative outlines guidelines for the strategic development of the Republic of Slovenia (RS) in the fields of:

- electrification of vehicles and e-mobility;
- efficient use of energy (electricity) in buildings and homes;
- sustainable management of energy and energy resources;
- **smart industrial mechatronic systems.**

The initiative comprises 45 small, medium and large enterprises employing over 14,300 employees with sales revenues of more than € 2.3 billion and all relevant research organisations. Crucial contributions of the initiative build on the systematic upgrades and extensions of the existing values chains with the aim to achieve the highest quality and functional level of the products as well as a higher level of integration and interconnectivity of the products.

The initiative is fully focused on innovative products that will reach the TRL 9 until 2020. The initiative incorporates only technological areas and product

families where Slovenian companies already have an established global presence or those where Slovenian companies feature a realistic potential to achieve a global breakthrough. It thus builds on established high quality products on one side while outlining the strategy to launch high quality high added value niche products on the other side.

In the frame of the initiative, 400 new products are to be developed that will increase export of the selected companies within the initiative from € 1.6 billion in 2014 to € 2.4 billion in 2020. A strong commitment to success originates from the fact that the initiative comprises a large majority of Slovenian companies in the field of efficient energy use and conversion and energy efficient systems as well as all relevant and leading research organisations which all have actively contributed to this initiative and their strong commitment to strengthen synergetic and integrational aspects of the product development.

An integrated initiative on a wider area of process control technology

The integrated initiative on a wider area of process control technology has been formulated within the frame of Technology Network Process Control Technology (TN PCT, TM TVP) with its Competence Centre for Advanced Control Technologies (CC ACT, KC STV).

Consequently, it focuses on those Technology fields and Fields of application in which the members of the Technology network and/or partners of the Competence centre play a central role or represent the integrative player, which made possible or indeed initiated the preparation of individual initiatives for Technology fields or Fields of application thereof in the frame of this integrative initiative. It should be pointed out that the main asset of integrative initiative resides in the synergy of individual Technology fields and Fields of application and in the horizontal cross-flow of knowledge between these fields. The essential element is also the connection with Technology field outside of control technology, which can take

place in a more organized and effective manner within the frame of integrative initiatives.

The initiative focuses on three domains:

- in the domain *Smart buildings and home* (2 Technology fields), the emphasis is on products for home automation and on products that enable construction and make part of active smart operating room;
- in the domain *Networks for transition into circulatory economy* (6 Technology fields), there is a strong emphasis on Smart Grids, and the other Technology fields address biological processes, water and alternative sources of energy;
- in the domain ***Smart Factories*** (6 Technology fields), the initiatives address the topics of holistic management and control of production; control and supervision of individual devices and machinery; and of tools and building blocks, which are essential for the implementation of the concept of smart factories.

All initiatives address the fields within the priority areas of the Slovenian RIS3 and connect practically all research capacities in Slovenia in the field of control technologies, and large majority of most prominent engineering companies in the field of automation in Slovenia, together with several leading industrial companies; the latter mostly as users or carriers of vertically organized offer of products on the market.

The proposed initiatives contain Fields of application/Fields of products, which are at the level of technology readiness at least TRL3 or further beyond that level. The estimates show that the initiatives have large potential market and that with investments in the range of € 60 million in five years – with the condition of uninterrupted and bumpless execution of Fields of application/Fields of products within their development cycles and in between consecutive technology cycles –

we can expect the increase of gross added value by approximately € 160 million and the increase of export sales by € 430 million.

The ACS4ICOMP initiative

The ACS4ICOMP initiative, led by the Automotive Cluster of Slovenia, brings together the Slovenian companies and R&D institutions in the achieving of the strategy for **implementing smart factories in the automotive industry**.

The initiative focuses on the highly successful results achieved by the Slovenian automotive sector in the past years, its economic and social significance for the country, its inclusion in the latest technological trends in the European automotive industry and its robust response to the last global economic crisis, which the Slovenian automotive industry overcame more successfully than until then any other significant Slovenian industrial branch. The improvement of the Slovenian automotive suppliers in the last 15 years has been outstanding. The involvement of a wide range of stakeholders from the economic as well as the R&D sphere shows that the effects of the initiative will have additional multiplying effects on the technological development, employment trends in the country and a healthy economic growth, which will significantly increase exports.

The initiative is in line with all key national and EU strategic documents, as well as the priority areas of Smart specialization strategy, and at the same time is based on the targeted EU strategy for the development needs of the automotive, medical and aviation industry based on smart technologies, smart manufacturing processes and products that will be more productive, sustainable and controlled.

For a breakthrough in niche markets with increased added value, for maintaining contact with the best in the world, and providing competitive advantages of the Slovenian automotive industry, a systematic and planned development is required.

The aim will be to raise the complexity in the direction of ‘High-Tech’ products and processes and in this way to increase added value.

The effects of new technologies, processes and tools will enable a more efficient, faster and cheaper production, which will be centrally controlled and will allow a new professional orientation and employment, especially of young experts.

Intelligent ‘i’ technologies and ‘i’ processes want to be upgraded with electronic components, data management systems and highly productive materials based on a top Slovenian knowledge, all with the aim to satisfy the future needs of customers. The added value will be greater, whereas technology, processes and tools will be more economical and environmentally accepting and last but not least more ergonomic.

The process of design, development and production of the product by means of a competitive (i.e. simultaneous) engineering will allow the customer a faster response to the market. With integrated computerized systems, the customer will actively monitor the status of processes and on the one hand provide the required level of quality and safety of processes and on the other hand their efficiency. It will be possible to monitor the current status of orders, the status of process parameters, wearing out, fractures and other defects, the number of pieces and other indicators. The final effect of the initiative is to establish systems for smart factories, which will develop and produce competitive products on a significantly more demanding technological level, which will ensure a better position in the European and global automotive supply chain and the placement of Slovenia as a ‘High-Tech’ region in the car industry.

The SMARTTOOLS initiative

The main aim of the SMARTTOOLS initiative is focused on the tool-making and machine engineering technology field and covers the production field of **Smart mechatronics tools and control of production machines and processes**.

Further development of the technology field has strategic importance for tool-making and machine engineering to preserve global competitiveness of Slovenian stakeholders. Industry 4.0 concepts and global leaders dictate a substantial increase of product complexity in the field of multi-functionality, sensors systems, mechatronics and smart control, which requires an entire technological adaptation of the traditionally oriented toolmakers.

The overall assessment of the state of play in the technological field currently reaches TRL 6 and should be raised to TRL 8-9. Of course, some areas are still under developed and reaching TRL 3, therefore further development is essential.

Until 2020, the main impacts of the initiative predict an increase of investments in: research and development by € 15 million, modernization of production equipment by € 40 million, and marketing by € 4 million. On average, the employment of development personnel will be increased by 33%, which will lead to an increase of added value by 17% per employee, while the number of new products will be increased by 6%. The current 70% export share will be increased by an additional 15%.

The initiative is in line with the priority field (S)INDUSTRIJA 4.0 and application field Smart Factories and is in accordance with the European strategic directive Industry 4.0 and Factories of the Future. The initiative includes stakeholders in the value chain that are responsible for the manufacturing of industrial tools and other equipment needed by OEM producers and provides an international integration of commercial as well as development partners.

The implementation of the planned activities that are focused in applicative development of solutions and products (smart mechatronic systems, automation and upgrading of development services) is essential in the following four years; otherwise, a large gap in the technological field will be created in comparison with the leading players. With respect to the current state of play, the realisation of the objectives is realistic.

The InnoTECH 2020 initiative

The main goal of the *InnoTECH 2020* initiative is the improvement of the competitiveness of partners based on knowledge, competences and capacities, which will enable them to exploit market opportunities on global markets, based on competitive advantages, i.e. a favourable performance/price ratio, their own R&D, and flexibility in the satisfaction of specific customer needs.

The prospective areas of applications are smart machines, devices, tools, components and systems, mainly for the automotive industry as well as production systems and devices for other selected industries. These areas represent the core of smart factories and the (S)INDUSTRY 4.0 Initiative is in line with EU orientations in the area of advanced production technologies, as defined in the programmes *Europe 2020* and *Horizon 2020*, initiatives *Manufuture* and EFFRA, and especially the public-private partnership FoF – Factories of the Future. Partners of the initiative collaborate with leading European R&D institutes, companies are suppliers of the leading European automotive producers like Mercedes, BMW, Audi, Volkswagen, etc. and leading world companies in the selected industries.

