Journal of US-China Public Administration, July-Aug. 2020, Vol. 17, No. 4, 133-146
doi: 10.17265/1548-6591/2020.04.001

Intellectual Capital and Territorial Organization for Industry 4.0

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The aim of this work is to confirm the importance of intellectual capital in the transition of enterprises to the 4.0 model and, above all, of adequate territorial organisation to support it. The complex transformation process that has led to the evolution of industry is interpreted by the institutional, industrial and scientific world through a mainly technological-productive reading. However, this reading is not enough, because technology is only one aspect of change. Therefore, after having defined in the theoretical-scientific international framework the three components of intellectual capital, we will focus on the knowledge 4.0 and the evolutionary process of the same, and then present the organization of the business network 4.0 in Italy. A brief focus on the organization of the Campania region testifies to the commitment to create collaborative networks to qualify intellectual capital and opens up new research routes to map reports and evaluate the socio-economic results that will derive.

Keywords: knowledge, ecosystem, industry 4.0, network

Introduction

In 2016, Italy presented the National Plan Industry 4.0, included in the Budget Law 2017, and amended it the following year to National Plan Enterprise 4.0, so as to allow all companies to work to face the digital transformation. Initially, it was seen as a plan to help companies make their work processes smoother, faster and more flexible (for example, by adopting innovative technologies capable of producing small batches at a lower cost or by halving the time between prototyping a product and putting it into production); increase productivity and quality of supply through easy product customization; reduce machine errors by employing sensors that monitor real-time work and predict machine failures and downtime. Specifically, the Plan identified two key areas: innovative investment and skills. But within a few years it was realized that the great change, supported by technological advances, would also impact on intellectual capital and territorial organization.

The complex process led to the evolution of industry up to the 4.0 paradigm, interpreted by the institutional, industrial and scientific world in an essentially technological-productive vision (Liao, Deschamps, De Freitas Rocha Loures, & Ramos, 2017). However, such an interpretation was insufficient in the sense that the Internet of things, artificial intelligence, robotics, autonomous vehicles and drones, virtual reality, blockchain, digital traceability, 3D printing, technologies, accumulated and integrated within an interconnected context, had begun to change the economy as a whole, so intensely as to suggest an effective Fourth Revolution, culminating after the First triggered by the steam engine (late 1700s), the Second, triggered by the paradigm of electricity and mass production (beginning of the 1900s), and the Third, triggered by the advent of the early

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computerisation processes (1960-1970). The four industrial revolutions not only epitomised a change of technical expertise, but also the transformations of the structures of the existent economies, and in particular, the ways and perspectives of production, including how a society is reproduced and grows. In other words, the substantial metamorphosis of relations between people, social groups, institutions, companies, etc.

The change of the 21st century requires the transition from a classical manufacturing economy to the knowledge economy and is based on a certain element: the exponential growth of the role of intangible assets[1], and in particular intellectual capital, as a key factor in global competitiveness.

In order to understand the contribution of human resources to the process of value creation it is also necessary to reflect on the existing links with the territory. The examination of relationships is related to a dynamic perspective of study that assumes that none of the components of intellectual capital is sufficient in itself to develop positive performance but it is necessary that each component interacts with others to generate value. Intellectual capital thus becomes a phenomenon of interactions, transformations and complementarities that can be understood by focusing both on individual resources and (and above all) on processes, rules, activities and connections (Marr, Schiuma, & Neely, 2004, p. 312; Cuganesan, 2005, p. 360; Cuganesan & Dumay, 2009, p. 1163). According to this approach, collaborative networks promote or prevent the generation and transfer of intellectual capital, as well as localized institutional and structural factors determine the success of the process.

This consideration is based on the evidence that having knowledge does not automatically mean knowing how to use it from an economic point of view (Iammarino, 2005), because intellectual capital is enhanced by a "learning by iteration" that is through the exchange of knowledge between different systems: each actor (be it a synopsis subject, an enterprise, an institution or a network) is in continuous interaction with the environment and can be considered an apprentice in an experimental situation (Pace, 2010). In support of this trend, the focus is on learning regions (Florida, 1995), innovation systems (Lundvall, 1992), territorial networks (Cappellin, 2001), in other words, those contexts in which interactive learning is encouraged outside traditional premises, based on the idea that innovation cannot be studied at company level but that the territorial organisation in which the company operates must be investigated. Since these concepts have found space in different fields (academic and political) they are too broad to be dealt with here, but it can certainly be said that: better is the intellectual capital (widely understood) the greater the possibilities of giving quality to the innovation process; however, the latter materialises in territorial contexts with high scientific and entrepreneurial skills, but also by aggregations of entities useful to develop coordinated actions and projects on specific sectoral priorities, as supported by the regional economy, according to which territorial connotations are important rather than industrial processes *stricto sensu* (Bounfour & Edvinsson, 2005).

