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WP T2

ECOSYSTEM INDUSTRY 4.0 IN CENTRAL EUROPE

Output T2.1

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Content

Preface suggestions

ECOS4IN Project wants to connect the partners from CE countries that have more specific idea about expected impacts of Industry 4.0 implementation on the region and wants to involve the entities from other regions dealing with similar problems. There is a strong common intention of partners to find new creative ways how to use the opportunities of Industry 4.0 and other technologies called “advanced manufacturing systems” while eliminating the risks. Different European Community and OECD Study shows the most of countries of CE needs or needs to improve the innovation ecosystem and platforms for stakeholders to become involved into Industry 4.0.

The project consortia design the ecosystem model for I4.0 implementation according to the regional conditions and context and equip the participating regions with action plans that will provide relevant material for forthcoming revisions of RIS3 strategies.

1. Part I, Industry 4.0 Knowledge Ecosystems, assumptions

1.1. What is a knowledge ecosystem?

The 4th industrial revolution is inevitable and will affect all industrial sectors. The impacts of the Industry 4.0 depend on readiness of regions to respond, accept and adopt the changes. Our model supports the sustainable cooperation of actors of innovation systems to strengthen and prepare the regional innovation capacities in CE area for such changes.

The information gained by ECOS4IN analysis was used in the process of describing the Industry 4.0 ecosystem model, which defines the components and links among them. Partners will adjust this general model to the regional conditions and context in next work package, pilot testing.

The idea of a knowledge ecosystem is an approach to knowledge management which claims to foster the dynamic evolution of knowledge interactions between entities to improve decision-making and innovation through improved evolutionary networks of collaboration.

(Shrivastava, 1998)

In contrast to purely directive management efforts that attempt either to manage or direct outcomes, knowledge ecosystems espouse that knowledge strategies should focus more on enabling self-organization in response to changing environments.

(Jae-Suk Yang, Seungbyung Chae, Wooseop Kwak, Sun-Bin Kim, and In-mook Kim 2009)

1) **Core Technologies**: Knowledge ecosystems operate on two types of technological core – one dealing with the content or substantive knowledge of the industry, and the other involving computer hardware and software and telecommunications, that serve as the „procedural technology“ of operations.
2) **Critical Interdependencies**: Organizational knowledge resides in a complex network of individuals, systems and procedures both inside and outside the organization. This network is established in the form of social and technological relationships. The relationships reflect vital interests and mutual histories. The elements of the network are dependent on each other for resources and mutual survival. Accessing and using this knowledge network involves understanding and maintaining the integrity of underlying relationships.
3) **Knowledge Engines and Agents**: This refers to the system of creating knowledge including the research and development processes, experts, operational managers/administrators, software systems, archival knowledge resources and databases.
4) **Performative Actions**: Organizational knowledge is converted into economic value through processes that involve action. These could be cognitive actions such as learning or deciding, or physical actions such as preparing a meal or writing a check, and social actions such as organizing or entertaining. Organizational tasks most often require all these and other types of actions to occur in a linked way for value to be created. They occur in the physical spaces, electronic spaces, economic transactions, and communicative exchanges of knowledge tasks. (Choo, Bontis, 2002)

(Bahrami, Evans, 2005)

1.2. Technological borders/definition of ecosystem

1.2.1. Definition of Industry 4.0

In order to create a common understanding, we would like to use following definitions of Industry 4.0 quoted by UNIVE.

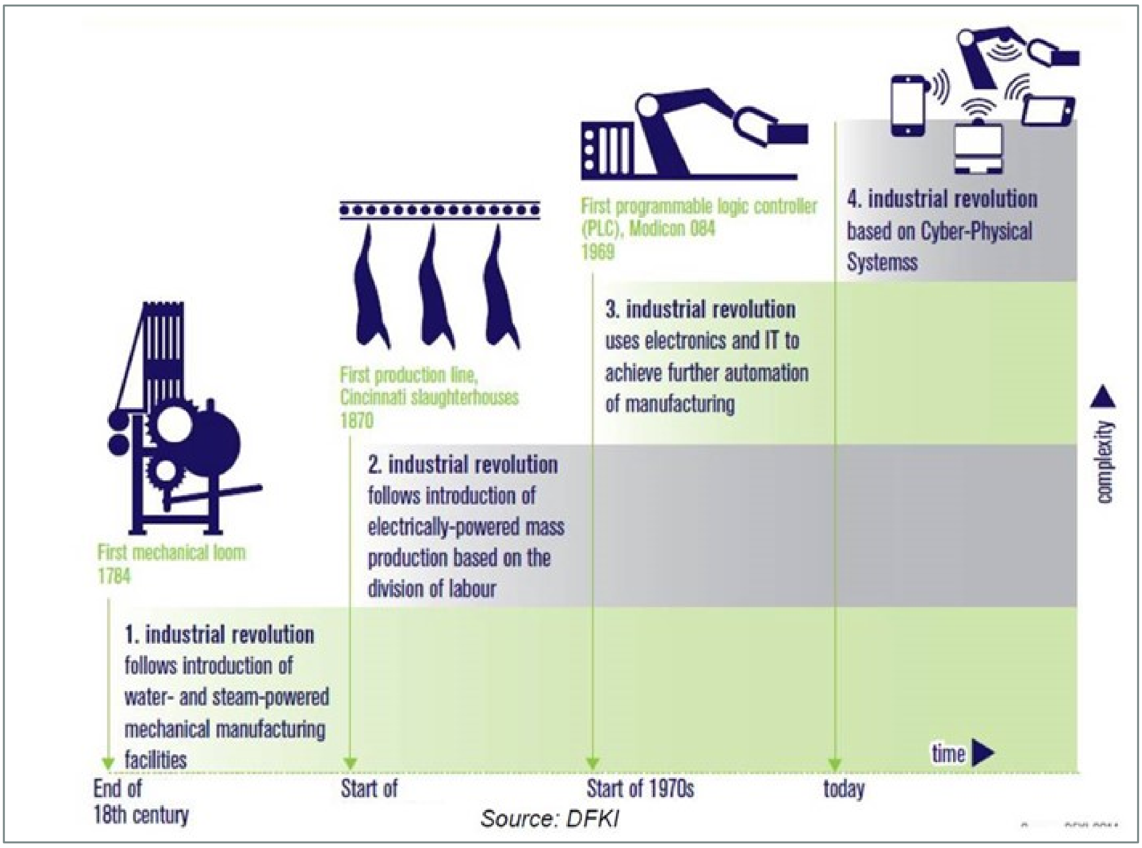
"The integration of information and communication technology into the industrial environment" Schuh et al. (2014)