Regarding the technology fields, the initiative is positioned mainly in TRL 5-7 and in TRL 7-9 regarding areas of application, which indicates realistic market orientations of the initiative.

Expected impacts of the initiative are an improved competitiveness of companies, which will result in an increase of sales and exports and a substantial increase of the value added per employee, which is estimated at € 50,000 per employee in 2020 at the level of the initiative, with the leading companies exceeding € 100,000 value added per employee.

The initiative is positioned in the core of the priority area (S)INDUSTRY 4.0 – Smart Factories, with partners being involved in global value chains as development suppliers of automotive industry as well as development partners of other industries.

The activities which are foreseen for the implementation of orientations are applicative R&D, marketing, technological investments, ICT investments, training of employees, application of new business models, and production, with effects realised already in the period 2016-2020.

The IOT Micro, nano electronics and photonics initiative

The *IOT Micro, nano electronics and photonics* initiative is aimed at the establishment of an infrastructure centre facilitating R&D companies in the field of microelectronics, nanoelectronics, and photonics. The Centre would encompass an advanced lab for thin films, a measurement lab, cleanrooms, capacities for the production of specific fibres, and a production process for system miniaturisation and the integration of heterogeneous technologies with the goal to **develop and industrialise smarter (predictive, reactive and cognitive) and energy autonomous systems.** Such capacities are currently lacking in the eastern cohesion region. The main research activities include an increase in the level of modular integration and combination of new functionalities at the micro and nano level through cost reduction, increased predictive and cognitive functions, and increased energy autonomy on the basis of energy management and energy

production from the working environment. The Centre would thus facilitate core support for the development and introduction of these technologies in companies and potential start-up/spin-off incubation. Research results are aimed at application-specific fields of the IoT, smart meters, biometrics and biomedicine, nursing and cyber-physical interfaces.

ROBO++

The industrial production in Slovenia is becoming less profitable due to the relatively high labour costs. Its preservation requires increased automation, which can be achieved through the introduction of advanced robot technologies, such as more flexible and adaptive robot systems. In Slovenia, there are several research groups conducting research in this area and collaborating in major European and international projects.

On the other hand, there are many enterprises in Slovenia that produce robot work cells and automated production lines, both for the domestic industry and for export (this export is the direct impact of ROBO++). In addition, numerous companies, most of them export-oriented, have been working on the introduction of robot technologies into their production lines. Together, these research groups and companies form the value chain of ROBO++.

ROBO++ brings into the area (S) INDUSTRY 4.0, domain intelligent factories, existing national and international competences and results to **introduce robot technologies for intelligent automation.** Twenty robot technology areas have been identified as the most promising to achieve this goal. The envisaged products include new sensor and actuator technologies, innovative robot periphery and grippers to complete industrial robot systems.

Intelligent, robot-supported automation means leaner production, suitable for small and medium batch size production, where automation is still minimal. This

will result in and increased quality of products and competitiveness in export markets. Advances are expected especially in the automotive industry, in machine building, as well as in glass and food industries (this is an indirect impact of ROBO++). With a sizeable investment and an increased number of application projects to transfer newly developed technologies into the industry, the technology readiness level is expected to raise from application research (TRL 4-6) to systems operational in real environments level (up to TRL 9) within 5-7 years.

The nanotechnology initiative

Nanotechnology-based products have exploded in the last decade and are becoming omnipresent in anything from cosmetics to smart phones and cancer detection, most of which we are not even aware. The Slovenian industry is mainly focused on the use of various nanomaterials in chemical technology, in various sensors and devices, and in components. Slovenian researchers have shown a world-class track record in nanotechnology in recent years, which gives an excellent starting position for new applications in the industry.

The proposed Nanotechnology Value chains follow the guiding principles of focused smart specialization by identifying four emerging technology areas of industrial interest arising from product lines in the leading Slovenian companies in the field, which can be expected to lead to competitiveness on a world level:

1) smart nano/bio/chemo sensors in environmental, industrial and medical applications;
2) smart surface coatings from medicine;
3) **industrial components in smart factories** and in medicine;
4) smart nanotech-based systems for sustainable environmental and energy.

The listed technology areas are based on numerous product directions displaying high values of Technology Readiness (TRL): four product directions indicate TRLs of 6-9, the rest being 4-6.

The Nanotechnology initiative brings together leading exporting industry partners with world-class research groups in research institutes, existing research infrastructure in centres of excellence, and university departments into focused (smart) specialization teams grouped around the identified product lines. It is expected to lead to the establishment of long-term product value chains in the four priority technology areas, enhancing the technology development, and linking the technology platforms in the field with leading industry players with the aim of enhancing product added value through increased technological innovation with visible indicators within five years.

The Nanotechnology initiative directly links to specific segments in all three priority areas in the Smart Specialization Strategy of Slovenia, with special emphasis in high added value segments related to medical applications and in high-volume nanomaterials applications as final products or within coatings, raising the average added value from the current value of € 60,000 per employee to a realistically estimated € 85-95,000, based on current projections.

Strategic Development and Innovation Partnerships

The S4 initiative aims to reach its goals by establishing ***Strategic Development and Innovation Partnerships*** **(SDIPs)**, which are private-public partnerships of all nationally relevant and investment-ready stakeholders for specific priority area. The purpose of these partnerships is to implement activities to eliminate regulatory barriers and well as speed-up the process of issuing and/or priority treatment of permits or consents within its jurisdiction, namely for investments and projects falling under the identified priority areas. Measures to improve the regulatory environment are also planned to be implemented which will eliminate

administrative burdens. The introduction of the SME test will ensure consistent implementation of assessing the impacts of regulations on the economy.

The institutions currently engaged in Industry 4.0 priority area involve government bodies, research institutes, scientific centres, universities, clusters, social partners, and strong representatives of the global industry value chains.

Slovenia will, also on the basis of the received proposals prepared in the framework of strategic partnerships and/or National Innovation Platform (NIP).

4.2. Social dialogue initiatives

The Social dialogue initiatives aimed at developing the technical skills necessary for the development of Industry 4.0 in Slovenia are performed by various institutions. Below are some of the identified initiatives.

The Chamber of Commerce and Industry of Slovenia

The **Chamber of Commerce and Industry of Slovenia** has launched its own initiative for the advancement of the economy called **Slovenia 5.0**. Its mission is to raise awareness in different public spheres on the importance of industry and the necessity of its advancement based on development programmes with the best chance of succeeding on the market. For this purpose, Slovenia 5.0 brings together stakeholders who know best how, where, and to whom new products, services, or technologies could most successfully be sold, which is also the goal of smart specialisation strategy.

In order to achieve its goals, the initiative focuses on five key areas: smart state, smart taxes, smart HR management, smart internationalisation and **smart development,** which are presented in the CCIS's **Industrial Policy Manifesto**.

The Metal Processing Industry Association of Slovenia and the Electronic and Electrical Engineering Association of Slovenia

The **Metal Processing Industry Association**, organised within the CCIS, is actively involved in the Industry 4.0 discussion on various levels, groups and events, such as the yearly ASM conference or the Association's Management Board. Another branch associations of CCIS actively involved in Industry 4.0 discussion is the Electronic and Electrical Engineering Association (EEIA). They were involved in Slovenian Smart Specialization process from the very beginning and helped frame the basic Industry 4.0 idea into the Slovenian manufacturing base. Their current activities are focused toward raising the awareness of the digital transformation among Slovenian companies by organizing best practice exchange events, regulatory and legislation workshops, digital academy for top management, and developing digital competence tools for carrier planners.

SKEI

For the purpose of the Industry 4.0 project, SKEI, the representative Slovenian trade union of metal and electrical industry, prepared a **statement** summarizing their point of view, current endeavours and future plans relating to the topic of **Industry 4.0 in Slovenia**:

"

1. Firstly, it is important to acknowledge the fact that many trade unions do not have the necessary professional capacities to fully engage in this significant topic.
2. Even though this also holds true for SKEI, we are aware of the importance of establishing an open dialogue in the field of Industry 4.0 with branch employers' associations as well as with

companies.

