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ASKFOOD – Alliance for Skills and Knowledge to Widen Food Sector-related Open Innovation, Optimization and Development

588375-EPP-1-2017-1-IT-EPPKA2-KA
January 2018-December 2020

Deliverable D 2.4

ASKFOOD Digital Business and Training Ecosystem (DBTE)

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Delivery date: December 2018

Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including Commission services and projects reviewers)	
CO	Confidential, only for members of the consortium (including EACEA and Commission services and projects reviewers)	X

Summary:

This document presents the structure and the main functionalities of the ASKFOOD Digital Business and Training Ecosystem (DBTE). Built upon an extension of the Digital Business Ecosystem (DBE) launched by the European Commission with the initiative "Go Digital" in 2004, the ASKFOOD DBTE is an Open-Source, Co-created and Distributed Platform that collects training pills and contents to support the operativity of the ASKFOOD Innovative Training Hub as Accelerator of an ecosystem (both virtual and digital) of partners and key stakeholders, who will invest in innovative training solutions for the food industry and the food-related sector. The general architecture of the DBTE was designed by Cassiopea and it was shared and the partners, jointly with the first collected materials from key players. The final release of the DTBE is now under-construction and it will be ready in M24.

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Content

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1 Introduction

Training in and for the food sector is facing disruptive challenges, pushing the system towards learner-centric, personalized, situated and context-specific and authentic educational schemes that can guarantee successful learning and continuous development for students and graduates, as well as for industry staff, food professionals and other stakeholders.

The ASKFOOD Erasmus + Knowledge Alliance is a joint effort made by 11 partners from all over Europe to create and to consolidate innovative approaches in training and continuous development of skills, thus to support significative transformations that the food industry is and will be more and more facing in coming years.

One of the key results generated by the ASKFOOD Project is the establishment of the ASKFOOD Innovative Training Hub, intended as a "Hub-and-Spoke"[1] System to support evolutionary schemes for:

(1) both academic and CDP formal training programmes (already existing or needed to be planned in the future);

(2) blended intermediated self-training schemes that will take advantages from the Personalized Learning Environmental Frameworks that will be tested in WP3;

(3) innovative models to combine formal, not formal and informal training to support change, innovation and quality within the food industry and in food-related sectors (e.g. tourism, circular economy, health and wellness, entertainment, nanomaterials, textile and apparel).

In deigning the ASKFOOD Innovative Training Hub, we make an explicit claim that knowledge creation and community building processes are inextricably linked. A 'knowledge model' will always also implicitly be a 'knowledge process'. A knowledge creation process, in turn, will also always imply an organisational structure. Transparency, Accountability, Identity, and Trust leads to an Open Governance and Institutional Innovation process to generate new knowledge for the food industry and the food-related sectors. The consequence of community renewal is to keep it open to the production of new knowledge.

The emergence of an organisational structure can be understood as a universal process of institutionalisation that characterises the dynamics of all social groups.

[1] The term "Hub-and-spoke" originally derives from air-transportation. The meaning is being or relating to a system of routing air traffic in which a major airport serves as a central point for coordinating flights to and from other airports. In this same approach, the ASKFOOD Innovative Training Hub (task 2.1.) is articulated on two levels: 1.) the Central Hub providing inputs and support and finalizing new products as well as innovative training schemes; 2) the local spokes, namely the "Knowledge Clusters" that will be organized at country-level in task 2.2.
This model was also applied as organizational model in the healthcare system (https://www.buxtonco.com/blog/the-future-of-healthcare-systems-a-new-hub-and-spoke-model), in franchising for dairy food and bakery (e.g. https://blog.greatharvest.com/the-bread-business-blog/great-harvests-hub-spoke-model-creates-leverage-multi-unit-franchisees) or in the Business Processes Outsourcing (BPO) (e.g. https://www.slideshare.net/VishalSadar/the-hub-and-spoke-model) .
This last approach is the one by which we were inspired in designing the ASKFOOD Innovative Training Hub as a "Hub and Spoke" system to organize in an innovative and efficient way the knowledge creation and knowledge sharing process referring to training and learning solutions for the food industry and the food related sectors.

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From a social constructivist point of view this phenomenon is associated with the formalisation through language of power relationships mediated by language. If allowed to develop spontaneously and unhindered, therefore, such a process can become an obstacle for democratic processes or knowledge production. It is useful to invoke a natural science metaphor, namely the balance between crystallisation (order, equilibrium) and randomised reconfiguration (chaos, constant variation) that biological organisms are able to strike as a fundamental requirement to remain alive. The 'biological condition' can thus be characterised by its ability to harness its perpetual 'falling' toward equilibrium as an 'engine' that drives order construction processes in the presence, however, of a constant flow of energy, mass, and information that maintains the organism perpetually far from equilibrium and able to adapt to changing environmental conditions.

From this social constructivist viewpoint the constraints on the knowledge production processes brought about by spontaneous institutionalisation processes could then imply a constraint on the social dynamics, and therefore a possible erosion of the innovation processes themselves upon which the community is based. It is therefore important (1) to acknowledge the emergence of power relationships and hierarchies as a direct consequence of the mediation of social interactions by language and communications; and (2) to devise a governance process that can maintain the dynamics of the community "far from equilibrium".

In this perspective, the ASKFOOD Innovative Training Hus is thought as an open community will allow a constant flow of members and ideas to influence its internal knowledge production and decision-making processes. Such a constant flow of 'new blood' will counteract the encroachment of incumbents and the formation of monopolies on any aspect of the knowledge or the community.

The mechanisms by which the 'counteraction' is achieved depend on transparency and accountability. The former depends upon and reinforces trust, the latter implies a process of formalisation of behaviour and its comparison with a shared memory of agreed principles of behaviour. Such a shared memory implies a rudimentary form of collective intelligence.

In this framework, the Digital Business and Training Ecosystem (DBTE) is an Open-Source, Co-Created Platform that supports communication and knowledge sharing between the hub (the central Service provider for and Aggregator of the local clusters – UNITE +IFA) and the spokes (the diverse Knowledge Clusters activated at local level).

Based on these premises, this document provides an overview of:

- The methodology used to design the DBTE
- The steps that were made to design and set up the Alpha version (version 1) of the DBTE
- The main functionalities of the platform
- The next steps that will be implemented by the end of the year to finalize the Beta version and the final release of the DBTE.

2 Business Ecosystems, Digital Ecosystems, Digital Business Ecosystems and the ASKFOOD DBTE

The European Commission, in recent years, has invested in programmes in support of SMEs, providing grants and support to single SMEs. Such direct investments—in a necessarily limited number of individual SMEs—can achieve only limited results. This is especially true when favourable conditions for business are not

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present, e.g. appropriate legislative framework; human capital, diffused knowledge and skills; technical infrastructures; entrepreneurial culture; and critical mass of available services. Such programmes should rather become focused on creating favourable environmental conditions and ecosystems of innovation: "Like individual plants or animals, individual businesses cannot thrive alone—they must develop in clusters or economic ecosystems" (Moore, 2003).

Thus, the Digital Ecosystem initiative was based on the assumption that public sector intervention should be aimed at creating favourable conditions for business. The optimum scale of intervention was judged to be at the regional level, where a multi-stakeholder process of policy development and implementation was likely to be more effective. The policy to support SMEs shifted from an individual approach to an approach focused on the context, aimed at building environments favourable to SMEs' business and their networking, compatibly with the EC policy for "Helping SMEs to go digital" (EC, 2001), which set three priorities:

1. promote a favourable environment and framework conditions for electronic business and entrepreneurship

2. facilitate the take-up of electronic business

3. contribute to providing Information and Communication Technology (ICT) skills.

This policy set can be seen as a starting point for the connection of four multi-layered concepts:

- Business Ecosystems
- Digital Ecosystems
- Digital Business Ecosystems
- Digital Business and Training Ecosystems

All of them are related to two big trends in present business and social environment:

(a) The movement of information goods to centre stage as drivers of economic growth
(b) The ever more widespread use of the peer-to-peer modes of conducting the distribution and utilisation of information, including its re-use in creating new information goods

These two trends are bound together and reinforced by the growing recognition that the "open" (and co-operative) process of knowledge production offers economic efficiencies that in general surpass those of other institutional arrangements, namely those that address the resource allocation problems posed by 'public goods' by protecting secretive practices, or creating and enforcing intellectual property monopolies (Dalle et al., 2005).

2.1 What are Business Ecosystems?

Empirical observation and the historical record in many different cultures and parts of the world indicate that economic development, industrial districts, and more recently technology clusters tend to be co-located geographically. The explanation for such a phenomenon uses a mixture of efficiency and cultural/social arguments. The interpretation favoured in the Digital Ecosystems initiative acknowledges the efficiency gains brought by shared physical infrastructures, lower transportation costs, etc, but also regards social constructivist processes as an important factor in strengthening this dynamic. In other words, it also sees the phenomenon as a natural consequence of the interpretation of technology production as an extension of the language spoken by a particular community: common language leads to a shared understanding of reality, which leads to shared means of expression and therefore similar and interdependent technologies. This is

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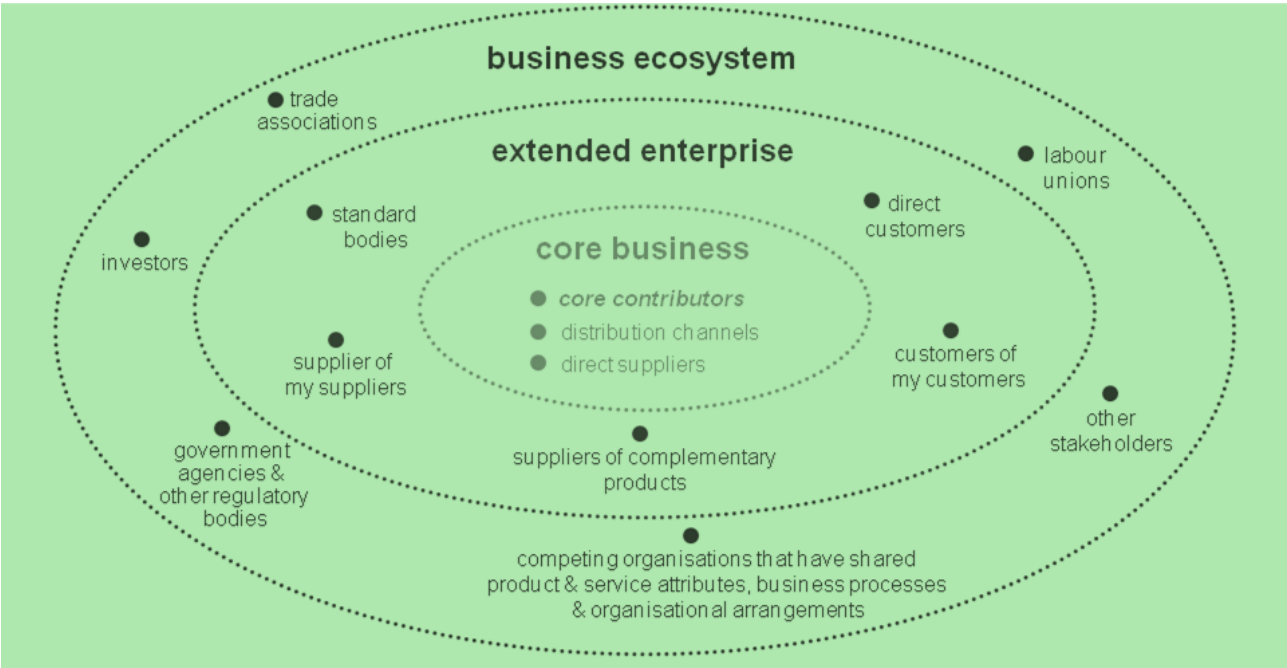
one of the reasons why digital ecosystems are seen as even more effective at the regional rather than at the national or international scale.

Figure 1: The business ecosystem actors



Regarding a particular business ecosystem, two main different interpretations of its structure have been discussed in the literature.