"The increasing digitization of the entire supply chain, which makes it possible to connect actors, objects and systems based on real-time data exchange" (Dorst et al., 2015; Spath et al., 2013).

Four pillars:

1. **Cyber physical systems** (CPSs) → the "integrations of computation and physical processes. Embedded computers and networks monitor and control the physical processes, usually with feedback loops where physical processes affect computations and vice versa." (Lee, 2008).
2. **Internet of things** (IoTs) → considers "'things' and 'objects', such as RFID, sensors, actuators, mobile phones, which (..) interact with each other and cooperate with their neighboring 'smart' components, to reach common goals" (Giusto et al., 2010)
3. **Smart factories** → combines the notions of IoTs and CPSs and by placing them inside the working space and at the core of operations.
4. **Internet of services** → based on the concept that services are available through the internet so that private users and/or companies can create, combine and offer new kind of value-added services (Hofmann & Rüsch, 2017)

Further we would like to refer to ACATECH-National Academy of Science and Engineering in Germany. Its "Industrie 4.0 Working Group" defined Industry 4.0 in their document "Recommendations for implementing the strategic initiative INDUSTRIE 4.0" as follows.



Source: DFKI

https://www.acatech.de/wp-content/uploads/2018/03/Final_report__Industrie_4.0_accessible-1.pdf

1.2.2. Industry 4.0 "core technology"

According to our understanding the technological definition has to be set on a macro level and then within these boundaries the ecosystem needs to be analysed.

All of our regions have a high rate of producing industry. The technological focus of our ecosystem I4.0 is so to say on "ICT used for intelligent networking of machines and processes in producing industry" and on I4.0 enabling technologies.

Therefore the "core technology" of the ecosystem model for I4.0 implementation is defined by the following key technologies.

The Key Technologies of I4.0 (Alcácer & Cruz-Machado, 2019):

1. The Industrial Internet of Things
2. Cloud Computing
3. Big Data and analytics
4. Simulation
5. Augmented Reality
6. Additive Manufacturing (products and process innovations realized through virtual reality simulations)
7. Horizontal and Vertical Systems Integration
8. Autonomous Robots
9. Cybersecurity

These key technologies are also listed in a definition of the Boston Consulting Group – this fact further strengthens our considerations. https://www.bcg.com/en-gb/capabilities/operations/embracing-industry-4.0-rediscovering-growth.aspx

1.3. Impact to SME

1.3.1. Prediction of main changes for SMES

- From rigid and manual work to agile and automated work.
- From product standardization to personalized and customized products.
- From large centralized companies to small factories and decentralized sites.
- From stock based planning to dynamic and predictive planning.
- From low cost and high efficiency to high return of capital employed (ROCE).
- From low and indirect customers (and end users) relationships to high and direct.

Source : Roland Berger, 2017

1.3.2. Main benefits for SME

A good definition of SME benefits can be derived from one of the objectives of the new Upper Austrian economy and research strategy #upperVISION2030. It says: "Use data to generate knowledge and create value by raising the innovation potential of new technologies in fields of strength with entrepreneurial capacities in the region and transferring new technologies into applications"

Main benefits:

- Increasing of competitiveness
- Creation of new business models
- Improving technological competences
- Efficient production with reduction not only manpower but also energy, raw materials, etc.
- Cost optimization – reduce manpower cost, boost labour productivity
- New opportunities – adapt to changing demographic and customer demand, identify new value generating services
- Greater operational efficiency – improve process visibility and quality of products, reduce variability in operations, allow remote monitoring and maintenance
- External factors – develop competitive pressure on other companies, derive benefits from government incentives

Source : Roland Berger and #upperVISION2030[1]

UNIVE Veneto stressed these points as a main impact on SMEs, at the regional level for SMEs it is required to improve the exploitation of Research and Innovation Infrastructures specially in the field of Key Enabling Technologies. Knowledge-based resources, scientific innovative equipment, e-infrastructures is provided by Research and Innovation sector to facilitate diffusion of technology for new innovation, especially by SMEs.