3. We are undoubtedly witnessing a new momentum in the development of the industry through digitalisation, but it is important to note that the so-called fourth industrial revolution cannot be achieved without employed workers.
4. What we are seeing is a digitalization of value-added chains, necessitating a new organisation of labour produced by workers by interconnecting different technological components.
5. Yet people will continue to organize the production and supervise the machinery, not vice versa.
6. In the future, this will require more qualified workers through adequate education and training, which will in turn require the expansion of social dialogue, all of which supports SKEI's current endeavours to include provisions concerning lifelong learning and the transfer of knowledge into the Slovenian branch collective agreement.
7. Changes in workplace will also occur: instead of working at the employer's premises, workers will be able to perform certain tasks outside of the facilities. This is an additional argument supporting SKEI's efforts to supplement the branch collective agreement with a provision on remote work.
8. The protection of industrial production will always be relevant; however, what is needed is a strengthened social dialogue on the need to increase investments in development, research, and innovation processes.
9. Additionally, communication processes will also transform and evolve. Social dialogue needs to ensure the social security of workers, which might become threatened due to reduced personal contact with employers (with information and communication technologies becoming the prevailing means of communication).
10. All of the above raises questions on how to provide job security in the light of digitalisation. It is necessary to establish social dialogue that will protect the interests of workers in the complex framework of the meaning of decent work, while further limiting precarious forms of employment.
11. SKEI will address the issues and challenges concerning Industry 4.0 in the scope of the Vienna Memorandum Group (which also includes the metalworkers' unions of Germany (Bavaria), Austria, the Czech Republic, Slovakia, and Hungary), as well as the

European trade union IndustriALL. SKEI will inform Slovenian employers' associations on all issues relevant for social dialogue.

12. Trade unions of the Vienna Memorandum Group will continue to be involved in the field with specialized foundations supporting research (especially the Friedrich Ebert Foundation), and will inform representatives of employers on all findings.
13. With respect to available capacities, SKEI wishes to remain an equal partner in the research and social dialogue on Industry 4.0 in order to ensure a balance of interests of capital and workers.

"

Bogdan Ivanovič
SKEI Secretary

4.3. Unilateral programmes aimed at developing the technical skills necessary for the development of Industry 4.0

KnowME project

In 2012 and 2013, **five European national sector organisations** (CCIS-MPIA, CCIS-EEIA, MASOC, LINPRA, ZEP RS) **from the metal and electro indust**ry carried out the EU-funded project on **skills and knowledge management *KnowME***[27] to explore the state of affairs in their industry sector.

The aim of the project was to **analyse the needs and requirements for better and future-oriented skills and knowledge management in the Metal and Electro Industry (MEI)** in the four project participating countries of Slovenia, Latvia, Slovakia and Lithuania, and to improve the capacity of social partners in the participating countries in **anticipating and managing change** in their sector as well as strengthen their cooperation on the European level.

[27] See the project publications in *know-me.gzs.si*.

For this purpose, interviews with companies and a survey were carried out in the four participating countries in skills and knowledge management. One of the most significant problems for companies of all sizes in the participating countries detected was that there are **not enough highly skilled workers on the labour market** and not enough apprentices from VET institutions available. Small and medium-sized companies (SMEs) have only limited capacity and personnel to provide the necessary trainings to respond to the newly upcoming qualification and skill requirements.

It was established that especially SMEs often lack the resources and the know-how to develop HR and training strategies to respond to current and future skill needs. In cooperation with the University of Applied Science Bielefeld (*Fachhochschule des Mittelstands*), a guidebook was produced to inform SMEs about the most important knowledge management practices.

The main result of the *KnowME* project was an increased awareness of the need for effective skills and knowledge management among SMEs in MEI and the tools and methods available. The improved management of skills and knowledge in SME in the participating new Member States, oriented to future skill and job needs, made an important contribution to better working conditions, better employability and productivity of workers in this sector, thus securing existing jobs. The involved social partners increased their capacity to support companies in anticipating, preparing for and managing industrial and demographical change. A stronger cooperation of social partners on the national and European level was established and the project made a quality input on management of change for the European debate.

SkillME Project

The Skills in the Metal and Electro sector – *SkillME* project[28] is a 3-year project (2014-2017) co-funded by the *Erasmus+* Programme of the European Union and led by CCIS-MPIA. The core aim of the project is to **identify the most pressing and widespread skill gaps in the industry of today and tomorrow and to design tools to help fill those gaps**.

Due to the rapid development of technology and knowledge, companies in the European metal and electro sector are finding it increasingly difficult to find competent workforce that could meet the requirements of their production processes, as out-of-date educational systems and the lack of flexibility are responsible for the widening skill gaps. Workers, on the other hand, are facing the challenge of keeping up with the ever-changing requirements of the industry so as to remain employable, competitive, and productive.

In order to fulfil the goal of reindustrialisation of Europe, extensive measures need to be taken in order to meet the demands of the market. The *SkillME* project is designed as a response to those needs. It is a collaborative project between vocational education and training (VET) providers, national regulatory partners, and representatives of the metal and electro industries of the EU Member States Croatia, Latvia, Slovakia and Slovenia, with the aim of **identifying the most endemic skill gaps in the metal and electro industry, develop state-of-the-art *curricula* to fill those skill gaps, and permanently integrate them into VET education systems** in project participating countries and throughout Europe.

As the *SkillME* project strives to improve competencies in the metal and electro industry in the long term, its aim is not only to determine the most current and widespread skill gaps of today, but also to **identify the areas of competencies**

[28] See *www.gzs.si/skill-me*.

that are going to be most sought-after in the future. As a result, the project will enhance competencies in the respective industries Europe-wide and foster cooperation of worlds of education and work by cooperation in curriculums design between the industry and VET providers.

5.
Outcomes

5.1. Analysis of survey responses

For the purpose of mapping the adaptation of Industry 4.0 technological innovations in the Slovenian metal and electro companies, the detected changes in skills and competencies connected with them, and Industry 4.0 expectations, a questionnaire titles *Industry 4.0 – A survey to build the future together* has been designed and distributed among member companies of the Metal-Processing Industry Association and the Electronic and Electrical Industry Association of the Chamber of Commerce and Industry of Slovenia via an online form and implemented in face-to-face meetings. All information regarding participated companies is kept strictly confidential.

In total, **54 companies of the Slovenian metal and electro industries** participated in the survey on Industry 4.0.

Company feature, type and size

- **Respondent companies' structure**

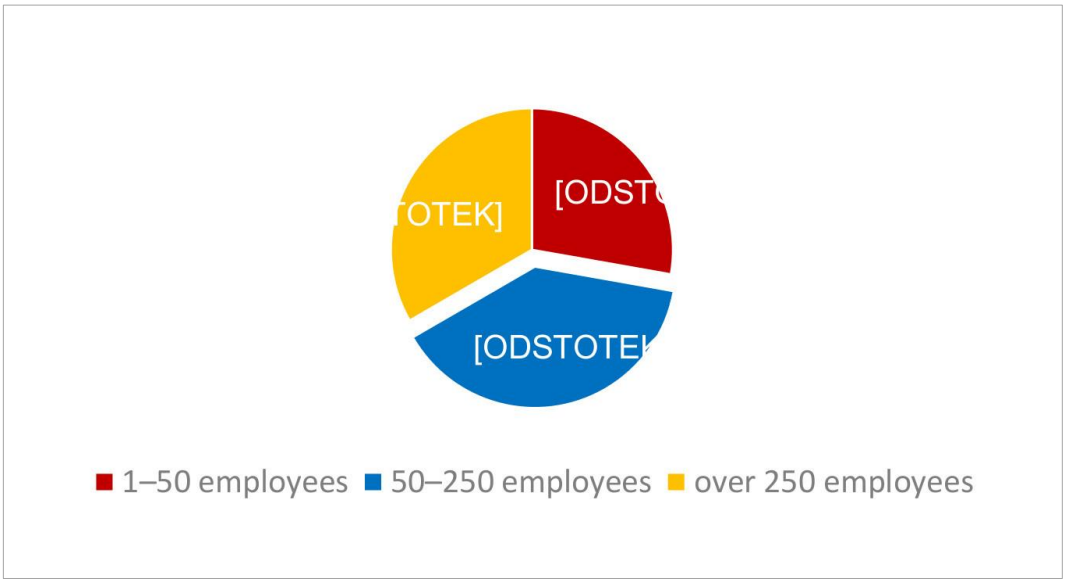
Nearly 40% of the Slovenian companies that participated in the survey come from the NACE sector C25 – Fabricated metal products. 22.2% of the respondent companies are active in the sector C27 – Manufacture of electrical equipment and a further 22.2% in the sector C28 – Machinery and equipment. The remaining companies come from the field of C29 – Manufacture of motor vehicles, trailers and semitrailers (5.6%), C33 – Repair and installation of machinery and equipment (5.6%), C24 – Manufacture of basic metals (3.7%) and

C26 – Manufacture of computer, electronic and optical products (3.7%). 13% of the respondent companies are active in the field outside of the C24 through C33 sectors.