The “keystone” model was assumed by Moore (1996); in this model the ecosystem is dominated by a large firm that is surrounded by a large number of small suppliers. This model works well when the central firm is healthy, but represents a significant weakness for the economy of the region when when the dominant economic actor experiences economic difficulties. This model also matches the economic structure of the USA where there is a predominant number of large enterprises at the center of large value networks of suppliers.

The model of business ecosystem developed in Europe, on the other hand, is less structured and more dynamic; it is composed of mainly small and medium firms but can accommodate also large firms; all actors complement one another, leading to a more dynamic version of the division of labour and organised along one-dimensional value chains and two-dimensional value networks (Corallo, 2007). This model is particularly well-adapted for the service and the knowledge industries, where it is easier for small firms to reinvent themselves than, for instance, in the automotive industry.

Whichever the model, business ecosystems always have eight dimensions that we took in consideration for the design of the ASKFOOD DBTE.

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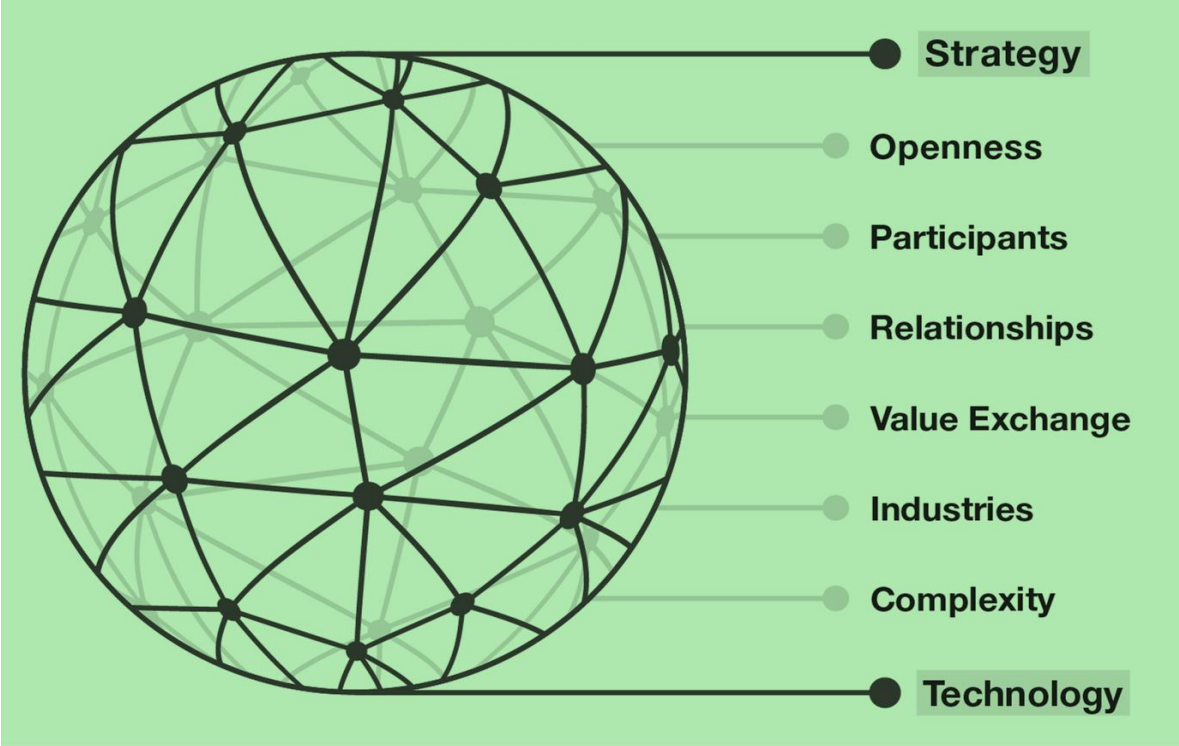
Figure 2: The eight dimensions that business ecosystems always have



2.2 What are Digital Ecosystems?

Digital Ecosystems were made possible by the convergence of three networks: ICT networks, social networks, and knowledge networks. The networked connections enabled by the Internet and the World Wide Web grew along the links of the pre-existing and underlying social, professional, collaboration, and business networks between governments, researchers, businesses, companies, and friends. Computing environments likewise spilled over from the single computer to the local area network (LAN) at first, and eventually to the global Internet. Networked computers motivated the development of distributed architectures and shared resources, culminating in the peer-to-peer (P2P) model. The faster and more pervasive communications enabled by the technology reinforced the already existing trend from a material economy based on manufacturing toward a service economy based on knowledge production and distributed value chains.

If limited to these aspects, Digital Ecosystems are not very original: in information and communication technologies often a group of applications complementing a specific product or platform is considered to form a “digital ecosystem”.

This concept was further developed into the peer production of a ‘digital nervous system’ that supports a participative society in which public and private organisations, professionals and individuals compete, interact, and collaborate for their own benefit and for the benefit of the organisations, teams, ecosystems and/or communities they belong to, in order to enable the participation of all players in the knowledge economy and in the knowledge society, and that empowers the creativity, the potentialities, the capacity, and the dynamic interactions (the relationships and the cooperation/competition) between all the economic players.

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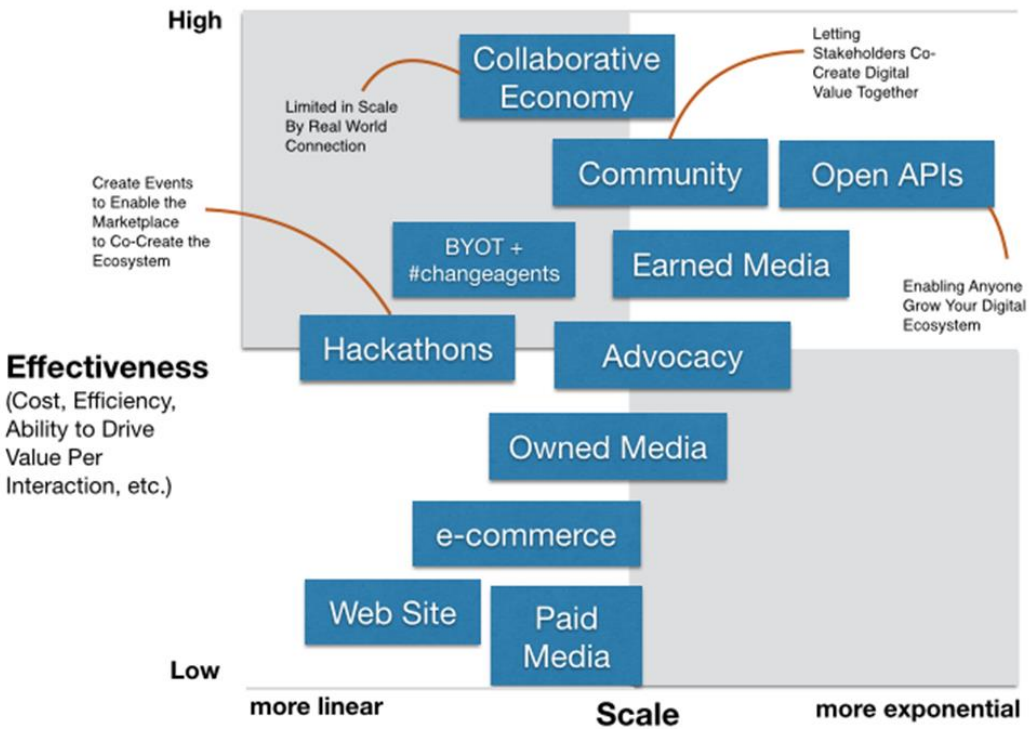
Digital ecosystems are based on eight specific characteristics, that were considered as crucial ones, also in the design of the ASKFOOD DBTE :

- **No single point of failure or control.** Digital ecosystems should not be dependent upon any single instance or actor
- **Equal opportunity of access for all**;
- **Scalability and robustness**;
- **Ability to evolve, differentiate, and self-organise constantly**;
- **Capability to enable global solutions that adapt to local or domain specific needs**;
- **Global solutions that emerge from local and sectoral inputs**;
- **Local autonomy**;
- **Activate and support self-reinforcing production and process networks**.

The above are the basic mechanisms of an autopoietic system, exhibited by living organisms and in natural ecosystems, but also by economic ecosystems. The objective is to produce a dynamic ecosystem of innovation; that is, to catalyse dynamic and remote collaboration and interaction between human and digital entities and systems in various structured and unstructured organisational settings, such as collaborative working environments composed of complex heterogeneous human and digital devices and systems. The ability to implement the production and the reorganisation mechanisms is crucial. Enabling the digital organisms, their networks and the whole system to exhibit mechanisms like self-organisation, selection, mutation, adaptation, and evolution brings the concept of ecosystem beyond a simple metaphor. Figure 3 shows the main evolutionary trends in digital ecosystems and their estimated impact.

Figure 3: Model and evolutionary trends in digital ecosystems and their estimated impact



The Digital Ecosystem realises a public good that expands the space of the digital public domain by creating an intangible 'digital commons', a digital resource that anyone within the relevant community can use under content-neutral terms. The access to the infosphere created by the digital ecosystem commons represents

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one of the most promising strategies to reduce the digital divide between SMEs and large enterprises. Although there is no consensus yet, many believe that lowering the barriers to entry, reducing cost and investment, and working at the centre of a peer knowledge production process allows small enterprises to overcome the activation threshold needed to use ICT in a novel and productive way.

2.3 What are Digital Business Ecosystem?

The synthesis of the concept of Digital Business Ecosystem emerged in 2002 by adding "digital" in front of Moore's (1996) "business ecosystem" in the Unit ICT for Business of the Directorate General Information Society of the European Commission (Nachira, 2002). In truth, Moore (2003) himself used the term Digital Business Ecosystem in 2003, but with a focus exclusively on developing countries. The generalisation of the term to refer to a new interpretation of what "socio-economic development catalysed by ICTs" means was new, emphasising the coevolution between the business ecosystem and its partial digital representation: the digital ecosystem.

The term Digital Business Ecosystem can be "unpacked" as follows:

- **Digital (ecosystem):** the technical infrastructure, based on a P2P distributed software technology that transports, finds, and connects services and information over Internet links enabling networked transactions, and the distribution of all the digital 'objects' present within the infrastructure. Such 'organisms of the digital world' encompass any useful digital representations expressed by languages (formal or natural) that can be interpreted and processed (by computer software and/or humans), e.g. software applications, services, knowledge, taxonomies, folksonomies, ontologies, descriptions of skills, reputation and trust relationships, training modules, contractual frameworks, laws.

- **Business (ecosystem):** "An economic community supported by a foundation of interacting organizations and individuals—the 'organisms of the business world'. This economic community produces goods and services of value to customers, who themselves are members of the ecosystem". (Moore, 1996) A wealthy ecosystem sees a balance between cooperation and competition in a dynamic free market.

- **Ecosystem**: a biological metaphor that highlights the interdependence of all actors in the business environment, who "coevolve their capabilities and roles" (Moore, 1996). Also, in the case of Digital Business Ecosystem, an isomorphic model between biological behaviour and the behaviour of the software, based on theoretical computer science implications and leading to an evolutionary, self-organising, and self-optimising environment (Evolutionary Environemnt or EvE).

