



Industry 4.0 for the future
of **manufacturing** in the EU

COMPARATIVE REPORT



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INDEX

1. Introduction: background information and methodology.....	1
2. The nature and network of INDUSTRY 4EU employers' associations in Germany, Italy and Slovenia	7
3. Governmental strategies to boost Industry 4.0	12
4. Activities performed by employers' associations in Germany, Italy and Slovenia in the light of Industry 4.0	18
4.1. A focus on skills.....	21
5. The awareness of Industry 4.0 and its features.....	30
5.1. Benefits and expectations from Industry 4.0 adoption.....	35
5.2. Skills, training and work organization for Industry 4.0	36
6. Position of the stakeholders about Industry 4.0 and world of work	40
6.1. Impact of Industry 4.0 on employment and work organization	42
6.2. Consequences on Industrial relations	43
6.3. Challenges for skills and training.....	45
6.4. Barriers for the development and role of social partners	47
Annex I. Survey draft for interviews with stakeholders	49

1.

Introduction:

background information and methodology

EU manufacturing output stands for 15% of the overall member states' GDP and EU (*Europe 2020. A European strategy for smart, sustainable and inclusive growth*, 2010) 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 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 labor market, including a loss of low and middle qualified jobs and a lack of high-skilled workers (Brynjolfsson, McAfee, 2014). 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 labor 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 more all the actors need to be involved in it (Seghezzi, Tiraboschi,

2017). 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 (*Europe 2020. A European strategy for smart, sustainable and inclusive growth*, 2010). 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 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 its 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 analyze and compare 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.

These 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 conducted 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 consider 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 valorize school-to-work transition in a 4.0 context.

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 climate 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. 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 (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

COMPARATIVE REPORT

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 involved 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* ⁽¹⁾ 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) ⁽²⁾ and officially presented in April 2013. Nordbildung defines it as «probably the most complete institutional

⁽¹⁾ http://www.acatech.de/fileadmin/user_upload/Baumstruktur_nach_Website/Acatech/root/de/Material_fuer_Sonderseiten/Industrie_4.0/Final_report__Industrie_4.0_accessible.pdf.

⁽²⁾ 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.

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 throughout Germany. As expressed by Nordbildung, besides launching the so-called *Industrie 4.0 Platform* ⁽³⁾, 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 ⁽⁴⁾ 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 Affairs started tackling the work-related implications of Industry 4.0 in a document entitled the *Green Paper – Work 4.0*

⁽³⁾ For further information please see www.plattform-i40.de/.

⁽⁴⁾ 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: i) to further explore and exploit the innovative capacity of Germany in order to enable further growth and employment; ii) 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; iii) to improve the security and safety of IT systems and services in order to increase trust among the public and the business sector.

(⁵) 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”).

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* (⁶), 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 Centers*, 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

(⁵) For further information please see <http://www.bmas.de/SharedDocs/Downloads/DE/PDF-Publikationen/arbeiten-4-0-green-paper.pdf>.

(⁶) For the complete document please see http://www.sviluppoeconomico.gov.it/images/stories/documenti/2017_01_16-Industria_40_English.pdf.

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; evolutive 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* ⁽⁷⁾. 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

⁽⁷⁾ For the complete document please see https://www.researchitaly.it/uploads/15147/ERA_Roadmap_Italiana_en.pdf?v=6a5f5bc.

assurance, regulation and data processing, intralogistics, 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, the Italian Federation of Metalworking Industries (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 centers 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 three-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 “Industry 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 foresees 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 be considered as another example of partnership between educational and productive systems. In Italy the Law 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 Confindustria 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.

COMPARATIVE REPORT

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 “*Industry4EU – 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: i) Mechatronics; ii) Robotics; iii) Internet of Things (IoT); iv) Big Data/Data Mining; v) Cloud Computing; vi) Cybersecurity; vii) Additive Manufacturing; viii) System of Virtual Simulation; ix)

Nanotechnologies; x) Smart materials. Each surveyed company has answered to a questionnaire divided into six parts: i) Company features; ii) Technological innovations; iii) skills and competences; iv) Job organization; v) Attitude towards Industry 4.0; vi) 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

Number of companies of the survey:

Italy: 527

Germany: 54

Slovenia: 54

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.

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.

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

Most known technologies:

Mechatronics

Robotics

Least known technologies:

Nanotechnologies

Big Data

Smart materials

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, Internet of Things, 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, Internet of Things 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 Internet of Things. 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 Internet of Things 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: i) Mechatronics; ii) Cyber-security; iii) cloud computing; iv) 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.

Italian and Slovenian companies also underlined that a

The main benefits attended by companies:

- Improve productivity
- Increase flexibility in product and services customization
- Optimise costs

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,

Greatest change in soft skills in companies:
 Digital communication
 Team working
 Problem solving
 Autonomy
 Accountability
 Flexibility
 Proactivity

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 rappsorts between the workers, but these affect the way which they approach the work itself.

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

Greatest change in technical skills in companies:
 Data analytics
 Managing IT infrastructures
 Programming and coding
 Robot management
 Prototyping and 3D production

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.

Data analytics skills are used primarily in reporting systems, decision making activities and (especially for the Slovenian companies) quality control, while IT infrastructure management skills were most used in relation to 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 it is underlined that these technologies have a big impact 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 "Industry4EU" 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 Industry4.0., 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 1). 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 Internet of Things (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 thanks 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 it 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, it 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,

according to.... 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 made, 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 I.

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 labor 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 labor law?
- 7) What are the roles and responsibilities for sustainable development of Industry 4.0?**