The majority of the participating companies either **produce finished products to the market** (38.9%), supply components (37%), and/or produce finished products for industrial customers (31.5%). The remaining responses represented less than 20% of all received survey answers.

In terms of **company size**, the respondents are **distributed quite evenly among micro and small companies, medium-sized companies, and large companies**, as can be seen from Figure 1. Most respondent companies are medium-sized, with the number of employees between 50 and 250 (38.9%). On average, companies employ **28 graduates in tertiary education**.

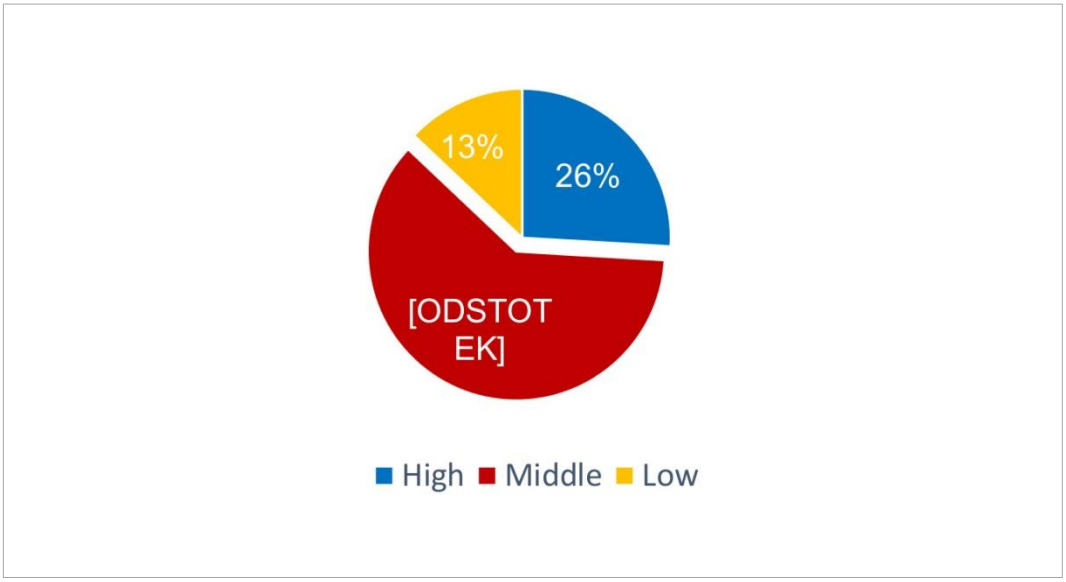
Figure 1 – Company size



- **Digitalisation level of companies**

According to the companies' self-assessment, **61.1% of them consider their digitalisation level to be medium**. High level of digitalisation has been noted in a quarter of the surveyed companies, whereas the remaining 13% stated the digitalisation level of their company is low, as seen in Figure 2. It is important to stress that no definition was provided as to what constitutes a low, medium, or highly digitalised company; therefore, the assessment is based purely on self-evaluation of the surveyed companies.

Figure 2 – Level of digitalisation

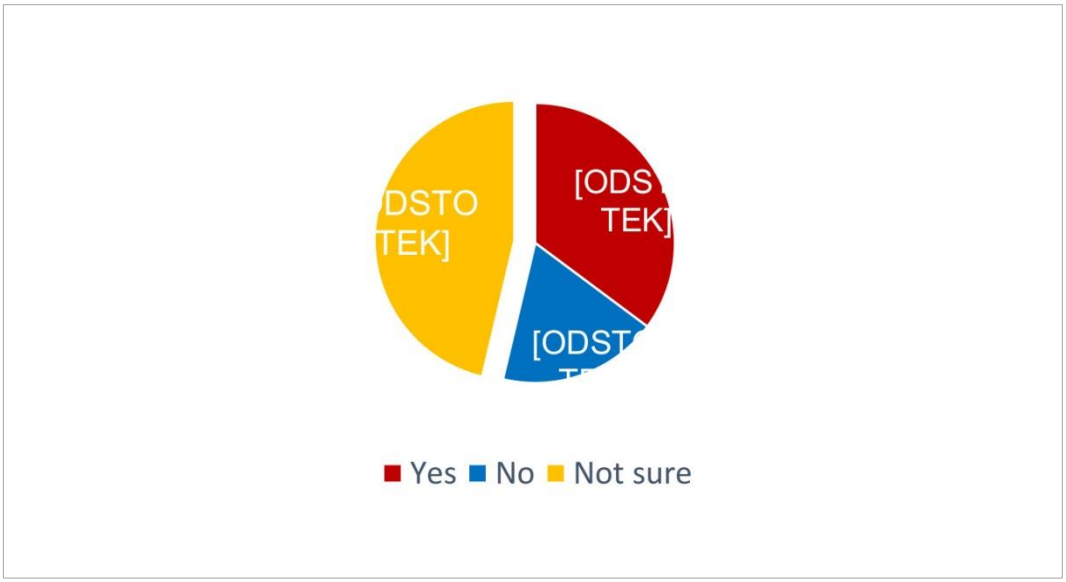


- **Collaboration relationships with Universities or Research Centres**

Almost half of the companies (46%) do not yet know or are not aware if they will be participating in public funding projects on Industry 4.0 for research and development, contrary to 35% who do intent to take part in such projects (Figure 3). Just under a fifth (19%) of the companies indicated that they will not participate in such public funding projects. **A decisive majority of two thirds**

(67%) of respondent companies foster collaboration relationships with Universities and Research Centres.

Figure 3 – Planned participation in public funding projects on Industry 4.0 for research and development



Technological innovations

In the second part, companies were surveyed on the 10 technological innovations pertaining to Industry 4.0, detected by the *INDUSTRY 4EU* project literature review. More specifically, the questions related to the companies' knowledge on innovations and their usage, their investment in these technologies, and the companies' benefits deriving from the use of the presented technological innovations. These technologies are **Mechatronics, Robotics, IoT, Big Data/Data mining, Cloud computing, Cyber-security, Additive Manufacturing, Systems of virtual simulation, Nanotechnologies,** and **Smart Materials**.

- **Knowledge about technological innovations**

The answers showed that companies are acquainted with all presented technological innovations. They are **most familiar with mechatronics, robotics, and cloud computing** (94.4%), followed by the IoT (87%), cyber-security (74.1%), virtual simulation systems (64.8%) and data mining (63%). Responses showed that companies are the least familiar with nanotechnologies and additive manufacturing (55.6% positive answers).

- **Usage of different technological innovations**

In the next step, respondents were asked to specify where the presented technological innovations are used in their company.

In 60.4% of cases, companies use **Mechatronics** for production purposes and 32.1% for the development of products. **Robotics** is used mostly in production (66%), but 22% of companies answered that they do not use this kind of technological output.

Regarding the **IoT**, almost half of the respondents (45.1%) replied that they are not using this type of innovation, however the other half uses IoT mostly for production (19.6%), development (13.7%), and commercialisation of products (15.7%).

Most of the surveyed companies stated that **Data mining** is quite unusable for them (63.3%), as only 20.4% of companies use this kind of output in production and 10.2% in the development of products. The rest is used for commercialisation purposes (6.1%).

Companies are also not inclined towards **cloud computing**, as almost half of the surveyed companies (43.1%) stated that they do not use it. Companies that do use

it use it mostly for development (19.6%), production (15.7%), and commercialisation (15.7%). **Cyber-security** is not in use in 44.7% of surveyed companies. This innovation is mostly used for production (31.9%) and product development (19.1%).