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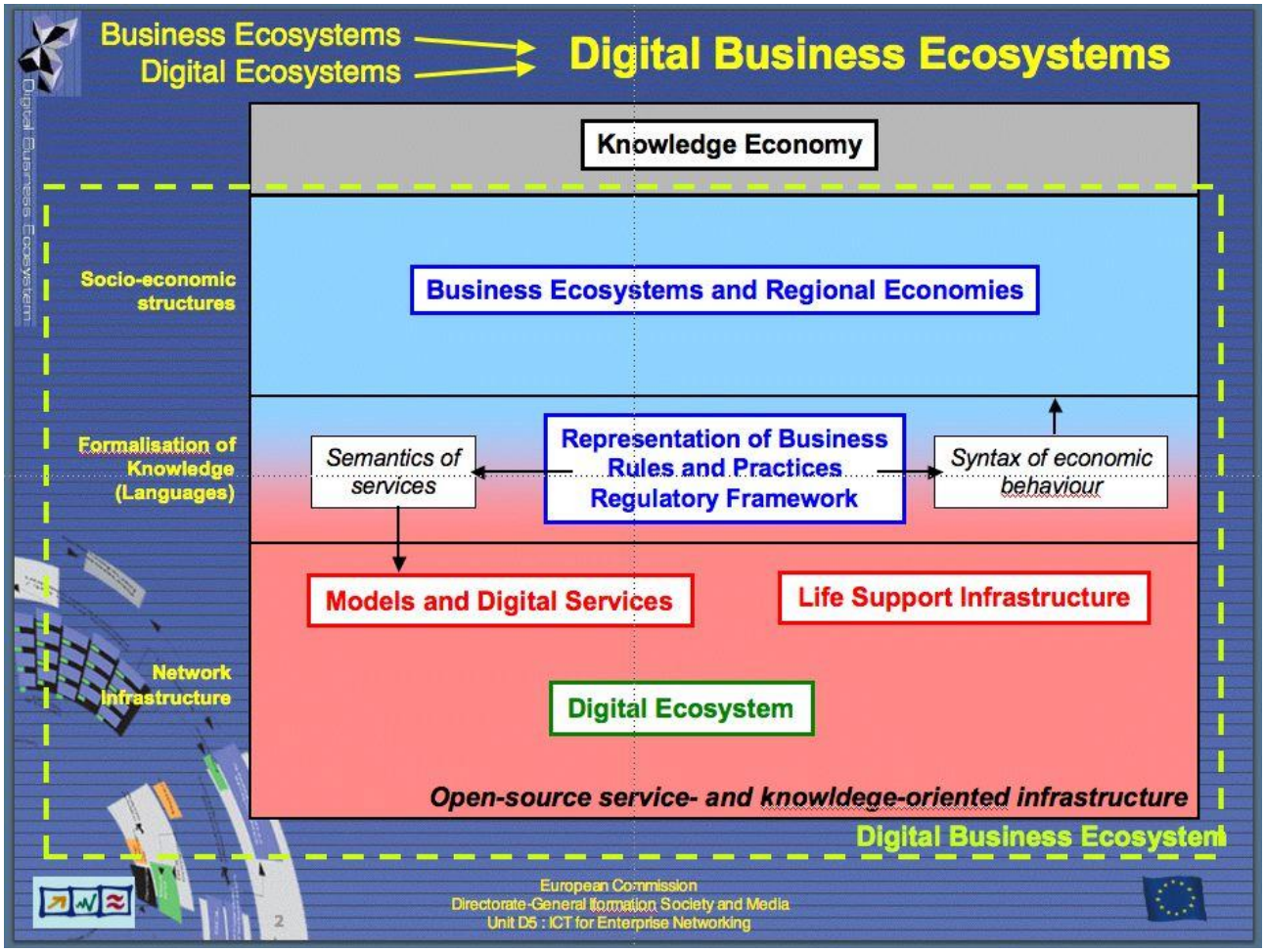
Figure 4: The representation of Digital Ecosystem according to the European Commission



Bringing these three terms together has been effective in broadening the appeal of the approach to a wide range of stakeholders from academia, industry, business, and policy-making. However, it has also rendered a clear explanation of what the three terms mean when used together very difficult. It is especially challenging to show how these three terms necessarily imply some characteristics of the technology and not others, or how they imply some policy and governance choices and not others. The understanding of the term 'digital ecosystem' and of the stakeholders that populate it has developed during the course of the research over the last few years. For example, research conducted in the context of the DBE IP has highlighted the importance of Regional Catalysts and other intermediary actors such as professional associations or volunteer open source communities. This has led to the broadening of the conceptualisation of the term 'business', by including also other actors according to a Quintuple Helix model (Carayannis and Campbell, 2010).

The digital business ecosystem is the ICT infrastructure designed to support economic activities, which contains the socially-constructed representations of the business ecosystem; it is essentially composed by:

- the **knowledge** that expresses different socially-constructed partial interpretations and views of the economy and which is represented through a variety of continuously evolving (natural and formal) languages and protocols.

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- the **architectural infrastructure** that enables the desired "autopoietic" mechanisms and manages the distributed and pervasive storage of such knowledge, as well as the tools enacting the formalisation and the "processing" of this persistent knowledge

Digital business ecosystems are similar to natural ecosystems, but instead of being populated by biological organism they are populated by fragments of knowledge: these are analogous to memes (Wilkins, 1998) that could be computed, expressed in formal or natural languages, digitised and "living" and propagating through the network. Thus, the ecosystem is an environment with a 'life support' architecture designed to enable the 'life' of its 'digital organisms'. The mechanisms embedded within the digital ecosystem, like a (collective) brain, operate on such languages and protocols. The digital ecosystem in its evolution will acquire more services and will be able to include more mechanisms of interpretation of knowledge ('introspection'), becoming more intelligent and providing more support to the business ecosystem. The digital ecosystem embeds evolutionary mechanisms that support the evolution and the adaptation of the languages that populate it (in both intentional an extensional representations). This approach is fundamentally an extension and a conceptualisation of the evolution of the Internet and of the Web.

We can also define them, by using different terms, as technologies and paradigms that enable the participation of SMEs and innovators in the knowledge-based economy, integrating them within local/regional/global socio-economic ecosystems and that enact unstructured dynamic business clustering to achieve greater competitiveness in the global economy.

2.4 What is a Digital Business and Training Ecosystem?

Building upon the three previous dimensions of Business Ecosystem, Digital Ecosystem and Digital Business Ecosystem, the **DBTE is an epistemological distributed structure to connect Knowledge Clusters** (as spokes that collect knowledge needs from local food business ecosystem and give back local responses to these needs, by creating or re-using training and knowledge sharing solutions) **among them and with the Hub** (that will create new services and solutions to stimulate innovation in training and in business models, and will re-aggregate and transfer to all the spokes innovations produced at local level).

2.4.1 System Theory and epistemological framework for DBTE

Epistemology is the branch of philosophy that studies knowledge. It attempts to answer the basic question about how knowledge is built and what distinguishes true (adequate) knowledge from false (inadequate) knowledge. In practice, these questions translate into issues of scientific methodology: how can one develop theories or models that are better than competing theories?

In 1936 the biologist Ludwig von Bertalanffy proposed Systems Theory (Bertalanffy, 1936) as a reaction against the reductionism inherent in the classical scientific analytical approach to isolate an external objective reality, separate it into its constituent parts or elements, and study and analyse it through correspondingly different disciplines. Such an approach is unable to uncover and highlight the interrelations between the parts that connect them into a whole and prevents the perception and understanding of systemic phenomena. In subsequent years **Systems Theory**'s view grew in importance. Many of the concepts used by systems scientists led to the closely related approach of **cybernetics**. The systems scientists and cyberneticists felt the need to separate themselves from the more mechanistic analytic approaches, and they gradually came to emphasise autonomy, self-organisation, cognition, and the role of the observer in modelling a system. In the early 1970s this movement became known as second-order cybernetics, which

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studies how observers construct models of the systems with which they interact (Heyligen, 2001). The movement culminated with the Principia Cybernetica Project, which developed a cybernetic philosophy based on the concept of the "meta-system transition" with implications for human evolution, political systems, and the foundations of mathematics.

The two basic principles of such an approach are:

- Knowledge is not passively received either through the senses or by way of communication but is **actively built up by** the cognising subject.
- **The function of cognition is adaptive** (in the biological sense of the term), tending towards fit or viability) and serves the subject's organisation of the experiential world, not the discovery of an objective ontological reality.

The importance of **constructivism** and its relation to cognitive science is best understood by comparing it with the opposite, more traditional, approach in epistemology or cognitive science, which sees knowledge as a passive reflection of an external, objective reality. This implies a process of "instruction": in order to get such an image of reality, the subject must somehow receive the information from the environment, i.e. it must be "instructed".

Cybernetics began with the recognition that all our knowledge of systems is mediated by our simplified representations—or models. Thus, first-order cybernetics studies a system as if it were a passive, objectively given "thing", that can be freely observed, manipulated, and for which we have to provide the "true" representation. A second-order cyberneticist working with an organism or social system, on the other hand, recognises that system as an agent in its own right, interacting with another agent, the observer.

By acting in this way, second-order cybernetics implies the concept of **autopoiesis** in the generation of knowledge and of systems that have knowledge creation as a purpose.

Maturana and Varela (1973) invented the concept of autopoiesis as a model that generalises the structure and function of a biological cell, and defines the characteristic of a living system. But autopoiesis is an epistemological option, which goes beyond the cell and the nervous systems, becoming a fundamental instrument for the investigation of reality. The concept has long surpassed the realm of biology and has been used to explain human communication and social systems impacting on sociology, psychotherapy, management, anthropology, organisational science, and law. An autopoietic system can be described briefly as a self-producing machine, or a self-generating system with the ability to reproduce itself recursively. An autopoietic system exhibits a network of processes and operations, which could create, destroy, or reorganise themselves in response to external inputs and perturbations. Since autopoietic systems are simultaneously producers and products, it could also be said that they are circular systems, that is, they work in terms of productive circularity. The reference to a "system" carries a specific meaning in the theory, namely the ability of an autopoietic system to delimit itself spatially through a physical boundary (the membrane for the cell, the interface with the "real word" for the digital ecosystem) in order for the autopoietic process to be able to discriminate the "inside" to which autopoiesis applies, from the "outside", to which it does not. In Digital Ecosystems research autopoiesis is used as the ultimate model of interactive computation, but it is also used as a metaphor for a generalised form of organisation. Specifically, "organisational closure" is defined as the stability of the organisational structure of the system, even when the system is open to a flow of energy and mass, such as a cell, whereby each element or sub-process of the system conspires to maintain the organisation of the system that makes it autopoietic.

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Autopoietic systems are structure-determined systems. The potential behaviour of the system depends on its structure. Maturana calls this concept structural determinism, i.e. a process of change of an organism that, at any point in time, is determined by the organism's previous structure but is triggered by the environment. Thus, the structure of a given system is not static; it is one of many ways in which its components can interconnect whilst retaining a recognisable organisation:

Living systems have a plastic structure, and the course that their structural changes follows while they stay alive is contingent on their own internal dynamics of structural change modulated by the structural changes triggered in them by their interactions in the medium in which they exist as such.

An important aspect of autopoiesis is its radical relativism, which is inescapable and manifests itself as structural coupling: a form of mutual and symmetrical interdependence between two entities that, at any point in time, is determined by each entity's previous structure whilst being triggered by the other. In other words, structural coupling is a form of interdependence between two actors or entities that satisfies the criterion of structural determinism mutually and symmetrically (conceptually similar to non-linear coupling in physics). Nothing in biology exists by itself; everything interacts with everything else. By extrapolating this concept from the physical level to the neuronal and cognitive levels Maturana and Varela made an explicit connection with the process of "languaging" between two or more entities. This is surprisingly well aligned with the social constructivism understanding of the intersubjective construction of reality through language.

These ideas acquire greater relevance when we consider that Digital Ecosystems include digital computable representations of both the micro-economic and the macro-economic aspects of the business ecosystem. The digital ecosystem provides representations of the business ecosystem, which are used for search and discovery, for aggregating and recommending services, for reorganising value chains, and for recommending potentially cooperating business partners. The digital ecosystem influences the structure of the enterprises and of their social and business networks, whilst the business ecosystem modifies the structure of the "organisms" of the digital ecosystem. The digital ecosystem and the business ecosystem, when they are viable, are structurally coupled and co-evolve forming a dynamic innovation ecosystem.