- Improved flexibility in manufacturing, mass customization, smart products, better quality and enhanced productivity are among the most cited benefits that can be reaped by the new digital industrial revolution that is characterized by the merger of digital and physical workflows.

- The Smart Specialization Strategy (RIS3) of the Veneto region highlight that the Key technologies of I.40 can be particularly beneficial for four main regional specializations: (1) Smart Agrifood; (2) Smart Manufacturing; (3) Creative Industries; (4) Sustainable Living. The clustering of key technologies of I.40 (most possible two groups 'information and communication technologies' and operational technologies) is expected to impact the productivity enhancement. The synergetic cooperation and the interconnection between two groups not only enhance the efficiency, productivity, and quality, but the ability to collect, analyze and share smart data enables the creation of new business models (Stock & Seliger, 2016; Shaba, Guerci, Gilardi, & Bartezzaghi, 2019).

- Considering socio-technical perspective, it is good to look at how to re-design the companies' organization based on the micro (e.g. skills and competencies, autonomy, teamwork, etc.) and macro (coordination mechanism and collaboration, role of management) organization design aspects (Bednar, & Welch, 2019; Ruhi, 2018).

- It is required to take skill development e.g. 'Punti Impresa Digitale by Unioncamere' and workers' training initiative e.g. Bulding Innovation Hubs like Confindustra, Confesercenti, cdo, etc. Incentivise Training 4.0 to protect and reinforce employment (Impresa40, 2017).

- Small and Medium Enterprises (SMEs) typically use key technologies of Industry 4.0 less frequently than larger firms, thus, it is needed to increase productivity in firms which face obstacles to the uptake of technology. SMEs have limited funding capacities to invest in industry 4.0

[1] www.uppervision.at

technologies. Large investments are needed to implement the transition to Industry 4.0. e.g acquisition of industrial robots.

- The openness to international markets can support SMEs' growth in size, financial consolidation and increased competitiveness.

1.4. Impacts on public administration

1.4.1. Prediction of main challenges for public administration

- Adjustment of VET training system, regional, national, multinational level
- Remove negative image of VET training among people
- Lifelong training
- Connectivity, 5G networks development, covering remote areas
- Industrial space – industrial zones, special industrial zones

1.4.2. Best practice for skill development

- Up to date curricula in line with industry requirement
- Practical training – learn and practice, dual training model
- Infrastructure – holistic learning environment, access to state of art industrial machines, equipment and tools
- Standards and Qualifications which allow students to change education tracks
- Quality of trainers -SWO trainers with industry experience and knowledge
- Increasing positive image of VET

Source : Roland Berger

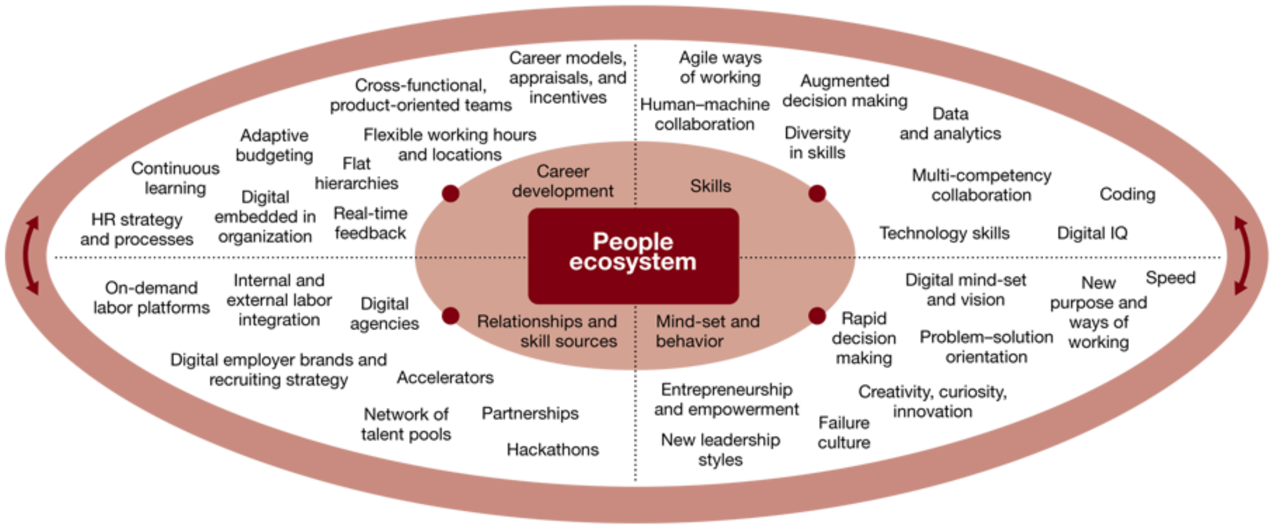
1.5. Impacts on workforce

- 90 % of employees need digital skills – basic ICT knowledge, machine to machine communication, ability to process and analyse data, understanding visual data presentation, basic statistical knowledge
- Long life training is essential
- Abilities -cognitive analytics, physical abilities
- Basic skills - content and process skills