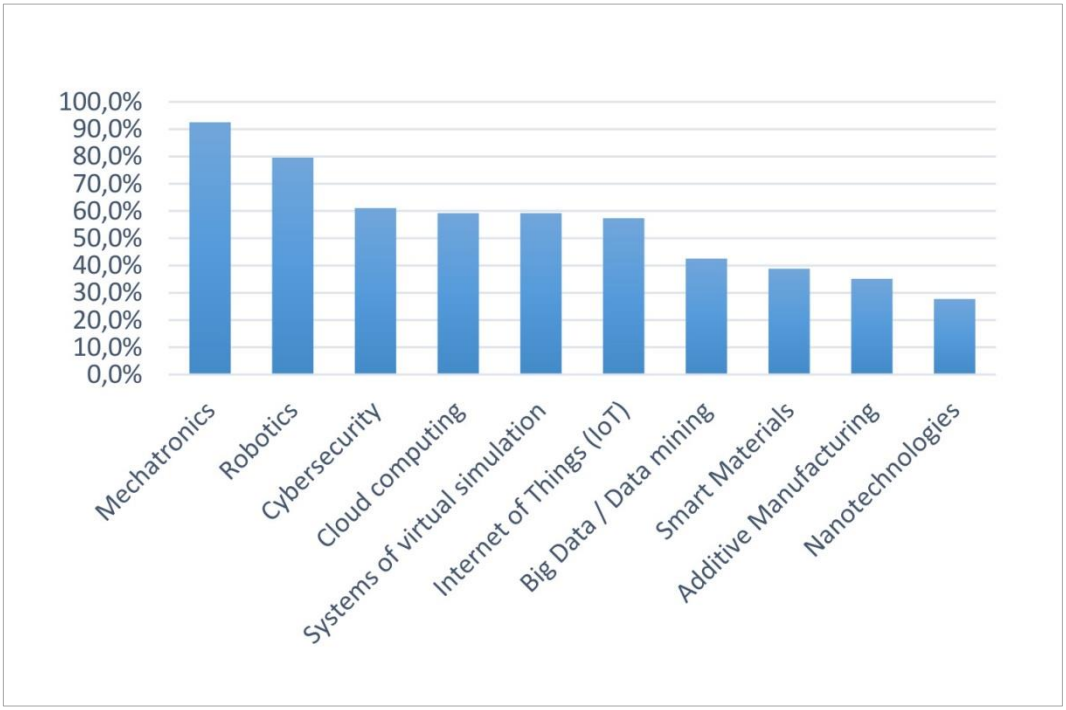
Additive manufacturing is not used in the majority of the surveyed companies (71.4%). As seen in previous answers, this innovation is mostly used for production (14.3%) and development of the products (10.2%). **Virtual simulation system** is used mostly for product development (47.1%), whereas the other half of the companies responded that they do not use this innovation either in production, development, commercialisation, or service.

Moreover, as much as 79.6% of surveyed companies answered that they do not use **nanotechnologies**. Only 12.2% of companies have this type of technology in their production development.

Smart materials are little used in production (16.3%) and in product development (16.3%), 67.3% of companies replied that they do not use this kind of innovation in their production.

To sum up, the survey showed that the **least used technologies** are **nanotechnologies** (the share of companies that do not use them is 79.6%), followed by **additive manufacturing** (71.4%), **smart materials** (67.3%) and **data mining** (63.6%), which is in line with the companies' feedback on the knowledge on technological innovations, whereas the **most used technology** are **mechatronics** (used by 93% of companies) and **robotics** (used by 80% of companies). Interestingly enough, although 94.4% of the companies are familiar with the technology of **cloud computing**, only 59% actually make use of it.

Figure 4 – Use of technological innovations in companies



- **Planning and investing in the following technologies**

Companies were asked whether they plan to invest in any of the technologies either short-term (within the next year), medium-term (1 to 5 years), long-term (in more than 5 years), or do not plan to make any investments in the indicated technologies at all.

Over 80% of the companies stated that they are planning to invest in the development of **mechatronics** in their companies. The majority will do so **within the next year** (48.1%), and a further 35.2% will invest in this technology in the medium term of 1-5 years.

Companies displayed similar plans in the field of **robotics**. Only 11% of companies do not plan to make any investments in this field, whereas the majority

plan to do so either **short-term** (53.7%) or, to a lesser degree, medium-term (29.6%), making this the most desirable technology for companies.

Regarding **IoT**, a third of the surveyed companies (33.3%) are not planning to invest in this technology, but the remaining companies are planning to invest in it in the near future, either in the **short term of 1 year** (38.9%) or in the medium-term period of 1 to 5 years (24.1%).

57.4% of the companies are not planning to invest in **data mining** technology. Of the remaining companies, 31.5% are planning to do so in the 1-year period. However, 63% of companies are planning to invest in **cloud computing**, be it short-term (38.9%), medium-term (20.4%) or long-term (3.7%).

40.7% of companies do not plan to make any investments in the field of **cyber-security**. However, 38.9% of the respondents are planning to invest in it in the period of **less than 1 year**. 16.7% of the companies replied that this type of technology is interesting to them, but they are planning these investments to be made in the period of 1-5 years.

Exactly half of the surveyed companies are planning to invest in **additive manufacturing**, mostly in the following year or in the medium term of 1-5 years (jointly 38.9%). The same share of companies plan to invest in **smart materials**, mostly also in the medium term (31.5%).

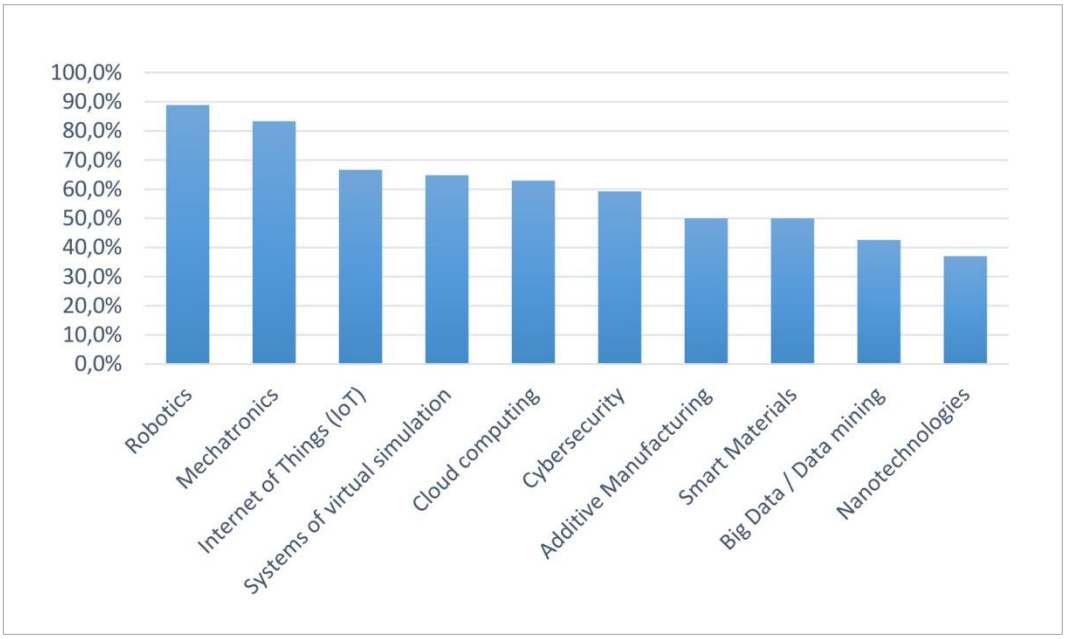
Investment into **virtual simulation systems** is not interesting for 35.2% of the companies, however 40.7% of the surveyed companies are planning such investments in the **1-year period**, and a further 20.4% of the companies are planning to invest in virtual simulation systems in the period of 1-5 years.

Out of all the indicated technologies, **nanotechnologies** seem to be the least interesting for companies as 63% of them will not invest in these technologies

either short, medium or long term. Most of the companies that do intend to invest in nanotechnologies plan to do so in the period of 1-5 years (20.4%).

In short, the survey showed that the technologies which are the most attractive to companies in terms of investment are robotics, with a total of 89% of companies stating that they are planning to invest in this field in the future, followed by mechatronics (83.3%), the IoT (66.7%), systems of virtual simulation (64.8%) and cloud computing (63%), whereas the technologies that companies mostly do not plan to implement into their production systems are nanotechnologies (37%) and data mining (42.6%). Additive manufacturing and smart materials will be implemented in exactly half of the surveyed companies, as seen in Figure 5.