It is through the daily interactions between people in the course of social life that our versions of the knowledge become fabricated. Therefore social interaction of all kinds, and particularly language, is of great interest to social constructionists. The goings-on between people in the course of their everyday lives are seen as the practices during which our shared versions of knowledge are constructed. What is considered as truth may be thought of as our current accepted ways of understanding the world. These are product not of objective observation of the world, but of the social processes and interactions in which people are constantly engaged with each other. Descriptions or constructions of the world therefore sustain some patterns of social action and exclude others. (Burr, 2003)

Concepts and categories are developed through language, which provides a framework of meaning. Languages are the necessary precondition for thought as we know it. The ways we understand the world, and the concept and the categories we use are historically and culturally determined, and do not necessarily refer to real divisions. Not only are they specific to particular cultures and periods of history, but are dependent upon the particular social and economic arrangements prevailing in that culture at that time (Burr, 2003). With the advent of the Information Society what we perceive to exist is mostly what exists in the media or on the Internet. The information, or the digital representations of the ecosystem, shapes the user perception of the business ecosystem. The more rich and more 'populated' a digital ecosystem is, the more aspects of the economy can be described and mediated. Thus, when we abandon the mirage of an objective

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reality and accept that reality is a collectively built and shared perception resulting from a social process mediated by languages, and we apply these insights to the digital world and to formal languages, we gain powerful instruments for development.

2.4.2 Community of Practices and AGILE approach to innovation as models for the DBTE

In order to create the largest richness in the DBTE, other two models need to be considered:

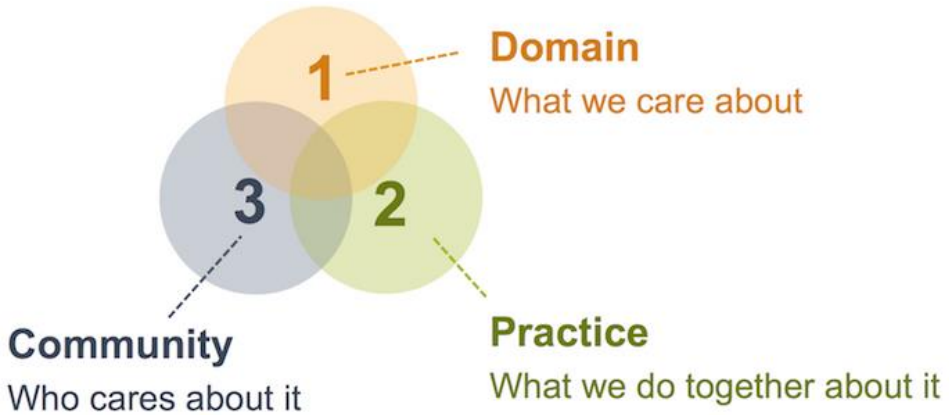
1. The evolution of the concept of **Community of Practices (CoP)**;
2. The **Quintuple Helix approach** to knowledge and education.

CoPs are organized groups of people who have a common interest in a specific technical or business domain. They collaborate regularly to share information, improve their skills, and actively work on advancing the general knowledge of the domain. The open membership of CoPs offers access to a wider range of expertise to help with technical challenges, fuel continuous improvement and allows more meaningful contributions across multiple domains.

According to Wenger (1999), CoPs must have three distinct traits (Figure1):

- **Domain:** An area of shared interest. In the case of the ASKFOOD DBTE this area is innovation in knowledge and learning process for the competitiveness of the food industry.
- **Practice:** A shared body of knowledge, experiences and techniques. In the case of the ASKFOOD DBTE this will be allowed by the Knowledge Clusters
- **Community:** A self-selected group of individuals who care enough about the topic to participate regularly.

Figure 5: The components of the Communities of Practices according to Wenger



CoPs are highly organic, and like most living organisms, they have a natural life cycle (Figure 2), beginning with the idea for a new community and ending when the community members feel the group has achieved its objectives and is no longer providing value.

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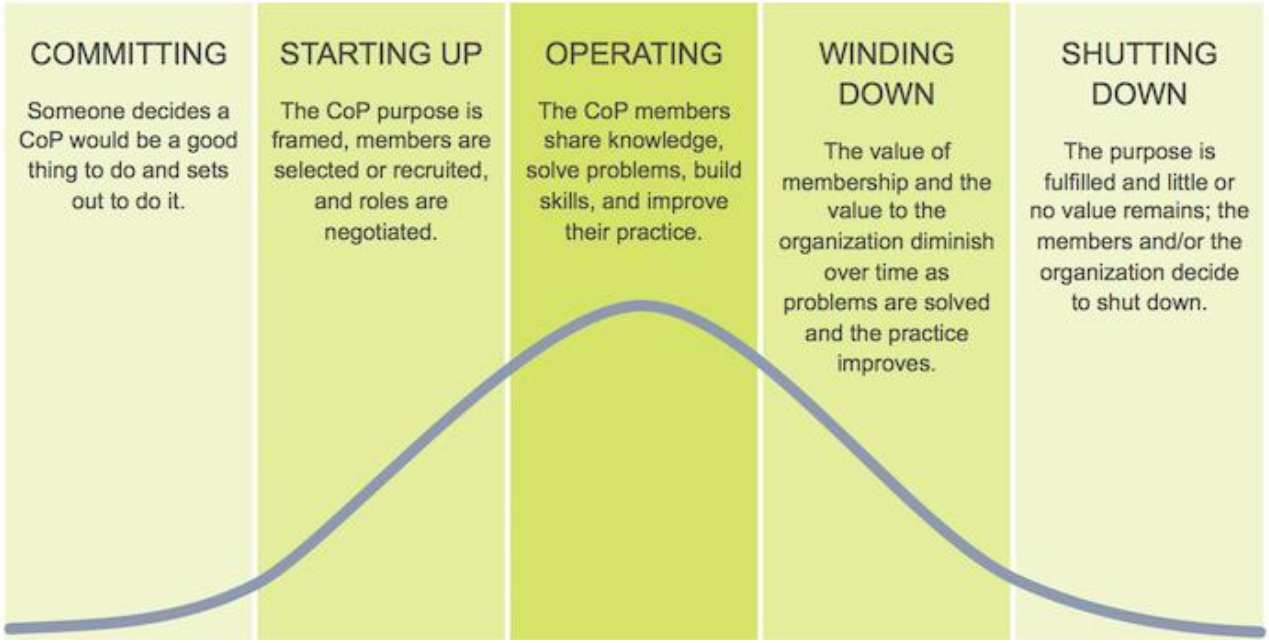
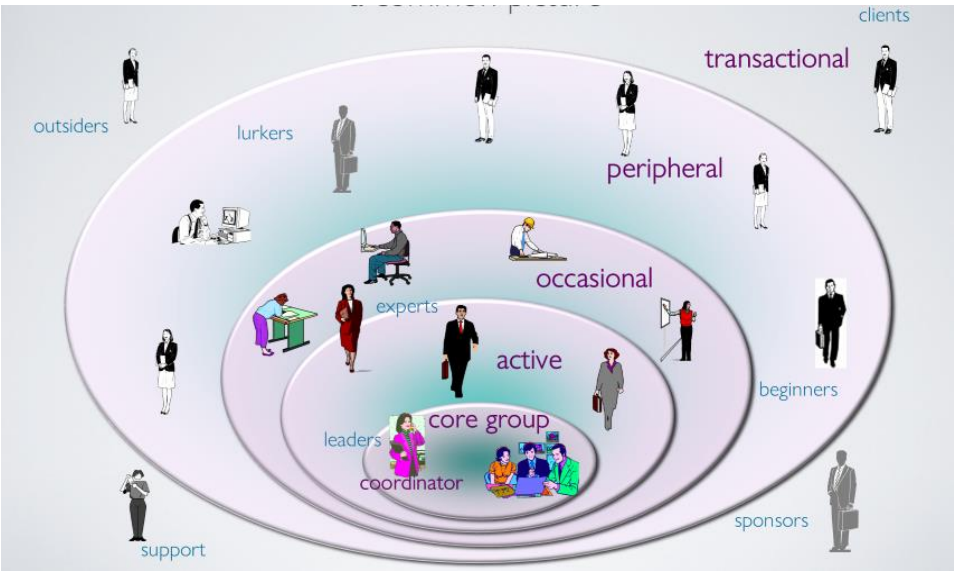
Figure 6: The CoP Life Cycle and stages of development



CoPs are formed in the committing stage by a small, core group of practitioners who share a common passion and need for a particular domain. Communities of practice usually involve multiple levels of participation, as do most social learning spaces. Because involvement can produce learning in multiple ways and the domain has different levels of relevance to different people, the boundaries of a community of practice are more flexible than those of organizational units or teams. As shown in Figure 7, CoP members exhibit multiple levels of participation and can move freely across the levels as needs and interests evolve.

Figure 7: Levels of participation in CoP



- **Core group:** a relatively small group of people whose passion and engagement energize and nurture the community
- **Active participants**: members who are recognized as practitioners and define the community (though they may not be of one mind as to what the community is about)

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- **Occasional participants**: members who only participate when the topic is of special interest, when they have some specific to contribute, or when they are involved in a project related to the domain of the community
- **Peripheral participants**: people who have a sustained connection to the community, but with less engagement and authority, either because they are still newcomers or because they do not have as much personal commitment to the practice. These people may be active elsewhere and carry the learning to these places. They may experience the community as a network
- **Transactional participants**: outsiders who interact with the community occasionally without being members themselves, to receive or provide a service or to gain access to artifacts produced by the community, such as its publications, its website, or its tools

Note that people will move in and out of these categories over the life of a community. Interactions and knowledge flows between these constituencies create many opportunities for learning and are a sign of community health. Different types of participants in a community of practice have different perspectives, needs, and ambitions.

Usually, a layered structure with various levels of participation is not a problem. It is a natural and healthy state for a community. Still there are cases where this situation can be a red flag and require active intervention. It is often a problem when the distinction between levels of participation reflects a distinction that comes from outside the community. For instance, if the core group is entirely from headquarters and people in the field are peripheral participants, this is usually a situation that is going to require some corrective action, such as giving people in the field some active role in running the community. Another red flag is when there is no movement across levels, no one from the periphery moving in, the same old core group, or no new blood among active members. Again it may be useful to be proactive in inviting people in.

2.4.3 The Quintuple Helix approach

The Quintuple Helix approach can be seen as the logical extension of previous models of knowledge, specifically mode 1, mode 2, the triple helix, mode 3, and the quadruple helix. These can be described as:

Mode 1. Mode 1 was theorized by Michael Gibbons and "focuses on the traditional role of university research in an elderly 'linear model of innovation' understanding", and success in mode 1 "is defined as a quality or excellence that is approved by hierarchically established peers".

Mode 2. Mode 2 was theorized by Michael Gibbons and is characterized by the following five principles: (1) knowledge produced in the context of application; (2) transdisciplinarity; (3) heterogeneity and organizational diversity; (4) social accountability and reflexivity; (5) and quality control.

Triple Helix. The triple helix was first suggested by Henry Etzkowitz and Loet Leydesdorff in 1995. The Triple Helix overlay provides a model at the level of social structure for the explanation of mode 2 as an historically emerging structure for the production of scientific knowledge, and its relation to Mode 1, and it is a "model of 'trilateral networks and hybrid organizations' of 'university-industry-government relations'.

Mode 3. Mode 3 was developed by Elias G. Carayannis and David F.J. Campbell in 2006. The concept of mode 3 is more inclined to emphasize the coexistence and coevolution of different knowledge and innovation modes. Mode 3 even accentuates such pluralism and diversity of knowledge and innovation modes as being necessary for advancing societies and economies. This pluralism supports the processes of a mutual cross-

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learning from the different knowledge modes. Mode 3 encourages interdisciplinary thinking and transdisciplinary application of interdisciplinary knowledge and allows and emphasizes the coexistence and coevolution of different knowledge and innovation paradigms.