Against this background, the objective of the work is to underline the importance of territorial organisation to enhance the contribution of intellectual capital to the competitiveness of enterprises 4.0. To this end, some brief reflections on the concept of intellectual capital will take place first, and then present the organization of the national network Industry 4.0.

[1] The definition of intangible resources is still debated today by many scholars. Just think that the New Paradigm Initiative launched by the Value Measurement and Reporting Collaborative has identified and catalogued more than 80 different scientific approaches developed to measure the value and performance of intangibles and each of these approaches proposes the own definition. In more general terms, reference is made to intangible assets that generate future income without however having a physical or financial aspect and their costs do not exhaust their usefulness in a single period, as they bring benefits over multiple periods.

Theoretical Framework on Intellectual Capital

The concept of intellectual capital, despite being the subject of debate for over five decades, still cannot claim a unanimously accepted definition (Petty & Guthrie, 2000; Guthrie, Ricceri, & Dumay, 2012), by virtue of the numerous fields of research and schools of thought involved. Furthermore, developments in the theoretical field are few compared to applied cases. Companies, consultants and scholars have advanced definitions particularly suited to specific context and experience, frequently without analysing in depth the abstraction and generalisation of the concepts that have emerged (Gröjer, 2001; Catasús & Chaminade, 2007). In literature, it has been defined for the first time by the social sciences as "an ideological process, a means to an end" (Galbraith, 1969). Only in the 1990s, was the term used in an economic-corporate sense acquiring varied meanings, based on static (Meritum, 2002), dynamic dinamiche (Mouritsen, Larsen, & Bukh, 2001; Mouritsen & Larsen, 2005; Mouritsen, 2009) and complex (Chaminade & Roberts, 2003; Bjurström & Roberts, 2007); not to mention quantitative (Edvinsson & Malone, 1997) and qualitative perspectives, proposing a more or less analytical description of the elements that comprise intellectual capital. Better understanding the definition and classification of intellectual capital becomes essential for businesses 4.0.

The inter-disciplinary studies on the identification of the constituent elements of intellectual capital, through the analysis of numerous classification models based on the taxonomy most common in doctrine and practice, confirmed first of all the relativism of the object under investigation according to the adopted and shared point of view and led to the conclusion that all models, although with various expressions, generally converge towards a tri-repartition of the same (human, organizational, relational capital).

Human capital is an integral part of knowledge, skills and attitudes belonging to employees working within the company in various capacities. The concept extends to include ethical and cultural values generated and shared within the organisation on the part of employees as opposed to those belonging to the company. Compared to Smith and Marshall, who have devoted much attention to the productive factor of work, the most recent authors tend to consider human capital the most important of the three components, as it is the origin of the process of development of most of a company's invisible resources and is often regarded as the means by which knowledge can generate value (Itami, 1987; O'Donnell etc., 2003). In such process it constitutes the base on which then to base the valorization of the invisible resources business, that is on the competences of bases those specialistic ones are constructed: for competent person, generally, an individual is understood to perform his or her work well and to achieve high and reliable performance, using appropriate language. The Recommendation of the European Parliament and of the Council (2006) on key competences for lifelong learning offers an interpretation of the term which also includes the other two concepts, in order to better delineate the interconnections:

- skills, that is, the proven ability to use personal, social and/or methodological knowledge, skills and abilities, in work or study situations and in professional and/or personal development;
- theoretical and/or practical knowledge, indicating the result of the assimilation of information through learning (set of facts, principles, theories and practices related to a field of study or work);
- ability (cognitive and/or practical) to apply knowledge and use know-how to accomplish tasks and solve problems.

To give importance to skills there is the social context, which requires man to work independently to solve problems of a certain complexity (Maccario, 2012) and to know how to respond to circumstances, for which

there are never predetermined solutions[2]. There is also the school context, which considers them as knowledge, skills, attitudes, emotions to effectively address the situations that daily reality proposes, in relation to their potential and aptitudes (Miur, 2012) and that, in line with the European Council, includes both knowledge and theoretical knowledge; and know-how, the practical and application part, moving away from an overly notionistic and sectorial culture in disciplines.

In the face of a socio-economic system in which personal interest and hyper-connection transcend the boundaries of individual environments and change the interpretative and cognitive codes, the strategic skills framework for the 21st century covering the entire life (lifelong learning) is developed. The required skills are "…literacy in both traditional and new media, the technical skills related to this literacy, the development of tools for critical analysis, the ability to navigate across, reconfigure, and evaluate different media forms, the ability to negotiate and work across diverse cultures and communities, the ability to synthesize material and bring together different methodologies to solve complex problems, the ability to interpret and construct models for responding to real-world situations, the ability to critically evaluate the potentials and limitations of new technologies, and the cultivation of a broad understanding of the social, historical, linguistic, and cultural context in which they are learning and working" (Presner & Johanson, 2009).