- Cross functional skills – social, technical, resource management, complex problem solving, system skills

Source : Roland Berger

Overview of the People ecosystem

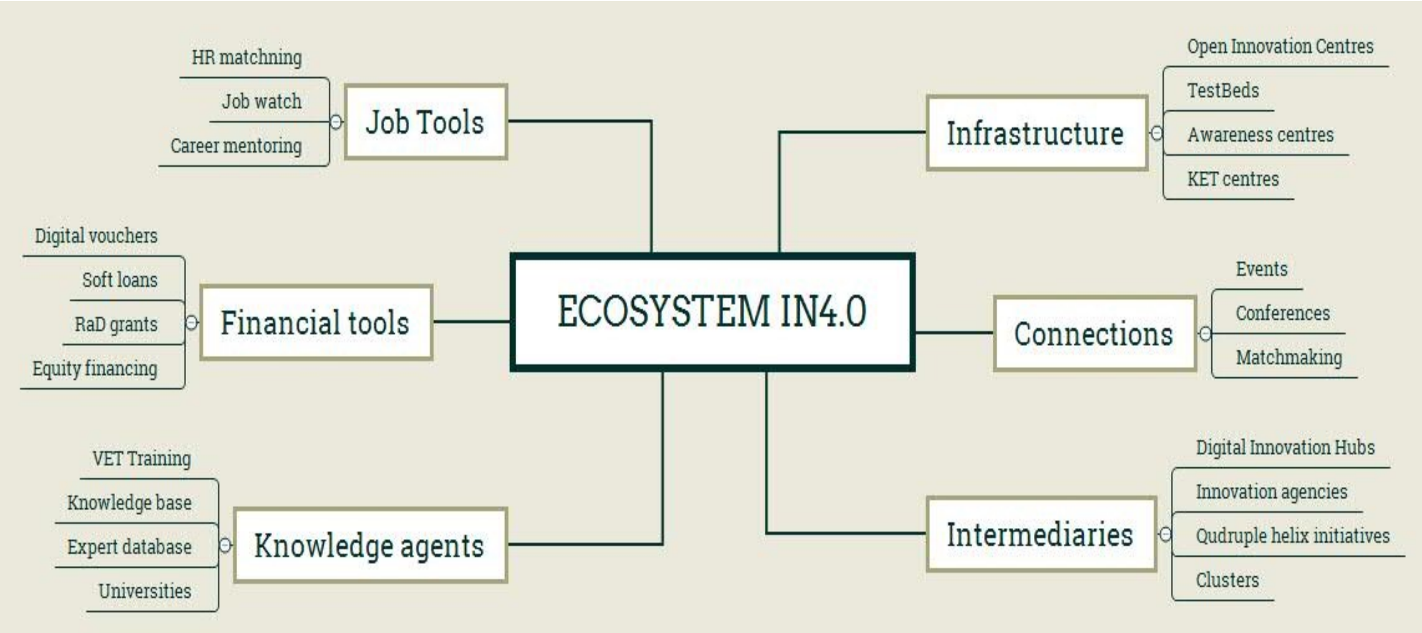


Source: PwC's Strategy& Global Digital Operations Study 2018

2. Part II, Ecosystem Industry 4.0 model - design

2.1. General model

The modified model of the regional knowledge ecosystem for Industry 4.0 is described in the following part of the document. This model does not solve „core technologies“, which are already described in „conditions“, i.e. in Part I, but solve the improvement of know-how necessary for development and utilisation of Industry 4.0 technologies, incl. their acceptance by users.

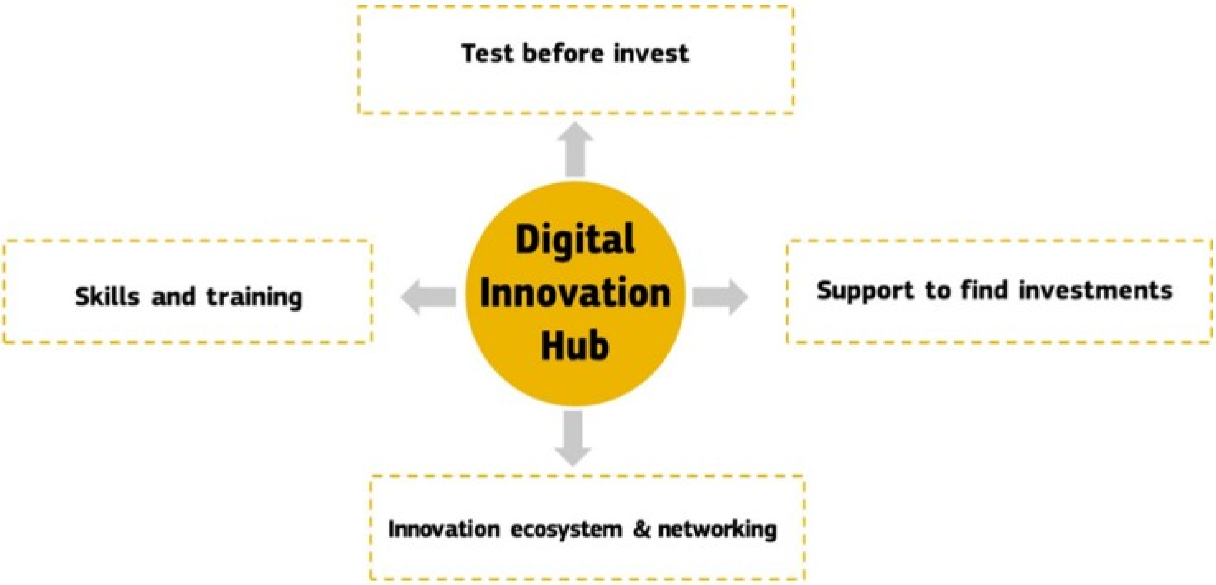


The model is divided into six main parts:

1) **Shared infrastructures** divided according the technological areas (IoT, cybersecurity, robotics, etc.), involving research, testing, educational and also promotional centres. Specific role play the sections focused on separated branches of digitisation (digitisation as KET, key enabling technology).
2) **Connecting activities**, conferences, seminars, etc., their task is to connect the critical mass of people, working in the area with the potential users and with other stakeholders (in quadruple helix framework).

3) **Intermediaries** – organisations enabling the introduction and networking, innovation agencies and especially Digital Innovation Hubs (DIH)[2] specified by the European Commission.

Source: Digital Innovations Hubs(DIHs) in Europe

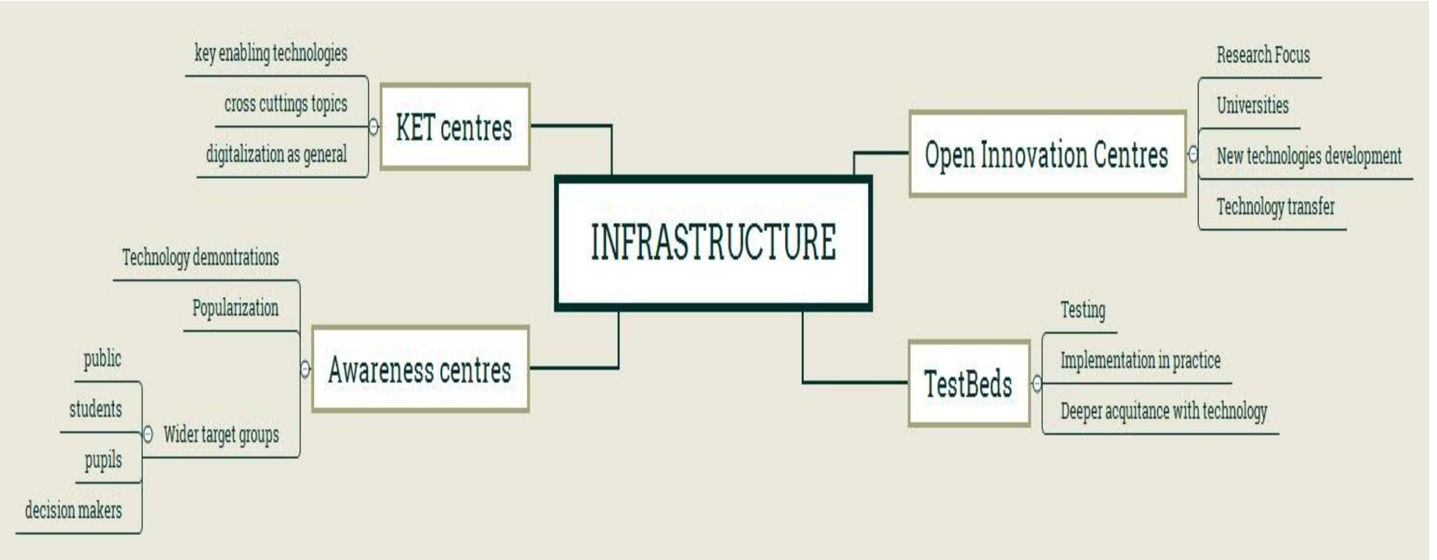


4) **Knowledge agents** (knowledge providers), i.e. Universities, research centres, schools and companies with good skilled staff and experts. The task of intermediaries is to establish the expert database of separated branches and functions (design, introduction, training, etc.)
5) **Financial tools** cover the needs of companies for new solutions development (equity financing, R & D grants), and the area of introducing the digitisation in companies (digitisation vouchers, soft loans).
6) **Job tools** – implementation of Industry 4.0 will have basic impact on labour force. The increase of demand on specialised positions is expected, these will be shared by several companies, also the need of soft knowledge development (communication, meetings) and also the necessity of retraining of work force providing the routine operations till now for new working areas.

[2] https://ec.europa.eu/digital-single-market/en/digital-innovation-hubs

2.2. Model description and types of actions/components

2.2.1. Types of infrastructure for Industry 4.0 technologies dissemination



Shared infrastructures are established as a mix of European, national and regional initiatives/platforms. The main tasks of the shared infrastructures are:

a) **Visibility** - ability to open the strong capacities not only in the respective region, but in the whole space mentioned above and simultaneously the ability to define the technologies needed by the companies (cyber- security equipment, rapid prototyping centres, etc.).

b) **Priorities** – clear focus on a branch and specialisation definition (e.g. digitalisation in nanotechnologies) based on regional competitive domain (knowledge base) or on the ability of the region to focus the sources on a new domain.

