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A knowledge hub to enhance the learning processes of an industrial cluster

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Abstract

Industrial clusters have been defined as "networks of production of strongly interdependent firms (including specialised suppliers), knowledge producing agents (universities, research institutes, engineering companies), institutions (brokers, consultants), linked to each other in a value adding production chain" (OECD Focus Group, 1999).

The industrial clusters distinctive mode of production is a specialisation, based on a sophisticated division of labour, that leads to interlinked activities and need for cooperation, with consequent exchanges of localised knowledge, mainly tacit.

In the new economic landscape of the Net Economy based on the Internetworked technologies, geographical industrial clusters may evolve towards new industrial agglomerations, that grasp the opportunities coming from these new technologies.

In this new competitive space, inside the cluster, it is emerging a coevolution process, that develops between the networks of localised knowledge, based on face-to-face interactions, generally defined as local social networks, and the trans-local knowledge networks, based on Internet platforms.

Following this view, in this paper we aim at presenting and discussing an Internet-based knowledge architecture, named Knowledge Hub (KH), conceived as an enabler of the dynamic externalities of the industrial cluster in the Net Economy. We'll focus on:

- a theoretical discussion about the cognitive space that develops within an industrial cluster, including both geographic clusters and new organisations based on the Internetworking technologies,
- a presentation of the main functionalities of the KH, and of the value it can be generated for the cognitive space of an industrial cluster.

A knowledge hub to enhance the learning processes of an industrial cluster

1. Introduction

The industrial cluster is generally defined as a distinctive mode of production organisation, based on a sophisticated division of labour, that leads to a set of interlinked activities and need for cooperation.

Generally, the analysis of this production organisation emphasises the role of the spatial organisation, based on a geographical proximity. Co-operation needs closeness mainly for just-in-time delivery and for the exchange of knowledge, especially in its tacit forms. Cooperation between specialised actors in geographic proximity leads to spillovers and synergies (Steiner, 1998). In this view, geographical industrial clusters may be considered as special patterns of economic activities related to an organised or hierarchical capitalism. Radical technological changes related to the new emergent tecno-economic paradigm of the Net Economy have become crucial over time for producing new patterns of economic activities (Knox and Agnew, 1998).

This new emerging tecno-economic paradigm is creating new interrelationships between organisational and spatial change, related to the digital innovation paradigm. In this economic landscape, geographical industrial clusters, based on localised knowledge, mainly tacit, may evolve towards new industrial agglomerations, that grasp the opportunities coming from the Internetworked technologies. Indeed, in this web-based world of business, a new competitive space is emerging, where "how do you business" is as relevant as "where do you business". In the new competitive space, the paradigm of the "extended enterprise" introduced by the industrial district scholars, tend to evolve towards an "Internetworked Enterprise (IE)" configuration.

This configuration allows the IE to extend its relationships and transactions behind the geographical proximity. The Internet platforms have today a strategic role in enriching the long-distance relationships, and allows to increase the levels of competitiveness of the industrial clusters, by combining the advantages grasping from the local network, that uses the territory as a medium to facilitate the division of labour, with the benefits coming from trans-local networks, that reduce the risks of the geographical peripheries related to the globalisation context.

In the IE competitive landscape, become more relevant the approaches that consider industrial clusters as systems of knowledge-based interactions, that increase their innovation rate. Following these approaches, we point out the existence, inside the cluster, of a coevolution process that develops between the networks of localised knowledge, based on face-to-face interactions, generally defined as local social networks, and the trans-local knowledge networks, based on Internet platforms. This coevolution process represents the main characteristics of the industrial cluster as a knowledge network. The knowledge network organisation includes the sources of competitive advantages related to both localised social networks and coming from the codified knowledge that can be acquired at a global level. At this level, three options are emerging for the knowledge-based interactions:

- Firstly, knowledge creation and knowledge sharing do not necessarily require physical co-location and face to face interaction;
- Secondly, development of communities based on trust and accepted ethical behaviour (internally defined) can take place in the cyberspace Internet-based;
- Thirdly, if knowledge creation is largely a process of tacit to explicit conversion of individual knowledge (Nonaka and Tackeuchi 1995; Boisot, 1998), then the virtual network's environment can be the locus of knowledge conversion processes that are conducive to innovation.

Each option tends to configure in the knowledge network a cognitive space along two directions, according to the nature of the knowledge exchanged:

- knowledge interactions focused mainly on tacit knowledge, nurtured by face-to-face relationships, by dynamic flows of experiences, culture, traditions, local identities, highly grounded in the territory, characterised mainly by learning by doing processes, knowledge socialisation and knowledge externalisation processes;
- knowledge exchanges focused primarily on explicit and codified knowledge, that can be transferred through Internet-based systems, with high potential to be open, characterised mainly by leaning-by-interaction processes, and by combination and internalisation processes of explicit knowledge.