When the human resource is occupied in the company can be considered a capital and assume a role both passive (because it is able to receive, implement and shape the business strategy of creation of value elaborated from the management) is active, as it creates an autonomous value through the ability to evolve its system of skills and relationships according to the inputs received and thus producing new knowledge (Chiacchierini, 1995). In addition, unlike tangible and financial capital, it is a temporary, highly volatile resource, given that the worker sells his work but remains his own person. Therefore, a company has to manage such form of capital appropriately to avoid value leaks (Stewart, 1997). The second component of intellectual capital is structural capital. It is envisaged as the wealth of knowledge that includes the knowhow necessary for the implementation of products and processes within the organisation (patents, software, manuals, databases, intranet networks, etc.), enables human capital to express its potential by establishing a relationship of dynamic interdependence. This form of capital facilitates the process of acquiring, creating, storing, circulating and reusing knowledge and also plays a key role in view of corporate turnover. Moreover, the formalisation of knowledge into elements accessible by the entire organisation enables new personnel to access past experience thus speeding up their learning process. Relational capital is defined as the set of relations with all external stakeholders (customers, suppliers, partners, institutions, etc.), is the knowledge exchanged (received and transferred) between the company and the outside world (Edvinsson & Malone, 1997). Such relations are crucial as they contribute to the process of acquiring knowledge in a logic of mutual learning and, therefore, by virtue of the consequent reduction in the costs of generating knowledge, its profitability increases. In other words, the interaction between human capital and relational capital produces new opportunities and ways of learning (Mouritsen & Thrane, 2006). The co-dependence of the components, leads to a critique of the linearity of effects hypothesised by certain authors (Edvinsson & Malone, 1997), suggesting co-influence links in which each form of capital is both input and output of other forms of capital (Figure 1).

[2] Some authors refer to "adaptive decision making": a problem, a situation in real life does not have a single real solution, but it has a more effective one, which best responds to that context (Goldberg & Podell, 2000).

The individual, the enterprise 4.0 and the context constitute the keys of reading and attention, therefore, moves from the company boundaries to a wider system: this shift is due to the idea that the presence of an appropriate social context, environmental, cultural and informative is fundamental so that intellectual capital can be created, developed and generate value for the company and its stakeholders. This evolution marks the transition from a micro to a macro analysis of intellectual capital and is the phase in which an attempt is made to create a bridge between knowledge within and outside the organisation, given that appropriate management of the two perspectives is becoming increasingly strategic and underpins a company's competitive advantage (Borin & Donato, 2015).

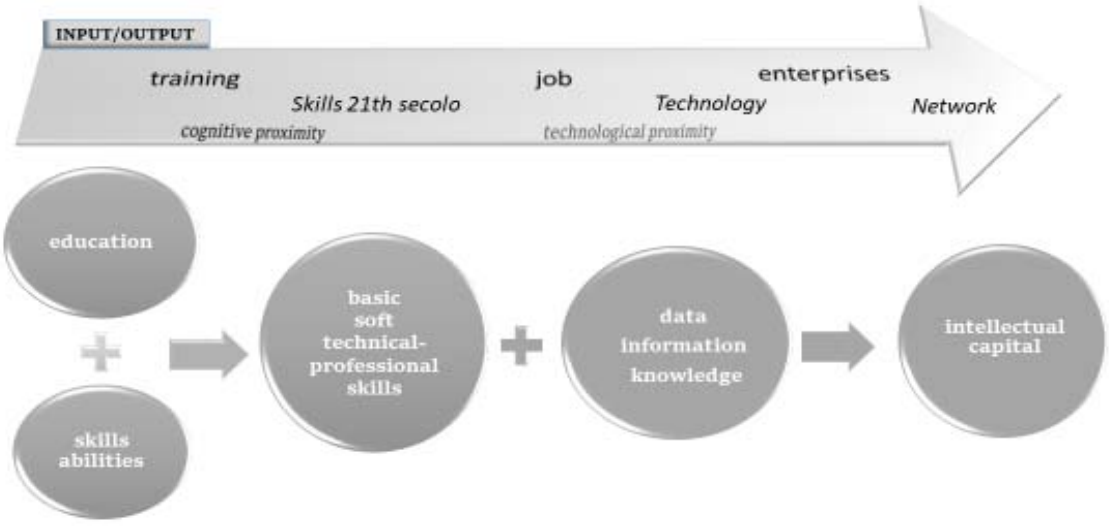

Figure 1. The process of creating intellectual capital in the enterprise 4.0. Source: elaboration on European Commission, 2016.