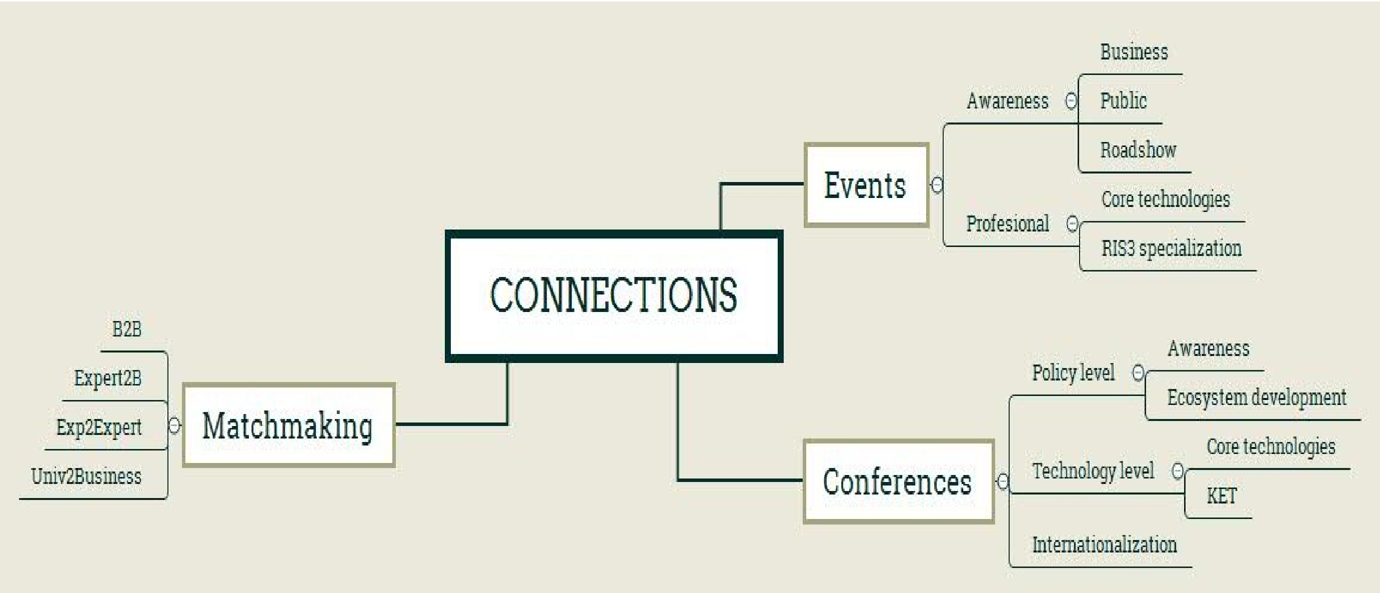
c) **Availability** – clear regulations regarding the utilisation, e.g. intellectual property rights, costs of services, available know how, marketing and communication of benefits of the available infrastructure.

d) **Networking** – with other centres with the aim to reach the complexity in services offered to regional companies. The ability to cooperate in development and testing projects with other specialised infrastructures.

Division of the forms of shared infrastructures:

a) **Open Innovation Centres** – mostly „laboratories“- technologies suitable for shared, collaborative research of universities, R & D centres and companies. The services of technology transfer will be part of the centres.
b) **KET Centres (key enabling technologies)** – crosscutting centres focused on a dissemination of technologies as nanomaterials and also digitisation „across“ branches (e.g. chemistry, agriculture, machinery, etc.).
c) **Test beds** – infrastructures serving for testing the possible of technologies utilisation in the respective SME, enabling the better understanding of the technology in praxis/operation, attracting the network of experts.
d) **Awareness centres** – demonstrator and communication centres introducing the utilisation of the technologies to possible users, consumers, selection of training and specialisation.