This second direction may represent a dynamic externality that increases the innovative capacity of the industrial cluster in the Net Economy environment. In this view we aim at presenting and discussing an Internet-based knowledge architecture, named Knowledge Hub (KH), conceived as an enabler of the dynamic externalities of the industrial cluster in the Net Economy. For the setting up of our KH model, we focused manly on one aspect of the huge amount of empirical literature on the agglomeration economies and on the industrial clusters: we focused on the analysis of the knowledge exchanges and learning processes that develop in an industrial cluster.

The KH "virtualness" enables the pervasiveness of innovation: innovation becomes ubiquitous in every industry, in every place and in every firm, and transcends local, regional and national borders. KH virtualness also contribute to generate dynamic external economies through which complementarities of knowledge and competencies or organisational and technological connections may accelerate collective learning processes, enabling innovative capabilities.

In the following paragraphs, we'll focus on:

- a theoretical discussion about the cognitive space that develops within an industrial cluster, including both geographic clusters and Internetworked organisations,
- a presentation of the main functionalities of the KH, and of the value it can be generated for the cognitive space of an industrial cluster.

2. Some approaches on dynamic economic agglomerations

A huge amount of seminal approaches is focused on the knowledge exchanges among the partners of the industrial clusters, that enable the innovative capacity of the firm (Becattini 1992; Brusco 1996; Bramanti, Maggioni 1997; Markusen 1994; Cappellin 1997; Sabel 1996; Scott, Storper 1993; Vaccà 1995; Lipparini, Lorenzoni 1996).

The evolutionary theory specifically points out that innovation springs from information/knowledge asymmetries and market imperfections. Knowledge accumulation and learning mechanisms are considered then as the key referring points of these approaches (Camagni, Quévit 1992; Maillat 1996).

The relationships between market and non-market organisations and institutions generate a context that Nelson and Winter define as “selection environment”. The selection environment forms what is called “the relevant milieu” (internal and external, broader or narrower) that explains industrial clusters as innovation networks or as local and regional systems of innovation.

At the core of these systems of innovation there are three profoundly interconnected processes: an adaptive and cumulative learning process, a system of interactions among proximate agents and groups and a dynamic coordination process built on the other two (De la Mothe and Paquet, 1998).

The process of collective learning existing in the clusters induces a stylised view of the innovation processes in a cognitive space, that considers knowledge accumulation process as path-dependent, non linear and shaped by the interplay of market and non market organisations and institutions (Nelson and Winter, 1982).

Our interest is mainly focused on the evolution of the cognitive space in the new competitive environment of the internet economy. It will allow us to analyse the emergence of new dynamic externalities useful to realise complementarity between advantages coming from the local relations network and the benefit of the internet based knowledge network. In the Fordist paradigm the cognitive space associated to industrial cluster is characterized by localized knowledge exchanges, mainly tacit in their nature. Territory, that is geographic proximity, is considered as a glue or better as a medium for interactions and exchanges of knowledge, that may in turn be considered one of the main sources of the industrial cluster agglomeration rate.

However, by referring mainly to territorial aspects, we are not able to analyse the aspects connected with the dynamics of aggregation and disaggregation forces in the cluster, and can’t build a general model able to describe all the different aspects involved in the aggregation phenomena. The study of economic agglomeration phenomena in the internetworked economy suggest an approach based on the more general concept of space. As highlighted by Bottazzi G., Dosi G., and Fagiolo G., (2002) the spatial dimension include both geographic aspect connected to the agent physical position in space and metaphorical spaces related to technological and institutional distances, inclusion and exclusion in networks and nations, level of knowledge and information sharing. The concept of space, defined in whatever way, is really important because being a part of a particular space influences the single agent identity, capacity, behaviour, interaction pattern and collective and individual performance.

Defined in this way, spatial dimension allow to analyse at different geographical level the environment in which relations between actors are confined and where the concept of relation is extended to the exchange of knowledge and collective learning.

With this approach, we may extend the actors agglomeration concept, from industrial district to business network; in this approach we may adopt the concept of business network generalising to all the agglomeration structure and observing that each agglomeration structure represent a set of firms, joint by some kind of spatial proximity that could be geographical, technological or institutional.

Moreover, it exists a life cycle in the aggregation phenomena, (Bottazzi G., Dosi G., and Fagiolo G., 2002) that could be connected to innovation and knowledge exchange cycle. Indeed the agglomerative strength tend to be reduced in time when innovative technological paradigm, characterizing the agglomeration, enter in their maturity and become a diffused and largely externalised set of knowledge. This situation allow the imitation by concurrences and the appropriation by oligopolistic international firm of the knowledge necessary for development and innovation.

Geographical cluster are extremely competitive in field in which is very hard to standardise and it is necessary fast and creative adaptation to perform uncontrolled change, exploring new meaning and building around them a complex network of specialization, transaction and exchange. Cluster can compete in such conditions because are able to develop new decentred, explorative learning path, based on attempt, imitation and tacit knowledge continuous exchange (Rullani, 2002).