Intellectual Capital in Industry 4.0

Industry 4.0 is distinguished by two important aspects: the intelligent factory, characterized by a digitalised production, which works dynamically, composed of fluid and interconnected processes; the intelligent production, adapted to modernity and its needs, able to make the best use of available resources. To achieve integration between the virtual world and the physical world one cannot think of the disappearance of personnel from the factory; the physical presence of man is necessary for such a production process. Therefore, among the factors enabling the evolution towards industry 4.0, in addition to innovations in the production process, there is intellectual capital. A perspective vision from which it is understood that:

- Investment in innovative machinery and systems is only one lever to increase the technological level of enterprises and increase their productivity;
- Acting exclusively on them means to deal with the solution of the problem partially with ineffective results.

The digital transformation of enterprises with the needs of highly qualified workers and a network ecosystem of actors and conditions (universities, physical and digital infrastructures, research centres, institutions, etc.) requires attention to be paid, first of all, intellectual capital. Within companies, low value-added processes are streamlined and focus on those with higher value, giving man (bearer of special human capital) the role of protagonist of this evolution, in the functions of entrepreneur, manager and worker

(World Economic Forum, 2015). In addition, even if all companies had access to the same technology and the same asset, it is not to underestimate the way in which these are combined and used to generate greater or lesser value. Capacity utilisation depends on strictly from organizational and relational capital, which becomes the discriminating element, because it allows a company, first of all, to survive and, then, to overcome the challenge of the market.

According to the Observatory Industry 4.0 of Milan Polytechnic, companies (faced with the speed and magnitude of change) show perception and awareness of having to equip themselves with specific skills in order to be able to really use all the extraordinary opportunities of the technologies enabling and characterizing the 4.0, but to a large extent they are still in the phase of defining a clear strategy. In fact, there are many studies aimed at identifying more specialized profiles needed to increase human capital, as well as those aimed at understanding how to design the working environment and how to enhance the effectiveness of relational capital. In according to High Performance Work Practices[3], many principles have been foreseen in companies' realities and a mapping of the generic and specific skills that characterize Industry 4.0 has been outlined[4]: a basic knowledge of the principles of robotics, in particular cooperative robotics, as an expression of the convergence between the mechanical, electronic and IT aspects of new manufacturing, the importance of bionics in developing robots that can increasingly interact with human behaviour.

For more specific skills, some professional profiles can be identified, such as the Industrial ICT Specialist, combining expertise in electronics and ICT (hardware/software) or Industrial Cognitive Sciences, with distributed sensor/actuator networks, robotics, perception (e.g., 3-D vision), cognition (e.g., action planning, cooperation, swarm intelligence) as focus domains. No less important is the prediction of non-mechanical and repetitive tasks that presuppose an active involvement of the worker in terms of creativity and mental reworking to develop increasingly customized products.

The talent 4.0 comes from the practice, understood as commitment and continuous exercise, but above all from the opportunities offered by the productive environments (Subotnik, Olszewski-Kubilius, & Worrell, 2011): it develops according to different trajectories, which are influenced by the abilities of individuals based on training patterns, as well as by the benefits of interaction in enabling contexts. They are the latter which allow the worker to stimulate his creativity and the production of new solutions. Many of these elements escape the techno-productive logic. It is necessary to place the worker at the centre of the company training process (with his interests, motivations and needs) in order to promote active research and the empowerment of that talent (Baldacci, 2002).

When you think of innovation within a company or an organization, it is natural to think of inserting an innovative quid into the well-established and often long experience. In the case of Industry 4.0, it will not be enough: the challenge is to think and design the new working environment not only as an expression of

[3] The High Performance Work System (HPWS) is generally characterized by a set of managerial practices that serve to enhance the involvement, commitment and competencies of the employee (Appelbaum, Bailey, Berg, & Kalleberg, 2000). These may be classified into three sets: the core practices involve changing the way jobs are designed and executed; a set of practices are used to guarantee that employees have the knowledge and competences to do their jobs under the high performance system; a set of practices aimed at ensuring that the organization attracts and retains people with the right motivations to work under such a system. The application of High Performance Work Practices is not widespread in small organisations (Kroon, Van De Voorde, & Timmers, 2012).

[4] Classification of the Strategic Research Agenda of the European Technology Platform on Smart Systems Integration which identifies the following application aspects of new technologies: manufacturing equipment, process control, robotics & factory automation, prototyping equipment, test & inspection.

renewed technological power but also as a place to rethink development from those “elements needed for authentically human functioning” (Nussbaum, 2012, p. 74). The specific skills are combined with the skills of a working environment characterized by complexity and flexibility, which requires communication skills and organization of their work, adaptation to different tasks, management of unforeseen and unforeseeable situations. The combination of high specialization/digital manufacturing therefore describes only a part of the skill set required of the new worker. Ultimately, adaptability, flexibility in the workplace and the ability to learn are those meta-skills without which the process of innovation in digital manufacturing is not able to take place fully.