2.2.2. Actions called „Connections“

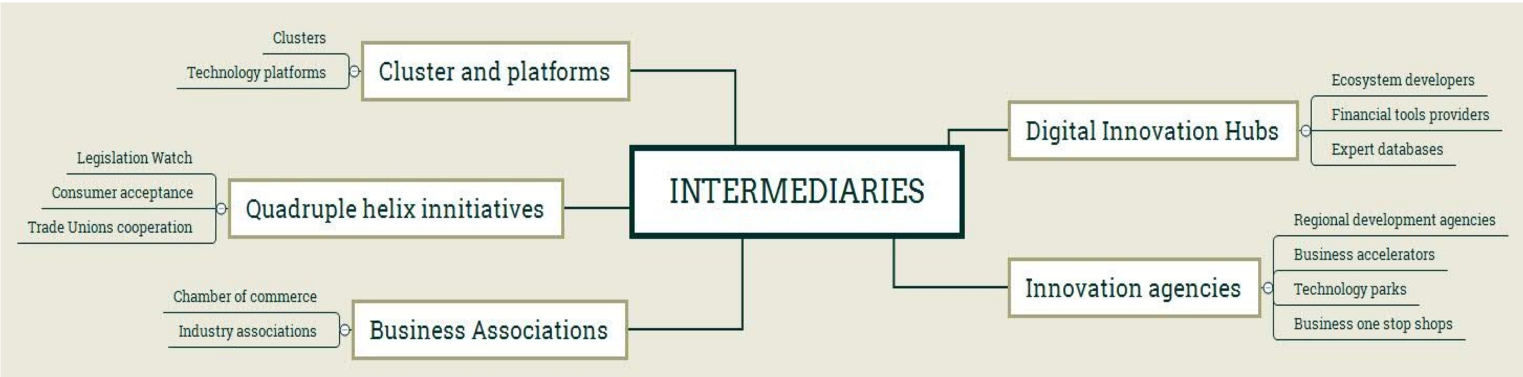


Actions as „connections“ provide networking, the interactions among experts with know-how and the users of know-how in the region. The connection with the „shared infrastructure“ and presentation of the equipment is expected. Actions are organised in line with the principles of „core technologies“ (robotics, digital twins) or in line with RIS3 specialisation of the respective region and as expert actions and public actions (dissemination of the awareness on technologies).

The communication of experts and users should be supported on B2B bases (matchmaking, speed dating) incl. networking with experts from different areas of „core technologies“ and different sectors (research, universities, VET, industry).

Other types of connections are the different e-portals focused on sharing of production, development or services capacities. H2020 project MARKET4.0[3]. can serve as an example. The creation of new business models will be developed (platform model, pay per use).

2.2.3. Intermediaries for know-how and contacts in the ecosystem



This part represents the core of our regional ecosystems. EC defines the new tool „Digital Innovation Hub“ (DIH). DIH will act as the driving force of the digitisation and Industry 4.0 in each region. DIH should be understood as heterogeneous group of actors operating in digitisation, hosted by one entity and diversified into more institutions (schools, universities, clusters, firms).

DIH will not be the owner of the shared infrastructure, but the promoter of the ecosystem, dealing with the wide network of experts and flexible financial tools supporting the introduction of the technology (digitisation voucher). The other task is the collection of data (market intelligence).

Three main tasks of DIH:

a) Ecosystem development – communities building, market intelligence, digitisation lobbying, knowledge development in the ecosystem

[3] http://market40.eu/

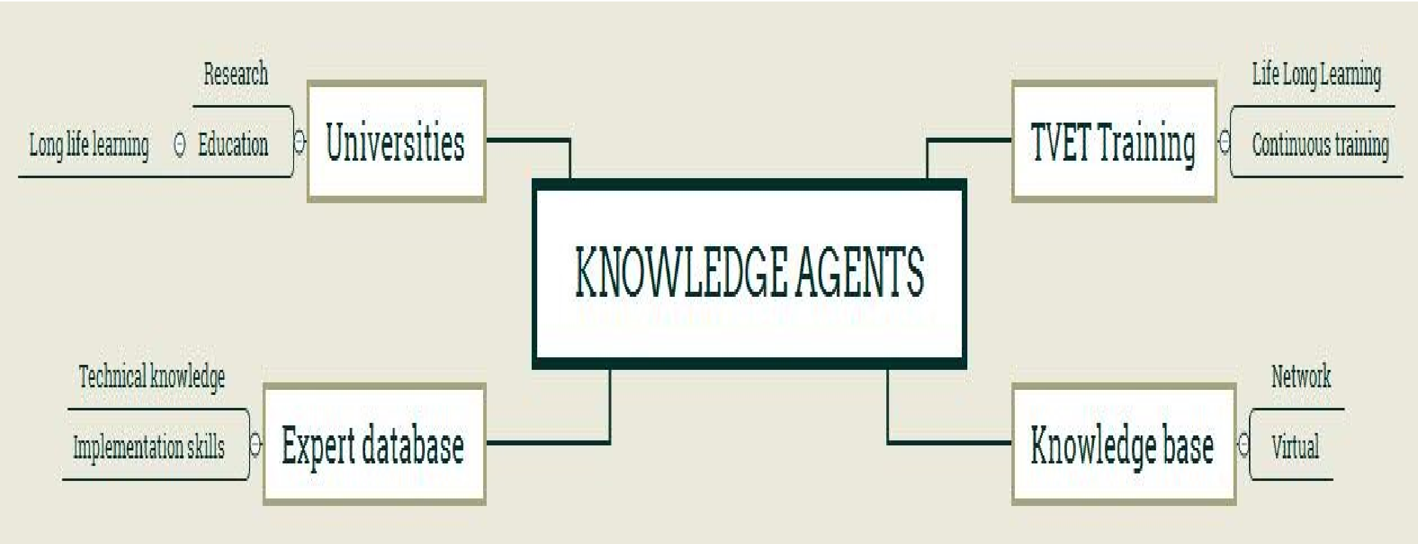
b) New technologies development – strategic R & D, collaborative research, technical support for scale up, testing and validation, laboratory infrastructure availability.
c) Business development – start up programmes, acceleration, access to financing, knowledge development, strategic projects launch.

DIH cooperates with other innovation agencies and business associations incl. different platforms, the cooperation is based on cooperation with social partners and technologies users (quadruple helix approach).

Concerning Upper Austrian experience, Clusters need to be highlighted as essential and important players.