Quadruple helix. Building on the triple helix model of innovation economics, the quadruple helix model adds a fourth component to the framework of interactions between university, industry and government: civil society and the media. This was first suggested in 2009 by Elias G. Carayannis and David F.J. Campbell in "'Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem". The aim is to bridge the gaps between innovation and users in the form of civil society. Indeed, this framework claims that under the triple helix model, emerging technologies do not always match the demands and needs of society, thus limiting their potential impact. This framework emphasizes a societal responsibility of universities, in addition to their role of educating and conduction research. The quadruple helix model also incorporates the concept of a 'media-based democracy',which Carayannis and Campbell, following Plasser, define as "media reality overlaps with political and social reality; perception of politics primarily through the media; and the laws of the media system determining political actions and strategies." Carayannis and Campbell state this fourth helix includes both the civil society and the users of innovation, thereby acknowledging that knowledge and innovation policies and strategies must incorporate the 'public' to successfully achieve goals and objectives. In the quadruple helix, public reality is constantly being constructed and communicated via the media, while also being influenced by culture and values through cultural artefacts like movies. When the political system (government) is developing innovation policy to develop the economy, it must adequately communicate its innovation policy with the public via the media "to seek legitimation and justification," i.e., public support for new strategies or policies. For industry involved in R&D, companies' public relations strategies have to negotiate 'reality construction' by the media. For university and academia, Carayannis and Campbell offer the example of improving the gender ratio in engineering courses by improving the 'social images' of women and technology in society in order to improve the "innovation cultures" involved. How to define this fourth helix has been debated according to Högluind and Linton (2018), and some researchers see it as an additional helix while others see it as a different type of helix which is overarching all the other helices. The quadruple helix has implications for smart co-evolution of regional innovation and institutional arrangements, i.e., regional innovation systems. The quadruple helix is the approach that the European Union has intended to take for the development of a competitive knowledge-based society

Quintuple Helix. Apart from active human agents, the most important constituent element of the quintuple helix is knowledge, which, through a circulation between societal subsystems, changes to innovation and know-how in a society and for the economy. The quintuple helix visualizes the collective interaction and exchange of this knowledge in a state by means of the following five subsystems (i.e., helices): (1) education system, (2) economic system, (3) natural environment, (4) media-based and culture-based public (also 'civil society'), (5) and the political system. Each of the five helices has an asset at its disposal, with a societal and scientific relevance.

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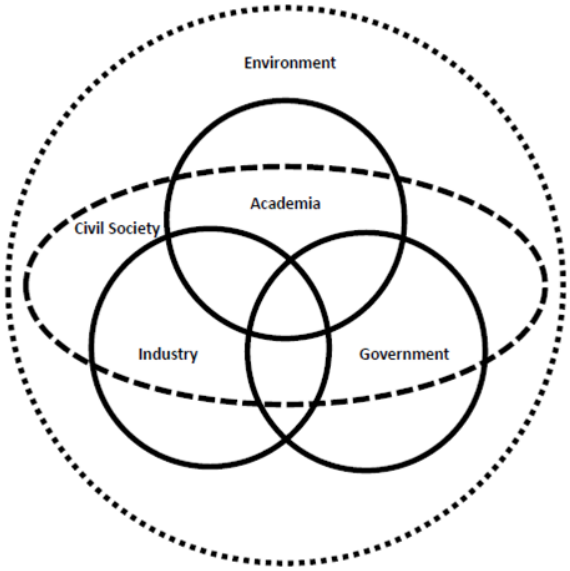
Figure 8: The Five Helices of the Quintuple Helix



1) The education system defines itself in reference to academia, universities, higher education systems, and schools. In this helix, the necessary 'human capital' (e.g., students, teachers, scientists/ researchers, academic entrepreneurs, etc.) of a state is being formed by diffusion and research of knowledge.

2) The economic system consists of industry/industries, firms, services and banks. This helix concentrates and focuses the economic capital (e.g., entrepreneurship, machines, products, technology, money, etc.) of a state.

3) The natural environment subsystem is decisive for sustainable development and provides people with natural capital (e.g., resources, plants, variety of animals, etc.).

4) The media-based and culture-based public subsystem integrates and combines two forms of capital. This helix has, through the culture-based public (e.g., traditions, values, etc.), a social capital. In addition, the helix of media-based public (e.g., television, internet, newspapers, etc.) contains capital of information (e.g., news, communication, social networks).

5) The political system formulates the will, i.e., where the state is heading, thereby also defining, organizing, and administering the general conditions of the state. Therefore, this helix has political and legal capital (e.g., ideas, laws, plans, politicians, etc.).

The resource of knowledge is the most important 'commodity' in the quintuple helix, and the circulation of knowledge continually stimulates new knowledge. Consequently, all helices in the quintuple helix influence each other with knowledge in order to promote sustainability through new, advanced and pioneering innovations.

The circulation of knowledge can be readily understood via the example of how injections of education in sustainable development circulate within the economy in five steps:

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Step 1: When investments flow into the education helix to promote sustainable development, they create new impulses and suggestions for knowledge creation in the education system. Therefore, a larger output of innovations from science and research can be obtained. Simultaneously, teaching and training improve their effectiveness. The output that arises from human capital for sustainable development is then an input into the economic system helix.

Step 2: Through the input of new knowledge via human capital into the economic system helix, the value of the knowledge economy consequently increases. Through the enhancement of knowledge, important further production facilitates and develops opportunities for a sustainable, future-sensitive green economy, based on knowledge creation. This knowledge creation realizes in the economic system new types of jobs, new green products and new green services, together with new and decisive impulses for greener economic growth. In this subsystem, new values, like corporate social responsibility, are demanded, enabling and supporting a new output of know-how and innovations by the economic system into the natural environment helix.

Step 3: This new sustainability as an output of the economic system is a new input of knowledge in the natural environment helix. This new knowledge 'communicates' to nature and results in less exploitation, destruction, contamination, and wastefulness. The natural environment can, thus, regenerate itself and strengthen its natural capital, and humanity can also learn from nature via new knowledge creation. The goal of this helix is to live in balance with nature, to develop regenerative technologies, and to use available, finite resources sustainably. Here, natural science disciplines come into play, forming new green know-how. This know-how is then an output of the natural environment subsystem into the public helix.

Step 4: The output of the natural environment results in an input of new knowledge about nature and a greener lifestyle for the media-based and culture-based public helix. Here, the media-based public receives information capital, which spreads through the media information about a new green consciousness. This capital should provide incentives on how a green lifestyle can be implemented in a simple, affordable, and conscious way, i.e., knowledge creation. This knowledge creation promotes the social capital of the culture-based public, on which a society depends for sustainable development. This know-how output then serves as new input, about the wishes, needs, problems, or satisfaction of citizens, for the political system helix.

Step 5: The input of knowledge into the political system is the know-how from the media-based and culture-based public together with the collective knowledge from the three other subsystems of society. Important discussions on this new knowledge in the political systems are necessary impulses for knowledge creation. The goal of this knowledge creation is political and legal capital, making the quintuple helix model more effective and more sustainable. Consequently, there is an output of suggestions, sustainable investments, and objectives. This leads to the circulation of knowledge back into the education system.

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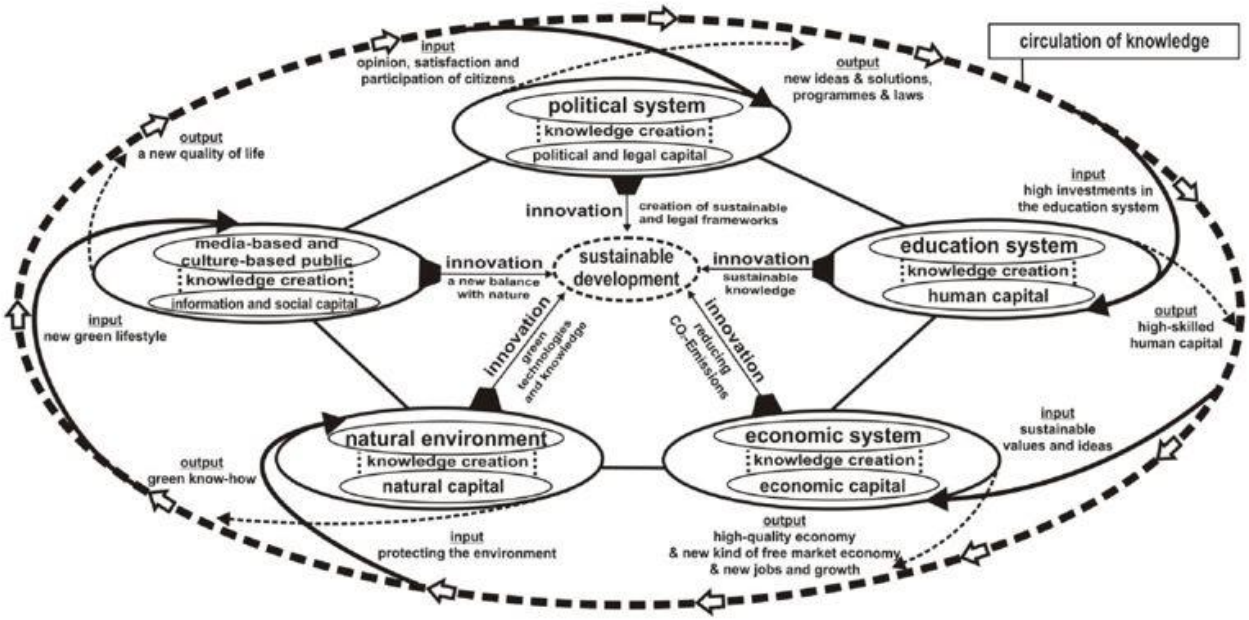
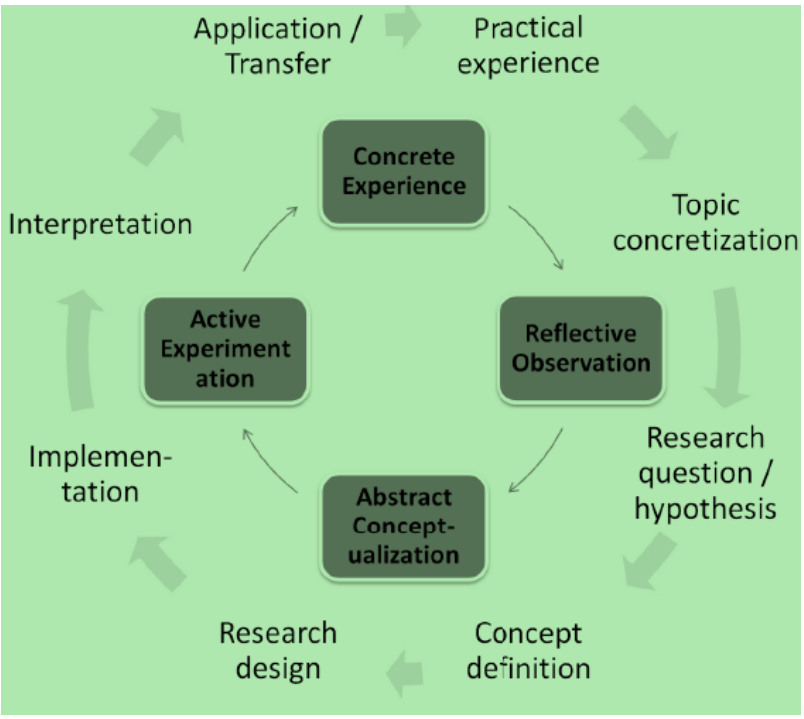
Figure 9: Effects of Investment in Education Sustainability in Quintuple Helix



2.4.4 The four main components of a DBTE that are originated by the methodological schemes

The ASKFOOD DBTE shall support the action learning process of/among the different components of the ASKFOOD Innovative Training Hub. It will collect practices and knowledge so to support a continuous learning cycle based on concrete experience, reflective observation, abstract conceptualization and active experimentation, as designed in Figure 10.