In more details we may look at the firm from an evolutionary resource based approach and observe that the firm evolution can be seen in term of the evolution of their organizational routines that look for continuous exploration of new production and interaction dynamics.

New firms as new species, co-evolve in a mutual adaptation behaviour exploring the isolated environment, with the alternative of fitting the right evolutionary niche or disappear.

The organizational routine are in this situation mainly based on tacit knowledge and represent the localized cluster's knowledge. The interactions among the actor are mainly based on tacit knowledge and are represented by the process of socialization and externalisation (Nonaka and Takeuchi, 1995).

When the technological innovation that is the main cluster source of success, enter in the phase of maturity and the related knowledge begin to be represented in term of explicit knowledge, the initiation of the organizational routine became simpler and cheaper and the local knowledge became global and shared, allowing exploitation from company that use production criteria based on cost reduction, standardize the processes, program production cycle.

The maturity level of the district main stream of technology influences also the codification of the knowledge embedded in the organizational routine and consequently the input output coordination mechanism, because of the larger content of explicit knowledge in firm interaction. This general standardization of input and output allows the companies to interact with other company worldwide, becoming part of new and different value chain and increasing the power of disintegration forces.

Summing up, when a new technology is applied or an old one is re-contextualized in innovative approach, exploring new unknown field and pursuing never proved way, we are in presence of mainly tacit knowledge and organizational routines hardly explicitable.

On the contrary mature technology is standardised and codified and is mainly related to explicit knowledge in the form of codified organizational routine and interactions between actors.

It means that the agglomerative force in the physical space can be seen as the manifestation of tacit knowledge interaction based in the cognitive space such as socialization and externalization while the disintegration one are related to explicit knowledge interaction such as internalization and combination .

Internet paradigm is introducing new dynamics, that allow the growth of new agglomerative forces, not necessarily connected to the actors geographic localization and on the contrary, specifically effective under explicit knowledge conditions.

The territory – the geographical proximity – represents the cognitive space of relations between actors mainly based on tacit exchange of knowledge-, is complemented by a cyberspace, where the emergences of new relations, mainly based on explicit knowledge allow the cluster to evolve in the direction of a network of relations.

From another point of view the maturity of technologies and the emergence of standard, allow the cluster to interact with widest network of firms enlarging their horizons and repositioning in a global and widest environment where the effects of the network (Metcalf Law) allow on one side an increased competitiveness and the possibility to find new partner and on the other side an access to the global knowledge that once systematized and absorbed will increase the innovation processes, and in this way will improve mutation and selection processes.

The emergence of internet economy, is enhancing the evolutionary patterns and the selection processes, producing, as an effect, on one side the disappearing of such firm in the network if this firm will not be able to find a right position in the global competitive context, but on the other side the development of new changing forces and new innovative impulses to co-evolve both at the territorial level, by exchanging knowledge mainly tacit, and at a cyber level by exchanging knowledge mainly explicit. The main emerging technological paradigm (internet technology) is creating new interrelationship between organizational and spatial change. In the new competitive space "how do you business" is as relevant as "where do you business". The paradigm of the "extended enterprise" introduced by the industrial district scholars tends to evolve towards an internetworked enterprise configuration.

The diffusion of the Internetworked technologies is generating new intelligent link-spaces a new link space, characterised by the ubiquitous provision and distribution of information in networks of agents. Following Carley, intelligent spaces will have four main characteristics (Carley, 2000):

- Ubiquitous access: Agent (human or artificial) will have technology to access or provide information wherever and whenever it is useful, thus acting and remotely enabling other agents to act.
- Large scale: Vast quantities of information will be automatically collected, stored, and processed by vast numbers of agents.
- Distributed cognition and intelligence: Information, access to information, and processing and communication capabilities (i.e., intelligence) will be distributed across agents, time, space, physical devices, and communications media.
- Invisible computing: The interface between the digital world and the analogous world will become seamless as computers are miniaturized, made reliable and robust, and are embedded into all physical devices.

In this intelligent spaces the "virtualness" becomes a new source of competitiveness, since:

- it offers a context where the value creation opportunities may result from new combinations of information, physical products and services, innovative configurations of transactions, and the reconfiguration and integration of resources, capabilities, roles and relationships among suppliers, partners and customers;
- it broads the notion of innovation since they span firm and industry boundaries; involve new exchange mechanisms and unique transaction methods (rather than merely new products, or productions processes); and foster new forms of collaborations among firms;
- it allows an alternative to ownership or control of resources and capabilities. The alternative is to access such resources through partnering and resource sharing agreements. Hence, value creation becomes more challenging, because rivals may have easy access to substitute resources as well;
- it decreases direct costs of economic transactions –coordination costs and transaction risks- and reduces indirect costs, such as the costs of adverse selection, moral hazard and hold-up.

The radical exchange induced by the Internet paradigm is in the new role played by the knowledge in its tacit and explicit form. While in a territory based approach such dicotomy influences the aggregation and disaggregation forces in the cluster, in the

Internet Economy it becomes a dualism that feeds new and unexpected dynamics of coevolution based on the interaction between local and global relations.

