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Section Two

Economic and social aspects

NEW PARADIGMS

European Commission
Information Society and Media

1 Towards Dynamic Clustering: Capabilities and IT Enablers

Ramon O'Callaghan
Tilburg University and IESE Business School
http://www.uvt.nl
r.ocallaghan@uvt.nl

Abstract

"Industry clusters" are systemic agglomerations of enterprises with common or complementary business interests. Firms in clusters benefit from sharing the fixed costs of common resources, such as infrastructure and services, skilled labor pools, specialized suppliers, and a common knowledge base. These sources of productivity lie outside of individual firms, and economists refer to them as "external economies of scale" (Marshall, 1920). Given that these factors are geographically concentrated, the benefits of clusters are traditionally associated with spatial proximity. But in the 21st century, one can posit a new way of clustering based on networking of knowledge and competencies that goes beyond geographical proximity and that overcomes the "inward looking" nature associated with traditional clusters and Italian "industrial districts".

This paper sets forth emerging forms of "virtual" clusters that transcend location, focus on international markets, operate as ad-hoc business networks, are IT-enabled and based on dynamic aggregation of capabilities of different (often small) firms. The working hypothesis is that these new organizational arrangements, which in this paper are called "extended dynamic clustering" (EDC), can help small companies position themselves better in terms of global market access and innovation. The paper also discusses roles for information technology applications, and suggests a research agenda and potential policy implications.

Business Networks: Cluster Precursors

A decade ago, networks were the policy of choice for increasing industrial competitiveness. Major networking programs were promoted, supported, and studied by United Nations Industrial Development Organization, the World Bank, USAID, the European Union, and Organization for Economic Cooperation and Development (Rosenberg, 2005). The transition from policies to build networks to policies to build clusters—and to a large extent back to networks—is a story of evolving economic development practices.

In the 1980s, when international competition and rapid technological change forced massive restructuring across industries, Miles and Snow (1986) introduced their view of enterprise networks as a flexible, fluctuating and dynamic structure. Within the trend toward disaggregation and looser coupling, managers experimented with various organizational arrangements. Instead of using plans and schedules, and transfer prices to coordinate internal units, they turned to contracts and other exchange agreements to link together external components into various network structures. The "flexible manufacturing network" was rediscovered in western Europe –particularly in Northern Italy– where inter-firm collaboration was documented and explained by researchers (Brusco 1982, and Sabel 1989) and supported by organizations such as the National Confederation of Artisans in Emilia Romagna and the Steinbeis Foundation in Baden Wurttemburg. The idea was simple: companies would join together to achieve economic goals unattainable by an individual organization on its own. They would network to produce more complex goods, extend their market reach, acquire costly resources or services, or simply reduce costs.

In 1990, the Danish Technological Institute in Århus designed what became the standard policy model to increase networking among small and mid-sized enterprises (SMEs). It consisted by five steps: 1) publicizing the concept among SMEs; 2) training network brokers to organize and facilitate networks; 3) training "multipliers" (e.g., accountants, consultants, and lawyers) to identify potential network opportunities; 4) creating a three phase grants program as incentives for organizing networks that agreed to collaborate on hard business opportunities, developing plans, and implementation; and 5) evaluating the outcomes. The goal was to create a program that would change the behavior of SMEs and create the culture of cooperation observed in Northern Italy.

Numerous network typologies can be found in the literature (Powell, 1990). Proposals range from strategic hub-and-satellite networks as in the automotive industry (Kerwood, 1995), clan-like structures as in Japanese Keiretsus (Ouchi, 1980) and regional networks up to temporary networks and dynamic virtual organizations. Some distinguish between "soft" and "hard" networks (Williams, 1996). "Hard networks" are relatively small groups of companies that have been established to achieve concrete business objectives such as entering new markets, joint product development, co-production, or co-marketing and are likely to require formal agreements for sharing profits or resources. Hard networks are thus formed with a specific "bottom line" motivation. Firms in "soft networks" also expect to make money but not necessarily through contractual business ventures. The soft networks have open membership, tackle generic issues, and provide some general services. They depend on membership fees for part of their funding, and thus tend to be quite large. Their goals and structures are similar to trade associations.

Most research on business networks has focused on the general characteristics of organically evolved networks, and on their structure and development processes. Less attention has been paid to intentionally developed nets and their management, with the notable exceptions of the work of Jarillo (1993) and Parolini (1999) on value nets, and the emerging theory of network governance in economic sociology and strategic management (Amit and Zott 2001, Gulati et al 2000, Jones et al., 1997). The challenges involved in operating in a complex network remain fairly unarticulated. Relevant issues in this context are: the coordination of tasks and processes within networks, the allocation of orders, the measurement of surplus or utility and the distribution of profits. Future research should aim at the development of network management. Such research could integrate notions from Industrial Network Theory and the Dynamic Capabilities View (Moller et al., 2002) in order to identify the basic capabilities required in managing different types of strategic networks, and to elaborate their characteristics and interrelatedness.