Figure 10: The Knowledge Creation Process in the ASKFOOD DBTE



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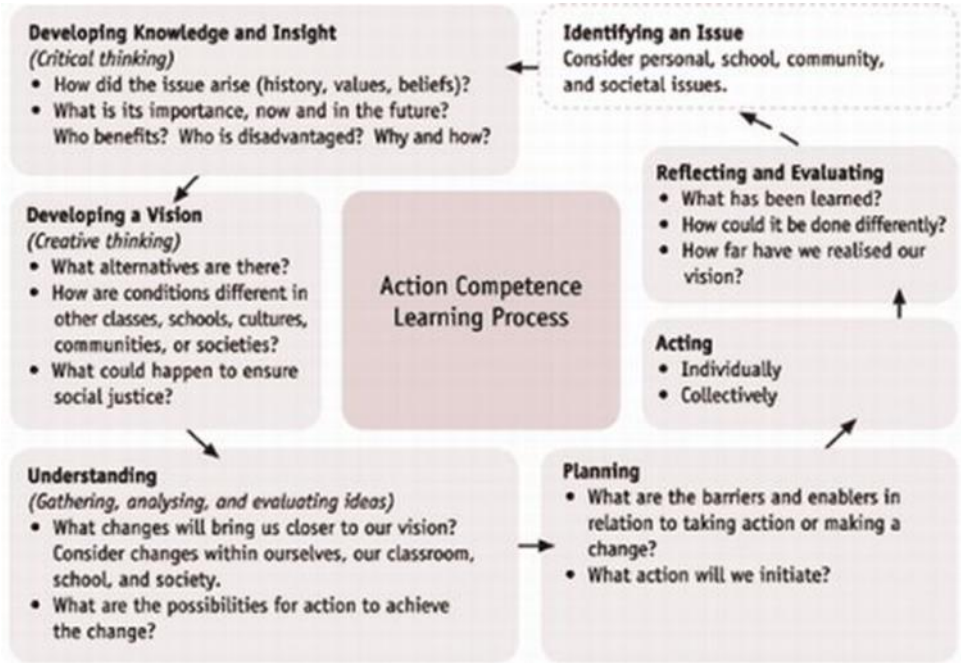
According to these reflections and methods, the design of a DBTE implies **four main components**:

(a) **The creation of a common language** that implies the validation of a shared model for the management of knowledge and of the peer-to-peer or mediated learning. This will be managed through a direct confrontation based on the action competence learning process (Figure 11).

Figure 11: The Action Competence Learning Process



(b) **The design of the digital architecture to manage memes, contents and solutions that can be shared and/or co-created according to a Quintuple Helix Approach.** Also in the training/learning ecosystems, supply chains are increasingly becoming value webs that span and connect whole ecosystems of suppliers and collaborators; properly activated, they can play a critical role in reshaping business strategy and delivering superior results. This is why the ASKFOOD DBTE builds on university-business relations to reshape training and innovation strategy.

(c) **The design of operational, organizational and web-based workflows to support the functionality of the ecosystem.** Properly designed business platforms can help create and capture new economic value and scale the potential for learning across entire food and food-related ecosystems.

(d) **The activation of the key stakeholders to make the DBTE effectively function.** As every ecosystem, also the ASKFOOD DBTE is a dynamic and co-evolving community of diverse actors who create new value through increasingly productive and sophisticated models of both collaboration and competition.

3 The steps for the design and the set up of the Alpha version of the ASKFOOD DBTE

The design of the ASKFOOD DBTE is based on the set up of an innovative scheme. Like every innovation and growth process, the operational flow to generate and manage it is based on traditional critical steps for innovation and growth (Figure 12).

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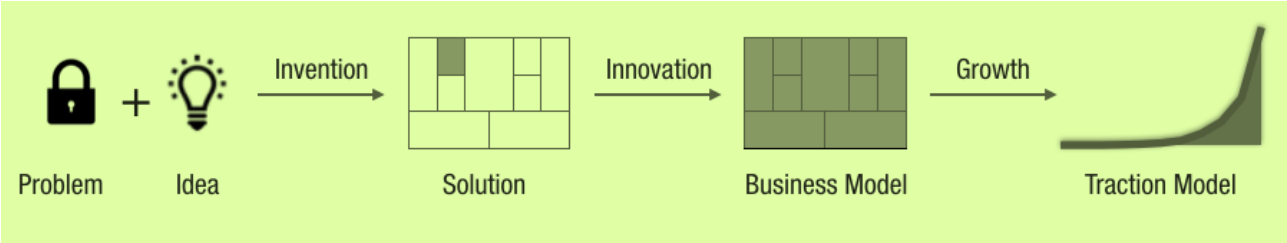
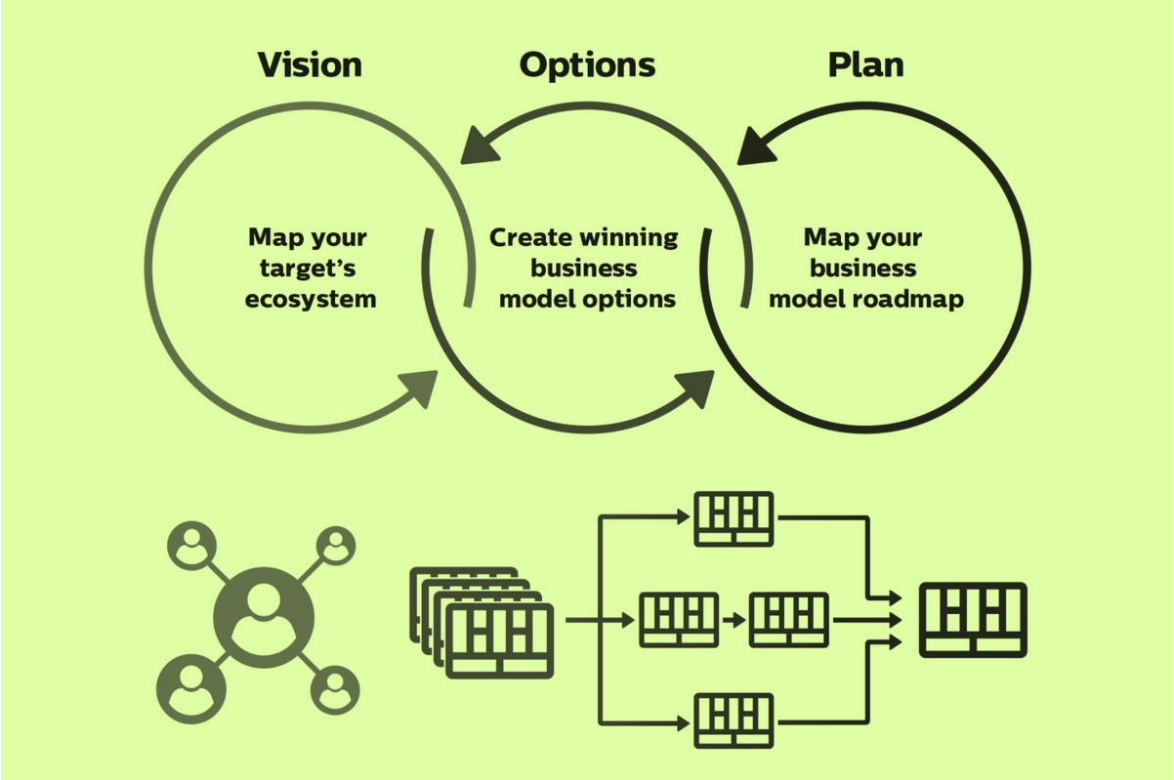
Figure 12: The traditional stages in innovation management



This general model was enriched by two additional specifications:

(1) we used an **ecosystem based approach** to generate the DBTE. This is meant a continuous interaction with the food industry's ecosystem, to create alternative winning business model options and to map consequently the plan for an effective implementation (Figure 13);

Figure 13: The interaction among the three stages of an ecosystem based approach to innovation



(2) the adoption of the **GO LEAN Approach** to generate innovative solutions. According to this approach (Figure 14) that draws heavily on lean startup principles and systems thinking: 1. Goal; 2. Observe and Orient; 3.Leverage; 4.Experiment; 5.Analyze; 6. Next Action

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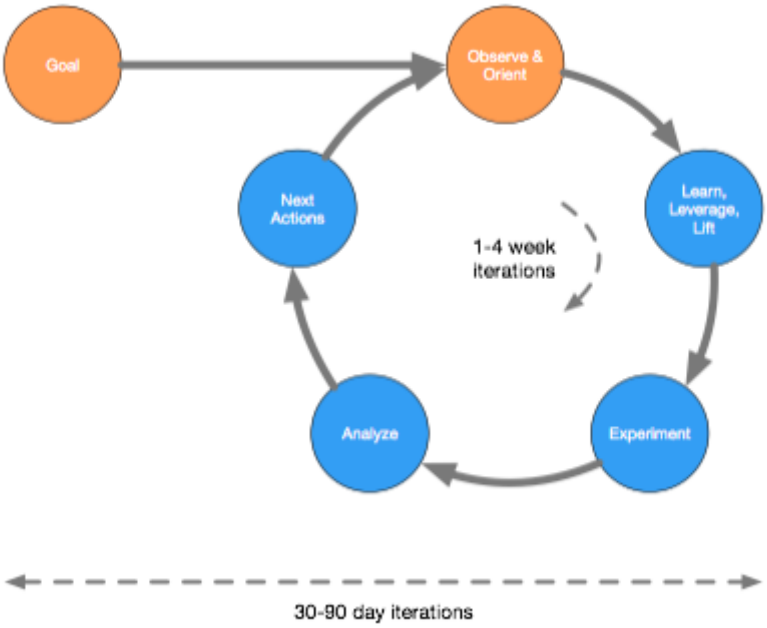
Figure 14: The steps of the GO LEAN Method



The design and the set up of the Alpha version of the DBTE covered from stage 1 to stage 4 of the GO LEAN scheme and it went through four main operational steps:

<u>Step 1:</u> Validation of the model and of the goal among the Consortium Partners

Description: This stage was dedicated to fix up the goal and the methodological and technological framework for the DBTE. It was managed through in-deep focus meetings with partners and confrontation with selected expert groups and representatives from the food clusters at local level.

Period: M8

<u>Step 2</u>: Internal Knowledge exchange about the six building blocks

Description: This stage was dedicated to observe and orient the business model and the content development by validating existing schemes and platforms related to the six building block of the learning process.

Period: M9

<u>Step 3</u>: Agreement upon the main functionalities of the DBTE

Description: This stage was dedicated to focus on the main functionalities that the DBTE should cover according to the structure and the aims of the ASKFOOD Innovative Training Hub (as defined in task 2.1) and to the specific purposes described in the Local Action Plans for the Knowledge Clusters (task 2.2.)

Period: M10

<u>Step 4</u>. Key Stakeholders Mapping and Enabling

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Description: This stage was dedicated to: (1) create the core group for the DBTE as a CoP; (2) recruit the problem owners and the experts; (3) create a stakeholder profiling and mapping to support future engagement by the Knowledge Clusters, starting identifying the Local Competency Boosters (who are players who can accelerate investments on innovative training schemes for the food industry) and the key stakeholders (classified according the MEET rule, by starting with profiling them as: Change Motivators, Change Enablers, Change Engineers or Change Triggers)

Period: M10

Step 5: Release of the Alpha version

Description: The first version of the DBTE, as the described in the following paragraph, was released (only for internal use).

Period: M12

4 The structure and the functionalities of the ASKFOOD DBTE

The DBTE is a Platform to support the activity of the CoP, that is organized as a Knowledge Map/Aggregator and Practice Sharing Tool around the six building blocks (BB) of the learning and knowledge management process:

BB1. Knowledge Diagnosis: A knowledge diagnosis is the qualitative evaluation of an organization's knowledge "health". The knowledge audit is the first major step of a knowledge management initiative. It's used to provide a sound investigation into the company or organization's knowledge 'health'. For those of you who are confused between a content audit and a knowledge audit: a content audit is focused primarily on the content in the organization. It just identifies what content exists and what doesn't. Details like what the content is used for isn't really looked into. A knowledge audit, on the other hand, looks at problems and puts the information in the context of the problem.

BB2. Knowledge Creation: Knowledge creation refers to the continuous combination, transfer, and conversion of different kinds of knowledge. This occurs as users interact, practice and learn. Put simply; it is the creation of ideas, which is at the heart of a company's competitive advantage. Knowledge creation is the formation of new notions and concepts. This occurs through interactions between explicit and tacit knowledge in people's minds. Explicit knowledge is information that is searchable and easy to find. Users can collaborate regarding the value and use of this type of explicit knowledge. Tacit knowledge, on the other hand, exists in people's minds. It is not searchable like explicit knowledge is. It is also not easy to share with another person orally or in writing.