- Clusters and networks play an important role in the networking of business and science. The primary objective is to initiate and support innovation projects that will significantly strengthen the competitiveness of companies.
- Tech-transfer-models like Open Seminars, Working Tables, B2B-Matching are operated as daily business within the Upper Austrian clusters.
- Cross-border cooperation in specific fields of technology will be unavoidable. In this respect, the establishment and maintenance of international relations will be a critical success factor. Relationships from projects such as ECOS4IN are therefore becoming increasingly important and should be used to derive further transnational measures.
- In order to use synergies and avoid duplication, a certain transparency about existing core competencies and key technologies is important.
- In order to coordinate regional S3 strategies in the best possible way, a network of responsible persons would also be necessary. The involvement of regional S3 managers is important.

2.2.4. Knowledge „Sources“ in ecosystem



The low attractiveness for young people and their parents of VET education is the long-term problem in industry. We expect the following increase of specialisation is expected in Industry 4.0 technologies, but also the need to connect the different branches/core technologies. The linking is the task of intermediaries and they have to be provided by activities as „connections“ involving the experts and knowledge base.

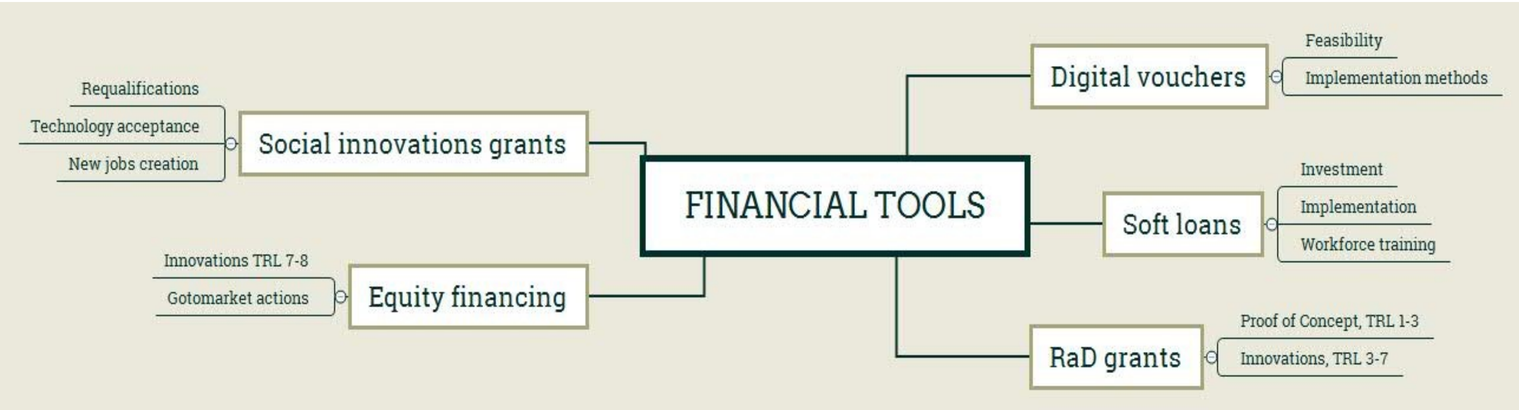
There also arises the need of motivation. This is provided by the provision of long-term education and trainings. The role of universities of applied sciences is crucial, and in case of Industry 4.0 implementation more relevant than academic basic research. The number of students older than 25 years in universities of applied sciences is 40% in the USA. The role of these universities is extremely high for the level of competitiveness in industrial environment.

These „Knowledge agents„ are expected to bring the practical know-how especially in the quality of work, intensity of production, utilisation of production capacities, reduction of costs, provision of labour force, development of new products and services.

2.2.5. Financial instruments to support digitization

There are 3 types of financial instruments. The first type is to support technology deployment (digital vouchers, soft loans), the second one is to support the development of new technologies (equity financing, research and development grants) and the third type is for addressing the impact of Industry 4.0 (social innovations grants).

From the point of view of the speed of solution of the induced changes, it is necessary for the public administration to shorten the time from submitting the grant to its implementation and to un-bureaucratise the whole process. This can be ensured, for example, by linking public and private equity for equity financing, or by placing more emphasis on midterm and ex post evaluations against ex ante evaluations for grant programs.



2.2.6. Tools to support effective employment during technological change

The ecosystem activities in the area of working tools are divided into three directions.

a) Monitoring the labour market and tasks searching for new types of work, educational curricula and promotion of new fields of study
b) Career mentoring focused on job description and career changes
c) Tools leading to efficient use of highly qualified specialists - job sharing, electronic job markets, ad hoc team creation, etc.

The necessary task of the stakeholders is to strengthen more positive image of VET (vocational education and training), especially from the point of view of using entirely new technologies (robotics, and others).

Conclusions

Central Europe is very heterogenous area consisting of developed regions with well performing innovation systems characterized by strong links among its actors as well as of mostly rural and peripheral regions characterized by low level of research and development and weak linkages within the innovation system. The opportunity to boost the innovation potential in the regions are in development of knowledge ecosystems, cooperation between different actors, strengthening the links among knowledge nodes from regional, national, and as well international levels. Ecosystem model will help to present what types of actions could be promoted in regions; it is a communication tool for describing innovation diffusion from research to new competitive products.

ECOS4IN ecosystem model will be discussed in partner regions. There will be created a pilot actions, which will help to develop and implement technologies marked as Industry 4.0. Description of this actions, region by region, will be attached to this paper. In common with results of opening analysis this will complete an ECOS4In knowledge base, which will be available for wider audience.

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