3. Knowledge Hub as a new dynamic externality of an industrial cluster

As discussed above, the knowledge flows of the cognitive space, the nature of exchanged knowledge and the tacit-explicit knowledge conversion processes deeply influence the development paths of clusters and networks, because they directly determine the standardization level of relationships among the several nodes, contributing, in this way, to the vertical disintegration and reconfiguration based on knowledge complementarities and interdependencies.

In the scenarios of Internetworked Economy, knowledge management systems assume a strategic role in supporting the shift from industrial clusters based on localized knowledge towards network configuration processes in which knowledge flows related to codified knowledge available at global scale are always more relevant.

To assume this role the knowledge management system should act towards two complementay directions: from one side, it should create a favourable context in which the tacit knowledge can be explicitated and shared; from the other side, it should allow and support the transfer of explicit knowledge.

The Knowledge Hub discussed in this paper is a knowledge management system focused on explicit and codified knowledge, enabling learning by interacting, knowledge combination and internalization processes. It can be also interpretable as an internet-based dynamic externality which complements the dynamic externality related to localized knowledge networks.

The Knowledge Hub here discussed enables the creation of network's memory, represented by all the codified knowledge: it promotes and sustains knowledge exchange processes, creating new relationships among nodes and reinforcing/modifying the existing ones.

The dichotomy between aggregation and disaggregation forces, typical of an analysis based on mechanistic and deterministic approaches, looses its meaning. Indeed, the Internet-based approach is a dual and complementar approach, typical of non linear phenomena.

3.1 The Knowledge Hub logical architecture

From the logical point of view, the Knowledge Hub can be represented by a set of services through which the actors of the network interact each other and with the knowledge base: services are linked to knowledge processes they enable; the knowledge base is the 'content' of the system and so it is deeply linked to the knowledge sources of the network.

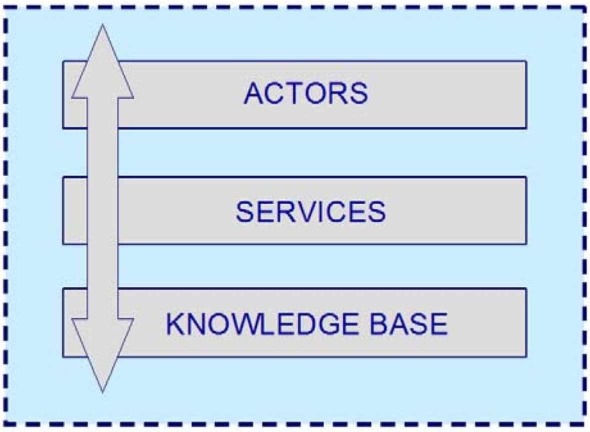

Figure 1: The Knowledge Hub logical architecture

Moreover, the high degree of system flexibility and adaptability allows the application of the system to different network structures, with heterogeneous relational and cognitive dynamics and a variable self organization level.

In this way, the Knowledge Hub is configurated as an internet-based knowledge management system aimed to:

- empower and extend the network of relationships existing among the involved organizations;
- enhance the frequency and the intensity of knowledge exchanges;
- activate inter-organizational learning processes and knowledge sharing processes;
- sustain knowledge exploitation processes into the network;
- support knowledge exploration processes considering the emergent knowledge of the network.

Actors

The actors, that are the users of the Knowledge Hub, evolve towards learning organizations, where individuals can improve their capacities to create results, where there is potential to generate new mindsets, where people learn how to learn together (Senge, 1990; Nonaka and Takeuchi, 1995; Sabel, 1996; Foss, 1996; Argyris and Shon, 1978).

In this way, each actor of the network is able to define visions, to create, acquire and share knowledge, to apply knowledge for defining strategies and for obtaining results, to set up and promote mental models. In this way an actor is able to:

- get, test and apply new knowledge and exploit the results of learning processes associated;
- learn from the past experiences and take benefits from past errors and successes;
- learn from others;
- amplify their learning spaces in the external environment.

Services

The services are designed and configured according to knowledge processes they enable. At this purpose, considering the different knowledge management models existing in the literature [Heisig, 2001; Tiwana, 2000; Radding, 1998], we focused on the main representative and essential processes considered also from the Competence Center Knowledge Management at Fraunhofer Institute in Berlin:

- knowledge store: that is the knowledge storage process into the knowledge base, after the validating and indexing processes;
- knowledge generate: that is the knowledge retrieval, acquisition and creation processes;
- knowledge distribute: that is the knowledge distribution, sharing and comparison;
- knowledge apply: that is the application process of created/exchanged knowledge of the network for designing and building new products, for experimenting new processes, for activating new business strategies.