BB3. Knowledge Transfer: Knowledge transfer refers to sharing or disseminating of knowledge and providing inputs to problem solving. In organizational theory, knowledge transfer is the practical problem of transferring knowledge from one part of the organization to another. Like knowledge management, knowledge transfer seeks to organize, create, capture or distribute knowledge and ensure its availability for future users. It is considered to be more than just a communication problem. If it were merely that, then a memorandum, an e-mail or a meeting would accomplish the knowledge transfer. Knowledge transfer is more complex because:

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- knowledge resides in organizational members, tools, tasks, and their subnetworks and
- much knowledge in organizations is tacit or hard to articulate

BB4. Knowledge Internalization: The internalization of newly created knowledge is the conversion of explicit knowledge into the organization's tacit knowledge. This requires the individual to identify the knowledge relevant for one's self within the organizational knowledge. That again requires finding one's self in a larger entity. Learning by doing, training and exercises allow the individual to access the knowledge realm of the group and the entire organization. In practice, internalization relies on two dimensions:

- First, explicit knowledge has to be embodied in action and practice. Thus, the process of internalizing explicit knowledge actualizes concepts or methods about strategy, tactics, innovation or improvement. For example, training programs in larger organizations help the trainees to understand the organization and themselves in the whole.
- Second, there is a process of embodying the explicit knowledge by using simulations or experiments to trigger learning by doing processes. New concepts or methods can thus be learned in virtual situation.

BB5. Knowledge Brokering and Sharing: It's the process that integrated pieces of knowledge from different owners. It requires translation, coordination and alignment between perspectives. It requires enough legitimacy to influence the development of a practice, mobilise attention, and address conflicting interests. It requires the ability to link practices by facilitating transactions between them, and to cause learnings by introducing into a practice elements of another. Toward this end, brokering provides a participative connection - not because reification is involved, but because what brokers press into service to connect practice is their experience of multi-membership and the possibilities for negotiation inherent in their participation.

BB6. Knowledge Codification: Knowledge codification is the conversion of tacit knowledge to explicit knowledge, so that the knowledge can be used in the organisation by the staff. In addition to this, it can be defined as the final result of Knowledge Conversion processes: (1)Conversion from tacit to tacit knowledge produces socialization where knowledge developer looks for experience in case of knowledge capture; (2) Conversion from tacit to explicit knowledge involves externalizing, explaining or clarifying tacit knowledge via analogies, models, or metaphors; (3) Conversion from explicit to tacit knowledge involves internalizing (or fitting explicit knowledge to tacit knowledge; (4) Conversion from explicit to explicit knowledge involves combining, categorizing, reorganizing or sorting different bodies of explicit knowledge to lead to new knowledge.

According to these six building blocks, members of the CoP can share materials, post news on the social walls, share practices, pose questions, deliver knowledge nuggets, create a thematic group or participate to one of those already in the DBTE, activate business exchanges referred to training solutions, knowledge management or learning models and materials.

Figure 15 presents the generic layout of the DBTE. The Platform allows uploading and downloading of materials; blogging with members of thematic group or within the single community (Local Knowledge Clusters).

The platform is articulated into 10 main areas of content:

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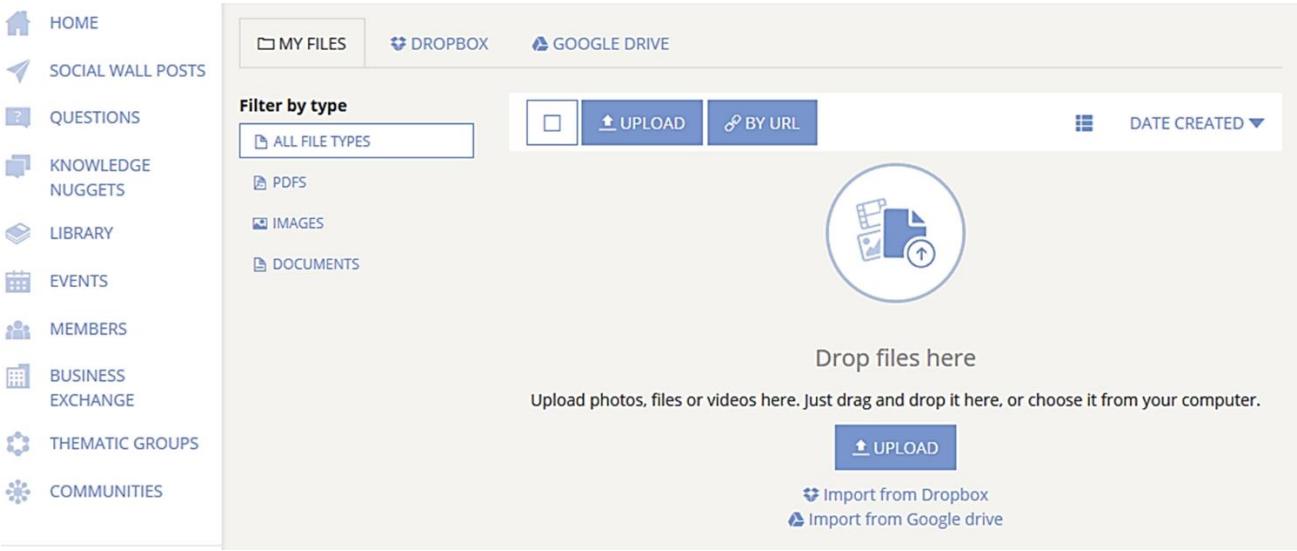
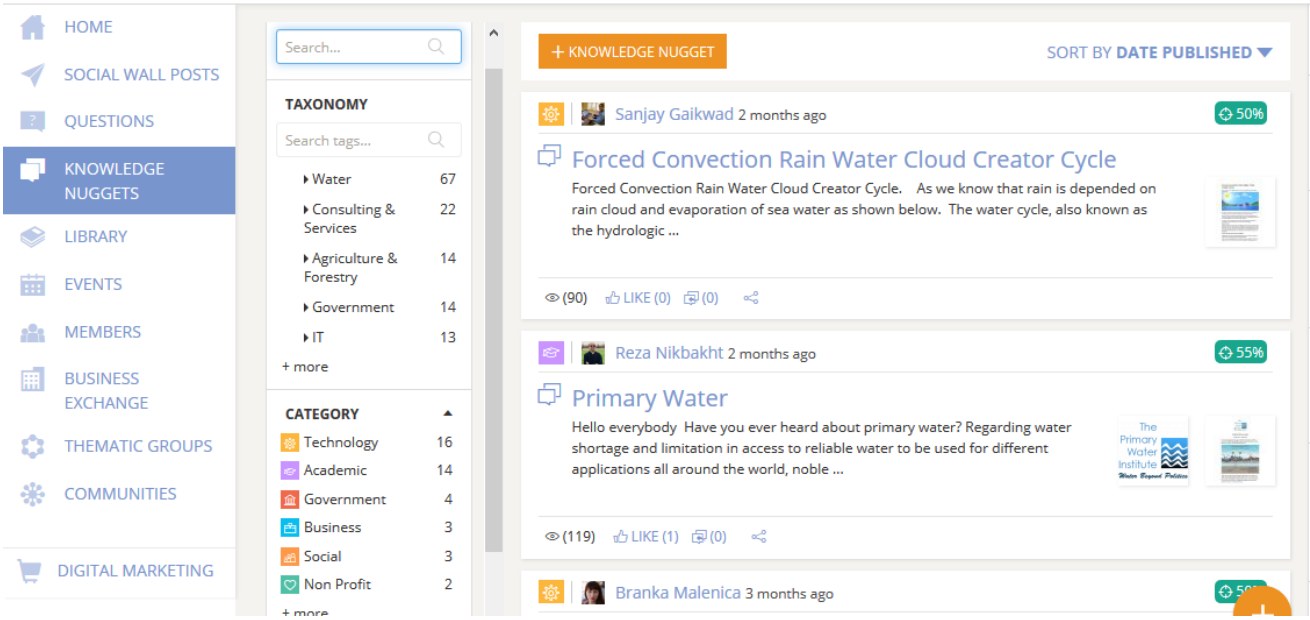
1. The **Home Page**, with links to the main sections of the Platform and the possibility to login to access reserved contents.

Figure 15: The landing page of the DBTE



2. The **Social Wall Posts**, containing news and messages open to public
3. The **Questions** area where members of the CoP can activate social intelligence and crowdsourcing to manage specific problems related to the categories/building blocks
4. The **Knowledge Nuggets**, giving evidence to results from practices/projects



5. The **Library**, containing methodological references and materials from blogs, papers, Open AIRE documents

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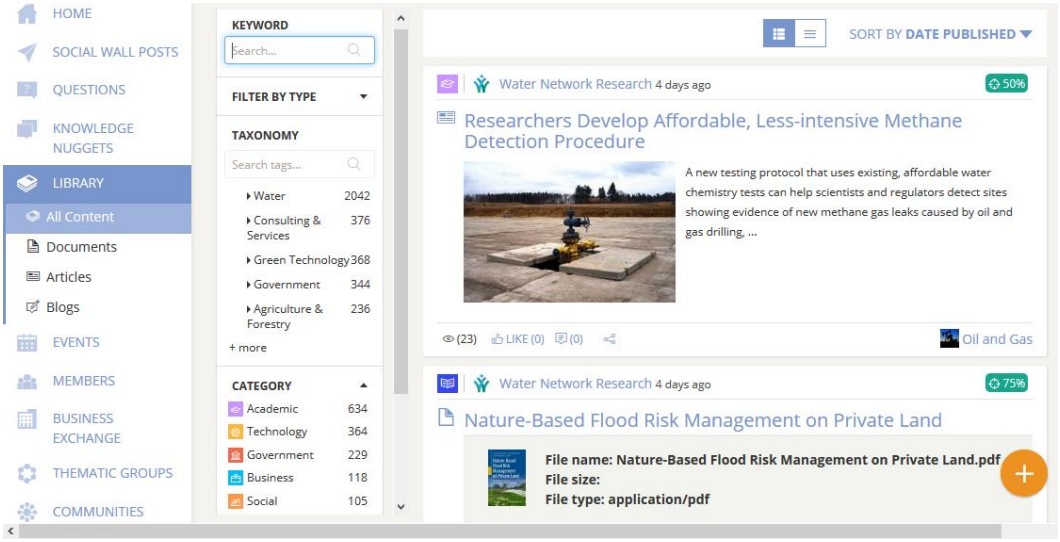
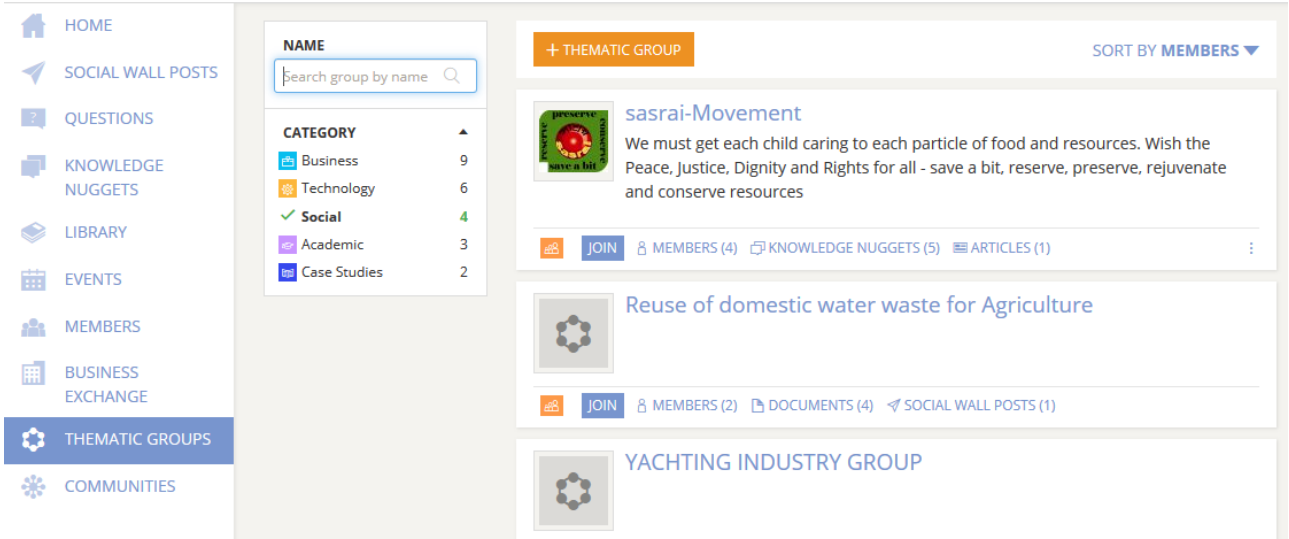
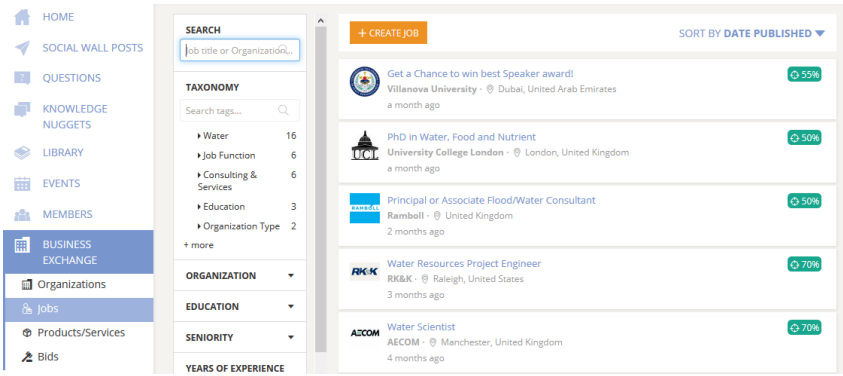