To confirm this, in fact, the common aspects that have led to success the innovations produced by companies are the ability of management: 1) to maintain a continuous balance between old and new, between exploration and efficiency, between discipline and experimentation; 2) to consolidate the elements of excellence of its business, but also to adopt strategies that push deeply on creativity; 3) to analyze the gaps between objectives set and results actually achieved, to make continuous corrections focused on the pursuit of the ultimate innovation goal. These are elements which generally denote the importance of capital (Di Minin, Marullo, & Piccaluga, 2019).

Given the need for specificity, sectoriality and specialisation requirements, the transfer of skills in an Industry 4.0 needs more complementary learning plans (training of technical and scientific bases, soft skills and direct experience in the workplace), which companies are not always able to cope with. However, investments in intellectual capital cannot be considered as a choice of the entrepreneur to support investments in technology. At present, an enterprise that wants to start thinking about its stability in an evolving market cannot ignore the centrality of the training dimension as the engine of innovation processes. Businesses have begun to prioritise investment in knowledge and scientific breakthroughs, recognising it as a key driver of value creation for the enterprise in the first place, but at the same time they understood that this intangible element is almost always not definable in a formal manner and must be acquired with a speed at least equal to or greater than the rhythm with which the external environment, the one in which the entity operates, is modified. Therefore, aggregations that accelerate the process of acquisition of intellectual capital are also important.

In parallel with the need for integral training of the employed, the review of cases applied in the literature shows that innovation generates positive impacts only if it develops in a systemic approach, without insisting on doing everything by only resources available within company. Industry 4.0 moves to the physical boundaries of the enterprise, transforming it into an “extended enterprise” (Capgemini Consulting, 2014) in which interactions with the industrial ecosystem take place in real time; its interconnected collaborative platforms create a networked production environment, based on flexible collaborations within the value system, both at the level of suppliers and customers; develop partnerships between different companies to attract the best ideas quickly and economically, transforming them into innovations that generate competitive advantages to the companies to which they are transferred. In addition, they will be interconnected spaces with a high density and concentration of resources, technologies and skills, by definitely breaking the walls that separate the factory from the school and the university as well as from research and development centres and start-ups from the perspective of network logic understood not as a simple sum but multiplication of value.

In short, there seems to be a holistic approach that goes beyond the principle of self-sufficiency of the factory or even of industrial districts, technological poles, clusters and business networks in production processes and value creation, affirming the importance of the territorial dimension (global and local) according

to a wide density of horizontal and vertical, formal and informal relations. The ecosystems of knowledge 4.0 are becoming increasingly important, for which ownership or the amount of fixed capital and increasingly the sharing of objects, services, knowledge, relationships, information are becoming increasingly less important.

They are environments formed both by the relations between the actors that compose it and by wider factors, such as the social and cultural environment, the institutional and organizational framework, the infrastructures, the processes that realize and distribute scientific knowledge. The ecosystem model gives greater emphasis to the activities and reciprocities between organizations, to the understanding of the dynamics of systems and their sustainability rather than the pillars that make it up. In this sense we cannot consider schools, universities, research centres, start-ups as parallel tracks (that is, mere centres for the supply of labour, ideas and knowledge) compared to the industrial fabric but, rather, as an integral part of a territorial network that balances the interests and objectives of the actors involved through co-responsibility and coordination mechanisms. Innovation in Industry 4.0 thus becomes the first derivative of the network of relationships and structures that define the cognitive domain in which the actors of digital transformation act (Costa, 2018, p. 62): relations of technological integration, integration in the labour market, productive integration between enterprises, integration between services and industry, financial integration, socio-cultural integration, institutional integration, interregional and international territorial integration.

Such needs lead to pass the development of Industry 4.0 necessarily for a model of systemic innovation with a cognitive-territorial approach, because it can only happen with an interactive learning within a network composed of different actors. This does not necessarily imply that innovation systems are formed by spatially contiguous subjects, or present in a geographically well defined area (Cooke, Heidenreich, & Braczy, 2003). It is therefore possible to find innovative systems that refer to “technological boundaries” rather than geographical boundaries. In short, a radical change of vision is needed: from the challenges to be faced around the application of enabling technologies, the increase in R&D expenditure and the definition of rational processes for the optimisation of resources lead to a perspective focused on the creation and exchange of knowledge, with the consequent increase of the productivity of the enterprises and the competences of all the participants actors, let alone with the transformation of the acquaintance from resource needed to win, that is essential in order to excel, in resource needed-to-play, essential to survive and govern change.