Figure 5 – Share of companies planning investments in technological innovations



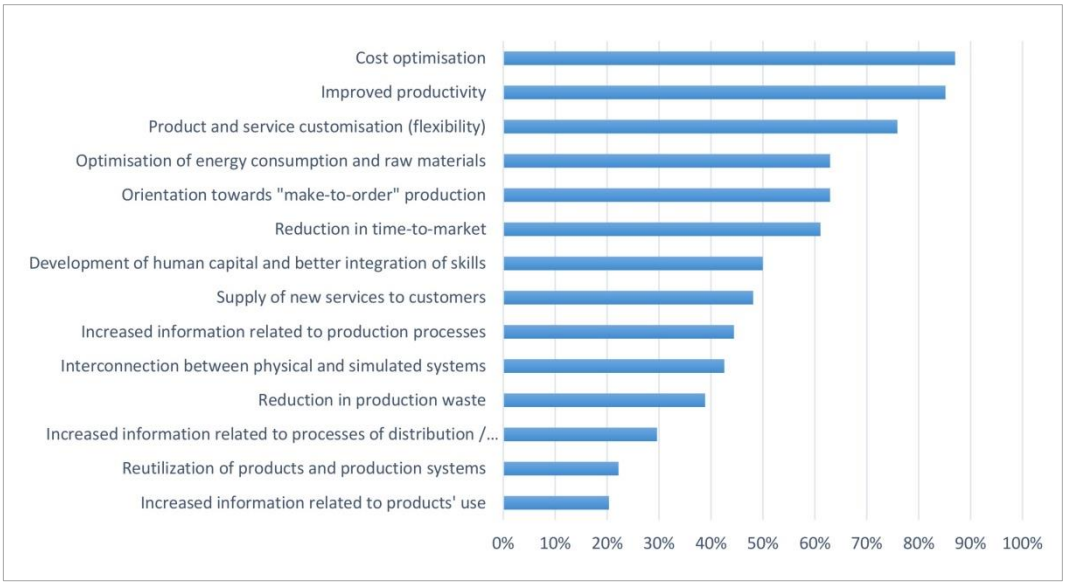
- **The advantages companies benefit from by using technological innovations**

The advantages from which companies mostly benefit due to the use of technological innovations outlined above are, in a decreasing order:

– cost optimisation (87%);
– improved productivity (85.2%);
– product and service customisation (flexibility) (75.9%);
– optimisation of energy consumption and raw materials (63%);
– orientation towards ‘make-to-order’ production (63%);
– reduction in time to market (61%).

Increased information related to products’ use and reutilization of products and production systems are kind of disadvantages of using upper technological innovations, seeing as in these fields, the benefit for the companies is quite low, as seen in Figure 6.

Figure 6 – Benefits for companies stemming from the use of technological innovations



Half of the companies answered that a positive aspect of the use of technological innovations is the development of human capital and a better integration of skills. 49% also see another benefit in the supply of new services to customers.

Skills and competences

An important part of the survey was the section aimed at investigating skills and competences in relation to technological innovations. The survey showed that on average, companies spend app. **24 working hours pro capita annually on skills development through training**. The question that was raised referred to how much have soft skills changed after the introduction of technological innovations in the surveyed companies, evaluating the changes on the scale of 0 (no change), 1 (modest change), 2 (some change), 3 (noticeable change) to 4 (significant change).

- **Soft skill changes after introduction of technological innovations in surveyed companies**

In over 75% of the companies, the introduction of technological innovations caused some to significant change in the **interdisciplinary approach**. Over 60% of the companies have faced some notable changes in the **team building approach** and in over 75% of the companies, the introduction of technological innovations caused some notable changes in the **leadership approach**.

In most of the companies (76%), the introduction of technological innovations caused some to significant change regarding **autonomy, accountability, flexibility and proactivity** among workers, and 74% of the companies registered a change towards **fast and focused decision-making and problem-solving**.

On the other hand, nearly half of the companies noticed that the introduction of technological innovations did not have any significant effect on **interpersonal relationships and empathy**. Only 27.8% of the companies noted a significant change in this respect. Half of the companies also noted that with the introduction of these innovations, **emotional intelligence** did not change considerably, with only 14.8% of companies marking a noticeable or significant change.

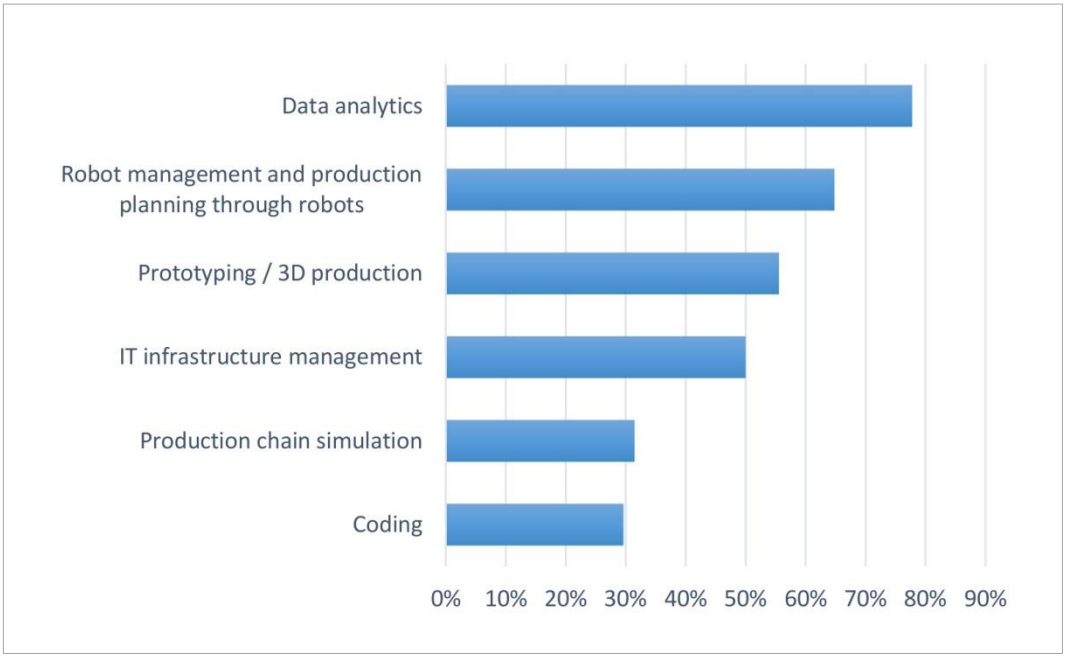
On the other hand, in most of the companies (51.9%) **team working** did change noticeably or significantly, perhaps due to the interconnected nature of technological innovations. Nearly 40% of the companies also noticed that **visual communication** improved noticeably to significantly after the introduction of technological innovations, which especially also holds true for **digital communication** (55%).

Overall, the most significant change in soft skills among employees was noticed in the field of digital communication and team working, whereas the least change was marked in the field of interpersonal relationships/empathy and intrapersonal relationships/emotional intelligence.

- **Advanced skills applicable within the company**

As presented in Figure 7 below, 78% of companies have staff skilled in **data analytics** and 65% skilled employees in **robot management**. 56% of the companies stated that the employ staff who are skilled in prototyping and 3D production, 50% in IT infrastructure management and only 31% in coding and 30% in production chain simulation.

Figure 7 – Level of skills in companies



- **'Data analytics' skills usage in companies**

'Data analytics' skills in surveyed companies are mostly used for **decision making** (82.2%), **reporting systems** (82.2%), and **quality control** (80%). They are less applicable for predictive maintenance (37.8%) and the distribution chain smart management (22.2%).

- **Use of 'IT infrastructure management' skills**

IT infrastructure management skills in the surveyed companies are mostly being used for the purposes of IT security management (93.5%). They are also used extensively in cloud, sensors and server management (77.4%) as well as for prevention (71%) and the solution of anomalies (64.5%).

Job organisation

The next set of questions referred to the field of **job organisation in companies**. It opened a question on how much has the introduction of technological innovations in companies influenced the job organisation, evaluating the changes on the scale of 0 (no change), 1 (modest change), 2 (some change), 3 (noticeable change) to 4 (significant change).

Results show that the introduction of the presented technological innovations in the surveyed companies had a notable influence on job organisation in the field of **smart working**. 27.8% of the companies noticed some change, whereas 50% of the companies answered that innovations caused noticeable to significant change.