6. The **Events** and the calendar of workshops, fairs, seminars of interest for the CoP
7. The list of the CoP **Members,** that are tagged for
8. **Communities** they belong at and for
9. **Thematic Groups** they are interested in or they create



10. A **Business Exchange area** that provides information about bids, calls, job posts, staff exchange opportunities, products or services demanded or offered



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For the Alpha version, these contents were tested to create the single elements of the DBTE:

BB1. Knowledge Diagnosis

BB1.1. Diagnostic Assessment in eLearning Based contexts

BB1.2. Online journals and their use

BB1.3. How to create and adopt effective Branching Scenarios

BB1.4. Knowledge Management Audits and Benchmarking for food companies

BB2. Knowledge Creation

BB2.1. Create Knowledge through inspirational daily focus

BB2.2. Collaborative Knowledge Creation

BB3. Knowledge Transfer

BB3.1. Peer-learning and other collaborative knowledge-creation practices and tools

BB3.2. Learning Pills and micro-learning

BB4. Knowledge Internalization

BB4.1. Staff exchange and cross-fertilization

BB4.2. How to embody explicit knowledge into the organization's tacit knowledge

BB5. Knowledge Brokering and Sharing

BB5.1. Knowledge Portals

BB5.2. Virtual Coaching

BB5.3. Reverse Mentoring Bootcamps

BB5.4. Unconferences

BB5.5. The Nine Archetypes of the Knowledge Broker

BB6. Knowledge Codification

BB6.1. SECI Model of knowledge dimensions and certification

For all this argument, a brief introductory definition, one practice example and one reading material was provided so to stimulate a practical confrontation on the types of contributes and of interactions that the DBTE should stimulate, support and evaluate.

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5 Next steps

The Beta Version of the DBTE is planned to be released on M24 after the establishment of the Knowledge Clusters at local level and the confrontation among the Consortium Partners of the perceived utility and of the preferences for the operational solutions of the DBTE.

The completion of the DBTE will be managed into three further steps:

Step 5. Validation of the update and reframe model in order to release the Beta version

The final update and reframe of the DBTE will be discussed among partners in the Project Meeting that is scheduled by the end of October 2019 (M22) and it will take into account the change in the perceptions and roles of the actors of the Network (which contents matter most, which expertise is easily actionable, who are new actors to be involved in the ecosystem, which are the interactions to be sustained or the ones to be recalibrated).

Step 6. Release of the Beta Version

After this meeting, we will release the Beta Version and fine-tune it through a massive interaction with the Knowledge Clusters set up at local level (M23). Simultaneously, we will start dedicated dissemination and exploitation activity to widen up the Community of Practice connected to the DBTE.

Step 7. Final release and opening up to the wider community

In one month from the release of the Beta Version, in M24, we will final release and open to the public the DBTE.

6 References

Arnkil, Robert; Järvensivu, Anu; Koski, Pasi; Piirainen, Tatu (2010). Exploring Quadruple Helix: Outlining user-oriented innovation models. Tampere: University of Tampere. ISBN 978-951-44-8208-3.

Barth, Thorsten D. (2011). "The Idea of a Green New Deal in a Quintuple Helix Model of Knowledge, Know-How and Innovation". International Journal of Social Ecology and Sustainable Development. 2 (1): 1–14. doi:10.4018/jsesd.2011010101. ISSN 1947-8402.

Bateson, G (1972). Steps to an Ecology of Mind: Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology, University of Chicago Press.

Baudrillard, J (1975). The Mirror of Production, Mark Poster (trans.), St. Louis: Telos Press.

Beer, S, Espejo, R, Grandi, M, and H Schwember (1980). “Progetto cybersyn: cibernetica per la democrazia”, Edited by De Cindio F, and De Michelis G, CLUP/CLUED.

Bertalanffy, L von, (1968). General System theory: Foundations, Development, Applications, New York: George Braziller. Revised edition 1976, tr. It “Teoria Generale dei Sistemi”, Milano: Mondadori.

Co-funded by the Erasmus+ Programme of the European Union

Burr, V (2003). Social Constructionism, 2nd Ed., Routledge.

Carayannis, Elias G.; Campbell, David F.J. (2010). "Triple Helix, Quadruple Helix and Quintuple Helix and How Do Knowledge, Innovation and the Environment Relate To Each Other?: A Proposed Framework for a Trans-disciplinary Analysis of Sustainable Development and Social Ecology". International Journal of Social Ecology and Sustainable Development. 1 (1): 41–69. doi:10.4018/jsesd.2010010105. ISSN 1947-8402.

Carayannis, Elias G.; Barth, Thorsten D.; Campbell, David F.J. (2012). "The Quintuple Helix innovation model: global warming as a challenge and driver for innovation". Journal of Innovation and Entrepreneurship. 1 (2): 2. doi:10.1186/2192-5372-1-2.

Carayannis, E.G.; Campbell, D.F.J. (2009). "'Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem" (PDF). Int. J. Technology Management. 46 (3/4): 201–234. doi:10.1504/IJTM.2009.023374.

Castells, M (2000). The Information Age: Economy, Society and Culture volume 1: The rise of the network society. Oxford: Blackwell.

Cavallini, Simona; Soldi, Rossella; Friedl, Julia; Volpe, Margherita (2016). "Using the Quadruple Helix Approach to Accelerate the Transfer of Research and Innovation Results to Regional Growth" (PDF). European Union Committee of the Regions.

Chesbrough, H (2003). Open Innovation: The New Imperative for Creating and Profiting from Technology, Boston: Harvard Business School Press.

Corallo, A, G Passiante and A Prencipe (2007). Digital Business Ecosystems, Cheltenham: Edward Elgar Publishing.

Dalle, J-M, David, P A, Ghosh, R A, and W E Steinmueller (2005). “Advancing Economic Research on the Free and Open-Source Software Mode of Production”, in How Open is the Future?, M Wynants and J Cornelis Eds., Brussels: VUB University Press.

Deloitte University Press, Business Ecosystems come of age, https://www2.deloitte.com/it/it/pages/operations/articles/business-ecosystems.html

European Commission (2001). Communication from the Commission: “Helping SMEs to “go digital”. COM(2001)136 final. 2001, 13 March.

European Commission (2006). “More interoperability needed to boost the European ICT industry, competitiveness”, IP/06/1635, Brussels, 2 pp.

Glocal Forum (2004). “The Glocalization Manifesto”, CERFE, September.

Heylighen, F and C Joslyn (2001). “Cybernetics and Second Order Cybernetics”, in: R.A. Meyers (ed.), Encyclopedia of Physical Science & Technology, Vol. 4 (3rd ed.), New York: Academic Press, pp. 155-170.

Leydesdorff, Loet (2012). "The Triple Helix, Quadruple Helix, …, and an N-Tuple of Helices: Explanatory Models for Analyzing the Knowledge-Based Economy?". Journal of the Knowledge Economy. 3 (1): 25–35. arXiv:1012.1937. doi:10.1007/s13132-011-0049-4. ISSN 1868-7865.

Co-funded by the Erasmus+ Programme of the European Union

Lessig, L (2002). The Future of Ideas, New York: Random House.

Maturana, H and F Varela (1998). The Tree of Knowledge: The Biological Roots of Human Understanding, revised edition, Boston: Shambhala.

Moore, J F (1996). The Death of Competition: Leadership and Strategy in the Age of Business Ecosystems, New York: Harper Business.

Moore, J F (2003). “Digital Business Ecosystems in Developing Countries: An Introduction”, Berkman Center for Internet and Society, Harvard Law School. http://cyber.law.harvard.edu/bold/devel03/modules/episodeII.html

Nachira, F (2002). “Toward a network of digital business ecosystems fostering the local development”, http://www.europa.eu.int/information_society/topics/ebusiness/godigital/sme_research/index_en.htm

Nowotny, H, Scott, P and M Gibbons (2001). Re-thinking science: knowledge and the public in an age of uncertainty. Cambridge, UK: Polity.

O’Callagan, R (2004). “Technological Innovation in Organisations and Their Ecosystems”, in Transforming Enterprise: The Economic and Social Implications of Information Technology, Edited by William H. Dutton, Boston: MIT Press.

Polanyi, Michael (1962). "The Republic of science: Its political and economic theory". Minerva. 1 (1): 54–73. doi:10.1007/BF01101453. ISSN 0026-4695.

Price Waterhouse Coopers (2004). Rethinking the European ICT Agenda - Ten ICT Breakthroughs for Reaching Lisbon, The Netherlands (EU presidency 2004), Ministry of Economic Affairs, Directorate-General for Telecommunications and Post, The Hague, August.

Provenzano, Vincenzo; Arnone, Massimo; Seminara, Maria Rosaria (2018), Bisello, Adriano; Vettorato, Daniele; Laconte, Pierre; Costa, Simona (eds.), "The Links Between Smart Specialisation Strategy, the Quintuple Helix Model and Living Labs", Smart and Sustainable Planning for Cities and Regions, Springer International Publishing, pp. 563–571, doi:10.1007/978-3-319-75774-2_38, ISBN 9783319757735

Rönkä, K; Orava, J (2007). Kehitysalustoilla neloskierteeseen. Käyttäjälähtöiset living lab- ja testbed-innovaatioympäristöt. Tulevaisuuden kehitysalustat -hankkeen loppuraportti [On development platforms to Quadruple Helix. User-driven living lab and testbed innovation environments. Final report of Future Development Platforms project.] (in Finnish). Helsinki: Movense Oy & The Center for Knowledge and Innovation Research, HSE.

Schön, D A (1973). Beyond the Stable State: Public and private learning in a changing society, Harmondsworth: Penguin.

Wenger, E (1999), Communities of Practice. Learning, Meaning and Identity, Cambridge University Press, 1999.

Wilkins, J S (1998). “What’s in a Meme? Reflections from the perspective of the history and philosophy of evolutionary biology”. Journal of Memetics - Evolutionary Models of Information Transmission, Vol, 2, Nr 1. http://jom-emit.cfpm.org/1998/vol2/wilkins_js.html

Co-funded by the Erasmus+ Programme of the European Union

Williamson, O (1975). Markets and Hierarchies: Analysis and Antitrust Implications, New York: The Free Press.

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