Knowledge Ecosystem Focus on Campania Region

Industry 4.0 requires a combination of different skills and companies must cooperate to increase and diversify their knowledge base, given the innumerable challenges to be faced. Developments should be based on collective learning processes and flexible forms of cooperation between different public and private, regional and international actors, large enterprises and small and medium-sized subcontractors, research and training institutions, public administration, financial institutions and local actors. In fact, to implement the Industry Plan 4.0, aimed at supporting the transformation process of Italian companies that want to seize the opportunities related to the Fourth Industrial Revolution, the national network Industry 4.0 was designed, consisting of three types of structures in the national territory: Punti di Impresa Digitale (PID), innovation hub, competence centre. They are not only physical places but they contribute to the creation of a national ecosystem aimed at fostering innovation connected to digital and are understood as enabling factors of production processes “based on the circular and open connection between intelligent systems”. Through interactions, ecosystem actors are able to consistently produce new results by combining skills and ideas. Contrary to studies

that have explored and argue that geographical proximity generates benefits for organizations, thanks to the reduced costs of transferring ideas and people, in the Enterprise 4.0 links even co-colocalised facilitate collective learning and increase the speed at which innovation is disseminated. This is justified by the fact that co-location can be replaced by virtual proximity between actors and a sector-specific cognitive proximity.

PID are service facilities located at the Camere di Commercio or Unioncamera to support the digitisation of enterprises. They are dedicated to the dissemination of the culture and practice of digital diffusion in companies in all economic sectors. The network of «physical» points (n. 88) is joined by a virtual network through the use of a wide range of digital tools: specialized sites, forums and communities, use of social media. With regard to the 91 Innovation Hubs, 21 Confcommercio Digital Business Ecosystems and 70 Digital Innovation Hubs (DIH) were created by Confindustria (21), Confartigianato (21), Confederazione Nazionale dell'Artigianato (28). In order to share projects and initiatives, it is necessary to create a dense network with some "territorial antennae" that allow companies to reach capillary. The latter, while being born locally, are shared among all innovation hubs, so as to ensure the homogeneity of activities throughout the territory. Partners of these structures are the eight Competence Centres, which are responsible for evaluating the digital maturity of companies, through the identification of priority areas of intervention and the development of high training courses, the dissemination of expertise on demonstration production lines and use cases, the concentration of industrial research and experimental development projects on technologies and solutions already on the market, or close to marketing, support to potential contractors in the implementation and monitoring of results (Table 1).

From this clear framework of the national territorial organization to improve intellectual capital and to facilitate the transition of companies to the 4.0 model, we move to a dense regional and/or interregional organization and difficult to map. Because of the multiplication of agreements between several bodies, there is a risk of giving back a poorly defined and overlapping organisation which sometimes proposes a duplication of initiatives. The Campania region, starting from an unfavourable situation in the national ranking in terms of human capital (Figure 2), with the L.R. n. 22/2016 "Manifattura Campania: Industria 4.0", has defined a strategic framework for the revitalization of the regional innovation system in key Industry 4.0. The guidelines are based on the transmission of digital skills, the integration of vocational training, universities, research and enterprises, collaboration and the exchange of knowledge, the formation of business networks and cooperation, in a framework of open innovation and dissemination of innovation, in order to promote the evolution of the digital know-how and skills of small and medium-sized enterprises, to qualify and retrain staff within enterprises, to develop integrated skills, to attract new investments and to activate reindustrialization processes, as well as to enhance the competitiveness of enterprises and the innovation of the manufacturing and artisan enterprises of the Campania territory.

Since 2017 has been committed to creating multiple relationships to enhance the effects on the intellectual capital of companies and presents with five PIDs, one per province, in order to disseminate basic knowledge about Enterprise 4.0 technologies, assess the digital maturity of companies, offer assistance in initiating digitisation processes through assessment and mentoring services, provide training on basic skills in the digital sector, and steer towards more specialised structures, such as DIH and Competence Centres. To this is added PIDMED, born from the synergy between Unioncamere, the Chambers of Commerce of Caserta and Salerno and the task force Societing 4.0 of the University Federico II of Naples and realized thanks to the COINOR and

the incubator Campania New Steel.