The introduction of technological innovations in surveyed companies also exerted quite a big influence on job organisation in the field of **knowledge sharing**. More than 90% of the surveyed companies answered that innovations led to changes regarding knowledge sharing: 9.3% of the companies noticed modest change, 33.3% some change, 40.7% noticeable change, and 9.3% significant change.

Industry 4.0 expectations

The penultimate set of questions was aimed at assessing the **companies' expectations** in the field of Industry 4.0 for the future. The companies were presented with various statements and asked to indicate their level of agreement with them on a scale of 0 (total disagreement), 1 (agreement), 2 (neutral), 3 (agreement) to 4 (total agreement).

Over 42.6% of the companies (totally) agree that **Industry 4.0 can be implemented gradually with contained investments**, even without radical changes in the basic technology normally used. The majority of companies (81.5%) do not share the opinion that **Industry 4.0 is unsuitable for SMEs**.

27.8% of the companies (totally) agreed and at the same time 24.1% of the companies (totally) disagreed that Industry 4.0 **requires important investments**. The rest (48.1%) were indecisive regarding this point.

Only 18.5% of the surveyed companies share the fear that Ind**ustry 4.0 will allow big companies to be more agile and therefore 'threaten' SMEs**, whereas more than half of the surveyed companies (51.9%) (totally) disagree and are of the opinion that big companies do not have such an advantage over SMEs due to Industry 4.0.

Similarly, only 14% of the companies see Industry 4.0 as an advantage for SMEs, agreeing with the statement that **Industry 4.0 will allows SMEs to be more efficient and competitive in the market, thus 'threatening' big companies**. 55.6% of the companies on the other hand (totally) disagree with the statement. This goes to show that companies do not think the size of a company is a major factor in determining the benefits of Industry 4.0 for the companies' competitiveness and successfulness.

Most of the companies (70.4%) however either agree or completely agree that **Industry 4.0 enables product customisation which can amplify competitive strength** and do not deem Industry 4.0 to be a passing trend (64.8%).

The question on whether **Industry 4.0 requires skills that the companies do not possess** showed interesting results: a third of the companies (33.3%) (strongly) agreed with this statement, a third disagreed, whereas a third could not decide on this question at this point. This means that two thirds of the companies do not yet feel fully prepared for the challenges of Industry 4.0 in terms of knowledge and would need extra training or additional qualified staff to successfully implement the Industry 4.0 technologies.

Finally, companies were asked whether they agree with the statement that **companies which will fail to grasp the opportunities offered by these innovations are likely to be excluded from the market**. The answers were mostly positive, with 31.5% of the companies agreeing and 24.1% completely agreeing with the statement, whereas 22.2% remain unsure and a further 19.2% of the companies not seeing Industry 4.0 technologies as a crucial part of their success in the future.

Corporate culture

In this segment, evaluations of the actions that companies must take in order to put into practice and facilitate the change towards Industry 4.0 were addressed. The companies were presented with actions and asked to indicate the level of their relevance on a scale of 0 (not relevant), 1 (marginally relevant), 2 (somewhat relevant), 3 (relevant) to 4 (highly relevant).

87.1% of the companies find it somewhat to highly relevant to **start to create synergies throughout the value chain, both horizontally and vertically, optimising the relationships with territorial networks**.

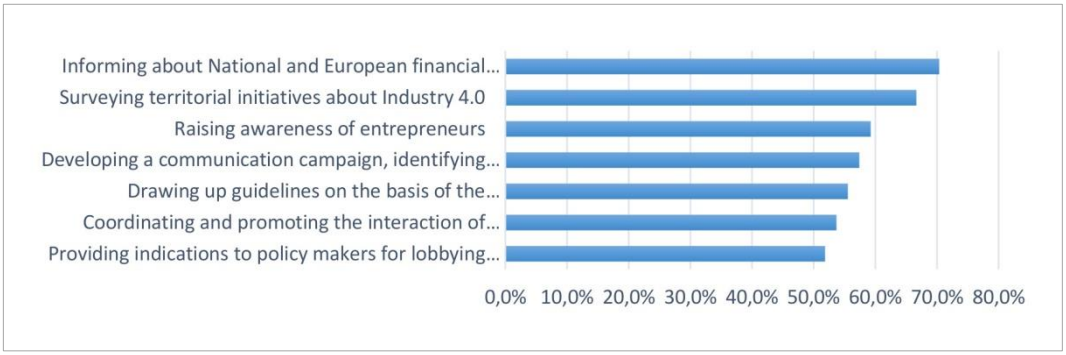
As much as 94.4% of the surveyed companies also somewhat to highly agree that **staff lifelong learning** is an important measure for the successful implementation of Industry 4.0 technologies.

77.8% of the companies think somewhat to strongly that they a **reorganization of its structure** will be necessary in order to ease the development of innovation, whereas 22.2% of the companies do not find this measure relevant. Similarly, the same share of companies are in favour of **facilitating a transition to the managerial culture**.

Further actions which should be developed by CCIS-MPIA

As we can see in Figure 8, companies' replies on the desired assistance and support by CCIS are quite evenly distributed among the available options. All actions are deemed quite important, but in their opinion, the most important action that CCIS should develop is **informing companies about national and European financial instruments on presented topic** (70.4%). Surveying territorial initiatives about Industry 4.0 is the second matter of importance (66.7%). Other actions such as raising awareness of entrepreneurs (59.3%), developing a communication campaign, identifying and disseminating best practices (57.4%), drawing up guidelines on the basis of the introduction of new technologies, skills and organizational models (55.6%), coordinating and promoting the interaction of companies with technology clusters, research centres and institutions (53.7%), and providing indications to policy makers for lobbying on the topic (51.9%) are also fairly equally important to companies.

Figure 8 – Desired CCIS support actions



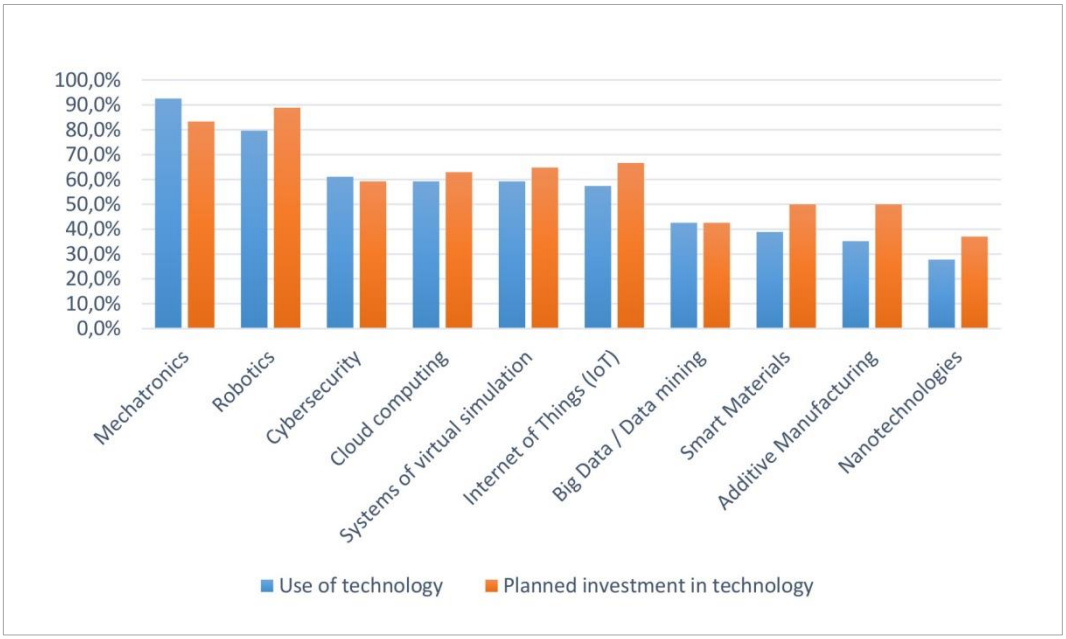
5.2. Remarks emerged by the analysis

It can be said that 54 responses on the survey is a great feedback and is also a clear indication that Industry 4.0 is currently a hot topic in the Slovenian industry. The business activities, company size and type of company are represented in the

same proportions as can be seen on the national level; hence, this survey was able to get the real standpoint of industry.