Knowledge Base

The knowledge base is the knowledge repository of the network and it contains the knowledge heritage associated with the cognitive sources (internal and external) of the network [Skyrme, 2000]:

- Knowledge in Customer: that is the knowledge of current and potential customers in terms of their profiles (with static and dynamic components), their preferences, their explicit and implicit needs, their feedbacks. This source is very important because it allows to understand new potential ideas and suggestions to elaborate and systemize for designing and creating new products/services or for improving the existing ones.
- Knowledge in People: that is the knowledge of the network nodes in terms of their skills, core competencies, experiences, projects, ideas.
- Knowledge in Processes: that is the knowledge embedded into the main operating and supporting processes useful to understand the on going processes and future processes. In particular the main processes involved in this knowledge source are:
    - Operating processes: understand markets and customers, develop vision and strategy, design products and services, market and sell, produce and delivery for manufacturing, produce and delivery for service organization;
    - Supporting processes: develop and manage human resources, manage information, manage information, manage financial and physical resources, manage external relationships.
- Knowledge in Products and Services: that is the knowledge embedded in products and services offered by the organization belonging to the network;
- Knowledge in Relationships: that is the knowledge embedded into the structural and social links of the network nodes;
- Organizational Memory: that is the knowledge of the network, that inspires each node to formulate the business and organizational strategies.
- Knowledge in Business Environment: that is the knowledge heritage external to the network and potentially linkable to the knowledge base of the network.

A very important feature of the knowledge base is that each knowledge object is semantically indexed using a set of domain ontologies. This enables processes of ‘knowledge standardization’ starting from all the knowledge heritage available into the network (both inside each node and inside the connections between nodes). In this way the building and maintaining processes of the ontologies generate many advantages related both to the richness of the knowledge flows among nodes and to the enlargement potentialities of network boundaries.

3.2 The Knowledge Hub technological architecture

From the technological point of view, Knowledge Hub is based on the emergent paradigm of Semantic Web. It has a web-based architecture for exploiting the main advantages of Internet (independence from platforms, interoperability, portability, reliability, low-cost communication). The system is also characterized by an high degree of flexibility in the services–actors assignment process. Through a simple and an intuitive graphical interface, Knowledge Hub allows direct and immediate learning interactions among the nodes of the network. Finally, each actor-organization of the network is considered as a potential knowledge creator and distributor: the technological platform is able to extract and store each cognitive contribution coming from all the actors during their mutual interactions. It is also possible to integrate external legacy systems to guarantee multiple knowledge sources access. The scalabilty of the system is possible both on the horizontal dimension (new services and new contents to integrate) and on the vertical dimension (splitting of the architectural layer in a multi-layer architecture).

The technological model of the Knowledge Hub is composed by two main subsystems: front-office area and back-office area.

Front-office area, organized as a portal, represents the access layer to the main services: forum, mailing list, chat, conference system, e-learning system, reporting system, on line questionnaires, publishing system (for news and editorial content), navigator.

Each service can potentially generate new codified knowledge, linked to a set of semantic assertions that simplify and enhance the efficacy of knowledge retrieval process.

The Knowledge Hub back office area is centred on the content management system, that is the ‘engine’ of the whole platform. The content management system is composed by a knowledge base, founded on a set of domain ontologies, and it is supported by a set of integrated tools for gathering documents (the spider), selecting and annotating documents (the validator), indexing documents (the indexer) and managing ontologies (the ontomaker).

In the following figure the technological architecture of the Knowledge Hub is represented:

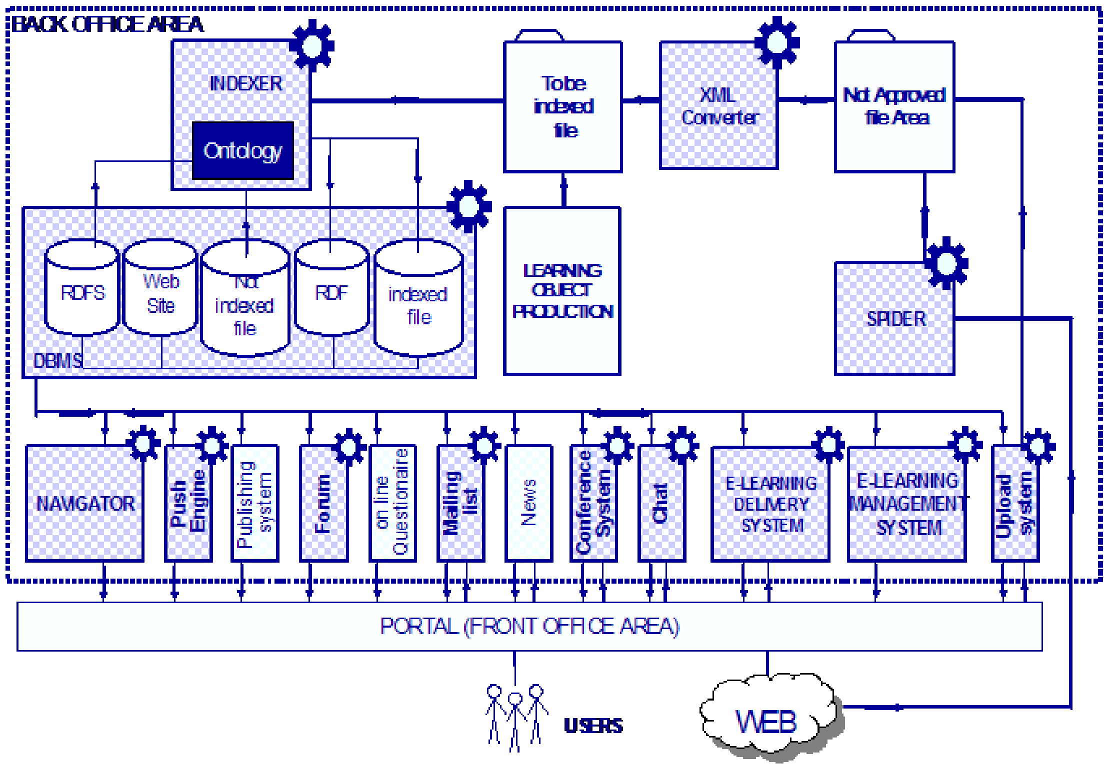

Figure 2: The Knowledge Hub technological architecture

Front Office Area

Front-office area represents the access layer to the main services: forum, mailing list, chat, conference system, e-learning system, reporting system, on line questionnaires, publishing system (for news and editorial content), navigator.

Each service can potentially generate new codified knowledge, linked to a set of semantic assertions that simplify and enhance the efficacy of knowledge retrieval process.

The distinctive services are briefly described below.

Conference system

Members belonging to the “Knowledge Hub Community” can book the conference system for scheduling meetings or brainstorming sessions, to extract knowledge items for feeding later the knowledge base. Through the conference system the personal relationships among actors can furtherly reinforce, benefiting from the virtual environment dynamics.

Publishing system

The main publishing services are news and editorial contents. The news service guarantees a daily up to date information according to the themes connected to the network organizations. The weekly news is a push system connected with the news service. This system sends by e-mail (to whom who have explicitly indicated their own interest in a particular content area) all the news collected in the current week and related to the specific issue.

One of the main functionalities available in the Knowledge Hub portal is the editorial content publishing, through which it is possible to publish papers, reviews, editorials and whatever can enrich the knowledge base. In this way, the system allows to add new pages to the portal in a very simple way. Every new page to be published, is inserted through a simple form to fill in on line: for such task no technical competencies are required. In addition to the content of the page, it is necessary also to specify the position of the page within the portal and its navigational links. All these information are stored in the knowledge base which dynamically produces both the content of each page and the navigational structure of the whole portal.

Navigator

The navigator allows to retrieve the documents not only through syntactic search techniques based on text analysis, but also through semantic search techniques and semantic navigation.

Semantic navigation is based on the use and application of ontologies. Here, ontology is considered as "an explicit specification of a conceptualisation" (Gruber, 1993). It can be represented by a set of concepts linked together by a set of semantic relations.

Semantic navigation starts by selecting a particular domain ontology. To visualize the ontology with a tree-structure, it is necessary to choose a navigational relation. Browsing

the ontology and clicking on a single concept, all the documents related to the concept are listed. It is possible also to specify an instance, for obtaining a subset of documents. This kind of navigation can be defined as a metadata driven navigation.
With the same process, it is possible also to build semantic assertions by which retrieving documents. With the term “semantic assertion” we mean a triplet structured as “subject-predicate-object”, where subject and object are concepts belonging to the ontology (or eventually their istancies), and predicate is the relation that links the two concepts (or istancies), defined according to the ontology structure.
In this way, browsing the ontology and clicking on a concept, navigator will extract the subset of documents that have been indexed with the chosen concept as subject. Then, the system, according to the ontology structure, will propose to user all the predicates suitable to the selected concept. If documents are available, user can specify the object, reducing the number of results, obtaining all the documents truly related to the defined semantic assertion. For each document, it is possible to visualize its semantic context, that is a list containing all the semantic assertions defined on it. In this way, end user can understand in depth both the ontology domain and the meaning of the document.
A particular aspect related to the extracting process is the relaxing of the query. In fact, during the searching and retrieval processes, the system adopts an intelligent management of the query structure and results: when a user specifies an instance and there are no results, the system, automatically, informs the user and modifies the query structure, considering the concepts to which instance belongs. In this way the probability of “documents not found” event is considerably reduced.
Finally, during the navigation of the ontology tree structure, users become protagonists of the learning by browsing process, by which they automatically understand the ontology domain starting from the structure of the concepts. This process is strongly enabled and sustained by the explicit navigation of the real structure of the ontology, that allows to users to explore the domain before to analyse in deep each single knowledge item.

Back Office Area

The Knowledge Hub back office area is centred on the content management system, that is the ‘engine’ of the whole platform. The content management system is composed by a knowledge base, founded on a set of domain ontologies, and it is supported by a set of integrated tools for gathering documents (the spider), selecting and annotating documents (the validator), indexing documents (the indexer) and managing ontologies (the ontomaker). The distinctive services are briefly described below.