Table 1

Mission and specializations of competence centres

Competence centre	**Mission**	**Enabling technologies and sector specialization**
CIM 4.0	To spread skills and good practices, including through training and experience on the ground, in technological sectors and industrial areas specific to the Piedmont region and other Italian regions	Additive manufacturing, data science and big data Focus: automotive, aerospace, energy
MADE	To describe the best technologies on the Italian and international market, in order to suggest to companies and, in particular, SMEs, innovative solutions for the modernization of industrial processes	Fabbrica 4.0—Cyber Physical System Cross-sector applications to sectors
SMACT	To guide companies, in assessing their level of digital and technological maturity; to train, in order to promote and disseminate skills in Industry 4.0; to implement innovation, industrial research and experimental development projects, and provision of technology transfer services in particular to SMEs	Social media, mobile, analytics and big data, cloud, IoT, automation Focus: clothing, furniture, food
START 4.0	Promote technological and digital development and the creation of advanced expertise in the industrial sector, with particular regard to SMEs; fostering the transfer of technological solutions and innovation in production processes and/or products and/or business models resulting from the development, adoption and dissemination of 4.0 technologies, with application in the field of security of strategic infrastructures and their optimized design	IoT, augmented reality, big data, block chain, robotics, connectivity Focus: energy, transport, water, production, port
BI-REX	Gather the know-how of the Emilia Romagna High Technology network and develop a system of training, guidance and advice to businesses; create a large ecosystem of innovation projects, experimental development and collaborative industrial public research-private; implement a demonstration production plant (Pilot) on which to implement and optimize the adoption of Industry 4.0 enabling technologies	Big data Focus: meccatronica, automotive, biomedicale, agrifood
ARTES 4.0	To provide partners and SMEs with technologies and services dedicated to meeting their needs, acting as a research transfer accelerator to promote industrial application and the transformation of research into new products, and organize or support training courses, creating high-skilled job opportunities	Robotics and virtual environments Cross-industry applications Robotics and virtual environments Cross-industry applications
CYBER 4.0	Carrying out guidance, training, research and innovation activities	Cyber-security Focus: e-health, automotive, space
MEDITECH	Carry out orientation, training, research and innovation activities and encourage the transfer of technological solutions and innovation in products, processes and business models resulting from the dissemination of technologies 4.0	All enabling technologies of Industry 4.0 Focus: automotive, aerospace, agriculture, pharmaceutical

It promotes an innovative research/action project which seeks to develop a Mediterranean model of innovation 4.0, which starts from listening to small and medium-sized enterprises, in order to identify the critical points and needs of enterprises in order to guide them in their digital transformation. They analyse the individual cases, listen to the individual companies and then understand whether, and how, the technologies can help their production, without losing, the competitive advantage they have in the world, given by connotations of craftsmanship, of authenticity and typicality. In addition, the Campania Digital Innovation Hub Association has operated since 2017. It is an innovative network of collaboration between research centres and institutional actors, such as Campania Ance, Confindustria of Avellino, Benevento, Caserta, Salerno, Unione Industriali Napoli, Cisco, NetgroupSRL, Stazione Sperimentale per l'Industria delle Pelli e delle Materie Concianti S.r.l., TIM Spa and Windtre Spa, to carry out activities relating to intellectual capital and in particular

information/training/dissemination of awareness on innovation and digital transformation of enterprises and adoption of technologies and processes related to Industry 4.0; to provide companies with mentoring and training services for managers and operators; to promote and implement, including through targeted collaboration agreements, a network/network of entities—public and private—with skills useful to foster and accompany the digital transformation of enterprises; to offer any other service activities to enterprises, considered useful to foster digital innovation and the competitiveness of enterprises.