It is clear that CEOs of Slovenian companies know technology innovations like IoT, Cloud computing, Cyber-security and are in general also knowledgeable about the application usage of these technologies in their companies. However, for a CEO knowing about a technology is not the same as embracing and/or investing in it. The analysis seems to show that companies only intend to invest in those technologies that they are already using, such as mechatronics and robotics, but not to the same extent in the technologies that are in general not in use, such as additive manufacturing or nanotechnologies, as seen in Figure 9.

Figure 9 – Comparison between the use of technologies in companies and planned investments by companies



It could be said that the digital transformation of Slovenian industry is still at the starting point with first adopters trying to integrate new technologies while the **majority of companies are still only observing** the innovation activities within their particular domain.

The advantages and benefits of technological innovation recognized by Slovenian industry indicate that **the main focus is not towards acquisition and/or development of Key Enabling Technologies (KETs) but more towards upgrading and enhancing already established role in the global value chains**. Flexibility, 'make-to-order', shorter time to market and energy and resource optimization emerged as top issues that are and should be addressed first within the digitization process.

Investing in these technologies is also not the norm in Slovenian companies. Technology solutions for production, maintenance, testing or R&D are more common business terms and they **usually combine several technologies from Industry 4.0 list at different levels and at different investment cycles**.

The downside of the survey seems to be that for an average CEO, this survey was too long and too technical. A number of CEOs quit before the end of the survey because they were asked to provide estimates on usage and future planes for particular technologies, **numbers that are not immediately available to an average CEO**. However, the results show that companies are aware of the changes in the production system that are and will be brought on by Industry 4.0 and serve as a good platform on which to build further support actions for the facilitation of innovative technologies implementation.

6.
Problems emerged within the mapping exercise

The mapping exercise of Industry 4.0 initiatives in Slovenia has proved that **Smart specialization process** could be the right framework for the formulation of initiatives during the entrepreneurial discovery and for helping them to produce market relevant results.

Eight promising initiatives were established during this process. Most of them were able to **group balanced triple helix stakeholders around fairly narrowed market niche** with the focus on applicability of key enabling technologies rather that developing them from scratch.

Ideally, these initiatives would now be picked up by national competence centres, business clusters, demo factories and industrial associations to quickly and effectively evaluate state-of-the-art technologies, develop business ready project proposals, establish value chain partnership and win the politicians support.

Such business support environment is unfortunately not available and is **the first challenge** the needs to be addressed in the near future. The **second challenge** is **the willingness and readiness to experiment** and to learn by doing. Otherwise, the Slovenian industry could miss the digital transformation wave and end up on the sideway.

7.
Perspectives of analysis

Results of the European *INDUSTRY 4EU* project survey, interviews, round tables, and individual meeting findings are in line with our knowledge about opportunities and challenges of Industry 4.0 technologies, gained from daily communication with Slovenian metal processing and electro companies and discussions within the CCIS-MPIA board of directors. They will certainly lead to further discussions on company, national and regional levels between key actors – stakeholders as they are defined in Chapter 3, *Stakeholder's involvement*.

Upcoming changes and technological developments will deeply affect labour market and ways of conducting business. Disruptive manufacturing and dispersed manufacturing sites will demand different business approaches. New value chains will be formed across sectors and as a result, new business models will have to accommodate ways of doing business globally.

Companies majorly perceive Industry 4.0 to be an evolution instead of a revolution, so that its features can be implemented gradually. Major challenges are perceived to be in the fields of adequate competencies. For them to be implemented in the work process in time, the life-long learning principles should be incorporated firmly into the culture of the organisations, educational bodies should reinvestigate their organisational schemes and should find new innovative ways and models of transmission of knowledge as soon as possible. It appears to be imperative to increase the collaboration between educators and companies, enhancing teacher experiences of the workplace training.

The CCIS-Metal Processing Industry Association has been deeply involved into finding solutions to challenges of Industry 4.0. Currently, we are coordinating the

EU project *SkillME*, which tackles the most endemic skill gaps in the metal processing industry. We identified the four major skill gaps for which we already developed curricula following the EQAVET and ECVET requirements, three of which are directly connected to Industry 4.0, which confirms the thesis that the challenges of Industry 4.0 have been very important for some time now.

MPIA is also very concerned about the demographic changes occurring in EU and especially in our country, where the retirement age is increasing rapidly. An especially vulnerable group are older, low-skilled workers, who have not been involved in any up-skilling/educational process and have been working in the same workplace for decades. Their workplaces are in jeopardy because of the technological development of production processes or because of legislative limitations to their work (night work, physical strains, etc.). On top of all, we have identified surprisingly strong aversion towards 'going back to school'. The results that have been reached with the *INDUSTRY 4EU* mapping exercise will only enhance our understanding of the state of Industry 4.0 implementation in Slovenian metal processing companies and serve as a strong platform in further orientation of the CCIS actions to facilitate companies' needs and expectations.

8.
Final conclusions and remarks

The findings of the report are fully in line with **CEEMET's findings on digitalisation**[29], which state that digitalisation is sweeping both industry and society with full impact. The atomization and robotisation we have seen in the past has sped up. Digitalisation has a continuous and unprecedented impact on how companies operate. It influences all aspects from development to production and logistics and is challenging business models and changing the work place and the way we carry out work. That is why a well-developed infrastructure and skilled workforce are pivotal factors in successfully transforming industry. Expectations are high, but only through a truly digital Europe – and a digital single market – will industry be able to reach the set goal of contributing 20% of EU GDP by 2020, whereby Slovenia has already reached this goal as its industrial contribution to GDP represents 23%.

From the employer perspective, qualification is a key Industry 4.0 challenge and one that needs decisive action. The skills challenge in the manufacturing sector is becoming more pronounced as industry becomes more digitalised. Manufacturers' plans to drive productivity improvements and to capitalize on the digital industrial revolution could be derailed because many countries across Europe are struggling to provide the right quantity and quality of skills to meet the sector's needs.

The digitalisation of products and of processes, as well as the digitalisation of work organisation, is leading to changes in the demands in MET industries workforce skills and competences. The skill sets required in both old and new occupations in the MET industries are changing. For some jobs and occupations

[29] See CEEMET, *Digitalisation and the World of Work*, 2016.

this transformation will be rather slow while for others change comes more rapidly. There is already today on the labour market a high demand and need for people with IT competence.

Engineers and programmers are lacking, but other occupations will also require increased digital literacy – and being a digital native will not be enough. IT skills are becoming more relevant at all levels, but other skill demands also emerge. For instance, there is a pronounced need for digital leadership with an understanding of how to create business models and business processes for the digital world.

Digitalisation and the demands it places on education and training in particular cannot be seen in isolation from other, broader societal developments. The demographic development in Europe is a major factor in terms of skills and competence in the MET industries, as the average age of the MET workforce is higher than in many other sectors. Together, these factors intensify each other. Therefore, developing the right pipeline of talent for the future will be crucial. Businesses must work closely together with governments and other stakeholders to map a future view of skill demand versus supply and together consider what a curriculum for the future might look like.

Trying to determine how skills and competence profiles will change for certain occupations in the MET industries is important, but it is perhaps more pressing to ask how we can deliver training that will meet the rapidly emerging demands, both in the existing workforce as well as in the education and training systems as a whole. As it stands, the educational systems around Europe are not fully prepared to meet the demands of new skills and emerging jobs. The lack of sufficient skills and competences as well as sufficient resources for technological equipment and updating or up-skilling teacher qualifications at educational institutions are major challenges that urgently need to be addressed through reform.

Manufacturers will also need to increase investment in training existing employees – in line with company needs – to keep up with new processes. A major challenge is to increase the digital skills of current workers, and in particular older ones, which means creating an offer of training on digital skills. That reflects the needs of the company.

The trend to acquire future skills through work-based learning will continue, with a focus on ensuring that training provision meets the changing demands of manufacturing in the future. Work-based learning is a central part of excellent vocational education and training (VET) that benefits both companies and students. It is also an effective way of getting digital skills into the workforce, not least by creating bridges in companies between young learners with a high degree of digital literacy and their senior colleagues and instructors. Work-based learning and ongoing qualification of employees in many countries has kept pace with all the technical developments in recent decades. What is different today for training in the workplace is the speed of technological development. Speed is one of the central drivers of change in digitalisation and one of the main factors that sets it apart from previous technological development, automation and robotisation. It will also be a crucial success factor in reforming education and training in Europe – speed in investment and speed in creating training for the new jobs.