Indexer

Indexer creates the link between documents and knowledge base. Basing on a set of ontologies, it allows to associate to a documents (but also to a part of it) not only a set of metadata, but also a set of semantic assertions, structured as triplets subject-predicate-object. Both metadata and semantic assertions are composed by concepts and relations belonging to the ontology.

For indexing a document, first it is necessary to open its XML version. Indexer will show it through its Xpath structure, on the right side of the screen. Then, it is necessary to open the ontology by which indexing the document. Indexer is able to interpret the codifying language of the ontology (in our case RDFS language), representing it through a tree-structure on the left side of the screen, according to the selected browsing relation.

Browsing the ontology by concepts and changing the relations, the user can easily individuate the most suitable concepts related to the document.

After Xpath selection, it is possible to associate one of the following typologies of assertion:

- semantic or no-semantic, depending on the nature of utilized ontology;
- simple or complex, depending on the reification degree.

Concerning the nature of utilized ontology, it is possible to use a domain ontology, or content ontology (Stojanovic, Staab and Studer, 2001), that provides the vocabulary valid for a particular domain, describing the content of the resource, or a structure ontology, or context ontology (Stojanovic, Staab and Studer, 2001), that provides general concepts, cross functional to specific domains, describing the type/structure of the resource, the form in which topics are presented. All the assertions are codified with a set of RDF statements (the number of statements varies according to the typology of assertion).

After the generation of RDF statements, the indexer processes them and stores the relative semantic assertion into the database. In this way, the document becomes part of the knowledge base, together with a set of metadata and a set of semantic assertions.

Then there is also a text editor for creation of ad hoc RDF statements, integrating them with statements created automatically.

The typology of indexing system above illustrated maximizes both the efficacy of the document retrieval and the knowledge base maintenance, because it assures an high granularity of stored documents.

Ontology maker

Ontology maker is a tool for building and maintaining the ontologies. It is a Java tool designed for not RDFS expert users to create and maintain an ontology in a machine-readable language. Ontology maker stores the ontologies in a relational database for two main reasons:

- It could be exported in any moment in the selected machine-readable language, for aligning to the standards of the scientific community;
- It allows to maintain, in a simple way, the structure of the ontology and the choice of concepts, relations and instances.

Knowledge base

Knowledge base is based on a set of domain ontologies. An ontology is a formal, explicit specification of a shared conceptualization, related to a particular domain. It is based on a shared vocabulary of concepts (each concept has own definition), related each other through a set of relations. We have first build the structure of the concepts through a semantic network approach using the traditional KL-ONE model.

Our second step has been the choice of a machine-readable language: RDFS (Resource Description Framework Schema) for formalizing the ontology and RDF (Resource Description Framework) for structuring the semantic assertions. This choice is justified from the arising importance of these two languages in the semantic web community (for web content definition), and for the role they play in structuring other languages (such as OIL).

The knowledge base (composed by the ontologies and the semantic assertions) is stored in a relational database and, in any moment, it is possible to create the set of RDF statements related to the semantic assertions and the RDFS code related to the representation of the ontology. This choice is supported by the following considerations:

- an enhancement of the efficiency in searching documents;

- an improvement of the maintenance of the knowledge base (in fact, it will be possible to correct concepts and their instances without modifying the source code of RDF and RDFS files).

The following table presents the association between knowledge processes and Knowledge Hub subsystems:

	Generate Knowledge	Store Knowledge	Distribute Knowledge	Apply Knowledge
Front Office				
Forum		X	X	
Mailing List			X	
Chat	X		X	
Conference System			X	X
Reporting System			X	
e-Learning System	X		X	X
On-line Questionnaires		X		
Publishing System	X		X	X
Navigator			X	X
Back Office				
Knowledge Base		X		
Spider	X			
Validator	X			
Indexer	X			
Ontomaker	X			

Tools above presented, judiciously integrated and set up, configurated according to actors' profiles, constitute a complete technological platform enabling cognitive dynamics and sustaining learning processes into a networked relational space.

4. A systemic view of the Knowledge Hub

The Knowledge Hub with its services, its knowledge processes and its knowledge sources becomes a powerful instrument enabling knowledge flows at global scale.

In the following figure a systemic view of the knowledge hub is shown. It integrates three essential components:

- the conceptual framework related to the knowledge strategy and explicitated by the knowledge sources (discussed above) [Skyrme, 2000];
- the conceptual framework related to the business concept innovation proposed by Hamel (2000);
- the conceptual framework related to the essential knowledge management processes (discussed above) [Heisig, 2001].