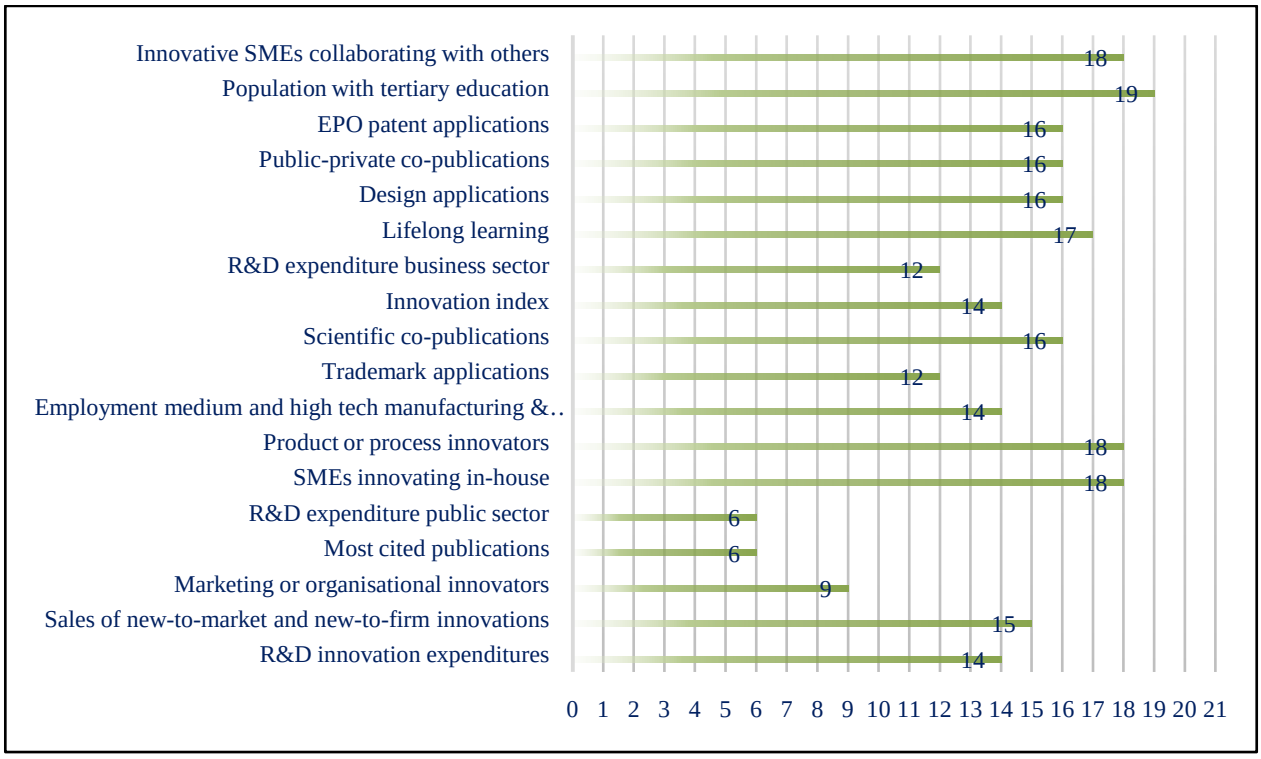

Figure 2. Position of Campania region in the national ranking for individual indicators (2019). Source: European Commission (2019).

To this is added the Competence Centre—Mediterranean Competence Centre 4 Innovation (MEDITECH), constituted from five University of Campania and three of Puglia, from the two regional institutions, from twenty-three ordinary consortia (of which one in shipbuilding, two in construction, three in pharmaceuticals, three in rail, three in automotive and civil, four in agri-food, three in aerospace and four in ICT and services), to which 109 members are added. The first group of companies received an assessment of full adequacy to the partnership, due to the significant size of the company and positioning in national and international market and technological contexts, the density of international relations, the marked propensity to innovation, the substantial content of skills and technologies 4.0 and the leading position of important technological and market sectors. The second (characterised by the small and medium-sized size of companies) was considered to be sufficiently adequate to contribute to the exploitation of intellectual capital, technological and operational skills in relation to the supply chains and the ability to offer specific guidance, training and/or technology transfer services. As part of the business training services, MEDITECH has planned to implement a Teaching Factory I4.0 that focuses on theoretical approaches to the new paradigm; practical with experimental insights within permanent thematic laboratories, equipped with technological demonstrators; by doing on the demonstrative

production lines, structured according to the specific training needs of the participants and their respective sector. To support the innovation of projects and businesses, increasing the level of knowledge and awareness of digital transformation was created the network of industry operators 4.0 “Campania Intelligente 4puntozero” that is the platform to which they participate beyond the aforementioned territorial organizations also the Regional Interuniversity Committee, FAB4 of the Confartigianato Salerno, Confapi, Federmeccanica, CNAhub4. Campania region, although not starting from an easy situation, is a virtuous example of community of innovators, committed to improving intellectual capital, following the paradigm of open innovation.

Conclusion and Future Research Directions

It should be pointed out that a reflection on these issues cannot realistically be considered systematic and exhaustive, given: the vastness and variety of issues involved in the field of investigation; the recent attention paid by the academic world, political and industrial; the multiple sources (national and international) to investigate; the shortage of empirical cases. However, understanding the importance of the three components of intellectual capital in the transition of enterprises to the 4.0 paradigm supports the inescapable contribution of knowledge ecosystems in this historical phase. Therefore, focusing on these accompanying structures and planning investments and/or initiatives to improve their operation and results are the focal points for the competitiveness of innovative enterprises. These aspects, at the same time, open up broad future directions of research. If the adoption of Industry 4.0 offers advantages and benefits that primarily invest the performance and competitiveness of companies, interesting studies may be carried out on the macroeconomic impacts, albeit to a varying extent by sector and by country, to outline medium- and long-term scenarios of increases in the main socio-economic indicators. In addition, new research will have to deal with the mapping of actors and learning processes, knowledge flows that change intellectual capital, their relationships in ecosystems in an evolutionary perspective and, finally, the evaluation of their work.

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