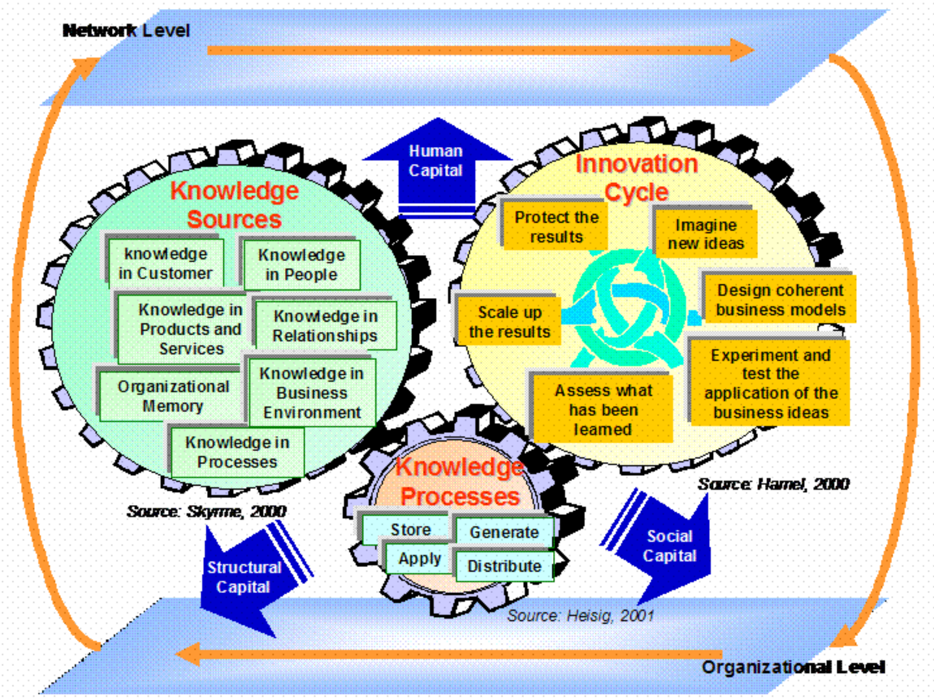

Fig 3: A systemic view of the Knowledge Hub

The emerging learning space characterized by knowledge interactions, activates complex dynamics that mainly develop towards two distinct and interdependent levels:

- a micro level (organizational level), in which each actor creates and exchanges knowledge and experiences into own organizational structure;
- a macro level (network level), in which the whole network evolves towards global knowledge patterns.

Strong interactions and interdependent processes arise between these two levels for contributing to develop innovation into the network: the innovation cycle represents completely the virtuous mechanisms generating innovation into the network. It evolves towards the following processes:

- imagine: that is the proposals coming from each actors of new ideas that could evolve into new projects, products or services;
- design: that is the design of new organizational or business models, according to ideas, plans and projects;
- experiment: that is the implementation and building of archetypes or prototypes for verifying the efficacy and the efficiency of the results, coherently with the business strategy;
- assess: that is the analysis and the control of the results obtained from the experimentation;
- scale: that is the diffusion and the replication of the experiment in other contexts or networks and the industrialization of the results;
- protect: that is the protection of the obtained results (patents, copyrights, brands).

The main result of the integration of these three components is the reinforcement and the consolidation of the Intellectual Capital of the network expressed by its three basic components [Seemann, 2000]:

- Human Capital: that is the knowledge (both tacit and explicit), skills and experiences owned by each node of the cluster;
- Structural Capital: that includes the explicit knowledge embedded in the network work processes and systems, in communication protocols, in written policies, documentation, shared knowledge base, common patents and copyrights;
- Social Capital: that reflects the ability of each actors to collaborate, to work together, to share knowledge effectively, to promote joint projects.

5. Conclusions

In the new competitive space, knowledge-based and Internet driven, the geographical industrial clusters, based mainly on localised and tacit knowledge, could evolve towards new spatial agglomerations, able to grasp the opportunities offered by the Internetworked technologies.

In this perspective, the Knowledge Hub (KH) described in this paper may be conceived as a knowledge management system that sustains the development of the dynamic externalities that enhance the knowledge-based transactions and the learning processes of an industrial cluster.

To set-up the model, we focused first on the huge amount of empirical studies concerning the analysis of the agglomeration economies and of the industrial clusters. In this phase a specific focus was given to the analysis of the knowledge exchanges and of the learning processes that develop within an industrial cluster.

Our model has then been defined as a system suitable for supporting mainly the explicit and codified knowledge exchanges of an industrial cluster, even if it aims also to support the inner learning-by-interacting process of a cluster, in order to trigger some of the Nonaka's combination and internalisation knowledge conversion processes.

Moreover the KH enables the creation of a shared memory of the network, made up of all the codified knowledge owned by its members. This memory supports knowledge exchange processes among the nodes of the network, creating new interrelationships among them, and reinforcing each node.

Indeed, the KH offers a set of services that allow the nodes of the network:

- to interact both each other and with their shared knowledge base, thus sustaining the network inner knowledge exchanges and inner relationships;
- to access to the explicit knowledge available at a global scale, thus boosting the development of the network trans-local relationships.

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