Perspectives on Regional Clusters

Like networks, clusters are composed of firms that co-locate around a variety of common interests or needs[1]. But, unlike networks, neither "membership" in an organization nor cooperation is required to be "in" a cluster. "Free riders," simply by virtue of geography, are able to realize non-exclusive external economies that accrue to members of cluster associations, including access to information that flows informally.

Regional clusters are examples of external economies derived from industrial localization. They are self-reinforcing agglomerations of technical skill, venture capital, specialized suppliers, infrastructure, and spillovers of knowledge associated with proximity to universities and informal information flows (Hall and Markusen, 1985; Arthur, 1990). Porter's identification of local agglomerations, based on a large-scale empirical analysis of the internationally competitive industries for several countries, has been especially influential, and his term "industrial cluster" has

1) A cluster includes groups of companies and/or services and all of the public and private entities on which they depend, including suppliers, consultants, bankers, lawyers, education and training providers, business and professional associations, and government agencies.

become the standard concept in this field (Porter, 1998, 2001). Also, the work of Krugman (1991, 1996) has been concerned with the economic theory of the spatial localization of industry. Both authors have argued that the economic geography of a nation is key to understanding its growth and international competitiveness.

Clustering gives businesses an advantage over more isolated competitors. It provides access to more suppliers and support services, to experienced and skilled labor pools, and to the inevitable transfer of knowledge that occurs where people casually meet and talk business. Clustering enables companies to focus on what they know and do best; they need not do things they do not do well. Firms also benefit from synergy. Companies able to operate more or less as a system can use their resources more efficiently and collectively produce more than the sum of their individual outputs.

Among the advantages of clustering, none is as important as access to innovation, knowledge, and know-how. Industry-specific knowledge and know-how is created and diffused through entrepreneurial initiatives and innovative companies. Firms gain from greater access to tacit knowledge, the movement of knowledge that occurs intentionally among friends and colleagues and unintentionally when employees change jobs. This perspective suggests a social network model of clusters. A social network approach provides insights into the structure and dynamics of regional clusters by focusing on the relationships between firms and the social structures and institutions of their particular localities (Powell, 1990; Nohria and Eccles, 1992). This view has been used to explain the divergent trajectories of Silicon Valley and Boston's Route 128 economies (Saxenian, 1994).

The Challenges of Globalization: Small firms within and beyond clusters

The trend towards globalization of the economy poses a number of challenges to the smaller firms in traditional clusters. Often, due to size, scale, specialization and not least regulatory and legal impediments, SMEs lack the capacity to respond adequately to market opportunities or participate in tenders in international procurement contracts. This shortcoming is related to both the conditions that SMEs face and the operation of geographically based clusters. More specifically, one can distinguish 'internal' reasons (specific to the SMEs) and 'external' reasons (specific to clusters and insufficiently developed cross-border and cross-regional collaboration mechanisms among clusters):

- Internal reasons have to do with limited resources and competences. SMEs often do not posses all the relevant skills and competencies, and cannot afford the specialized human resources (e.g. legal, and technical expertise) required to participate in collaborative cross-border or cross-region processes for the co-creation and delivery of products and services;

- External reasons span from the perceived complexities of international contract negotiation, to trust and financial issues, as well as the perceived disadvantages in terms of size and skills (e.g. SMEs may rule themselves out when they know that some large competitors will be bidding). External reasons include also regulatory and legal gaps that create roadblocks to cross-border collaboration, contract negotiation, intra- and intercluster governance policy and institutional issues which hinder the formation and efficient operation of cross-border and cross-regional collaborative networks.

From these two perspectives, a fundamental challenge is how to facilitate linkages, not only among SMEs within a given cluster but also how to build such capacity across clusters and networks of SMEs. This challenge involves building 'internal' capabilities by enhancing the organizational, knowledge and technological capacity of SMEs to enter into cross-border and cross-regional collaborative processes for jointly producing and delivering products and services. It also involves building 'external' capacity in the environments in which SMEs and their clusters operate. In other words, if the 'internal' set of issues refers to the business challenges SMEs face, the 'external' issues concern the 'enabling framework' that will facilitate cross-border and cross-regional collaboration among SME clusters.

The Extended Dynamic Cluster: a New Paradigm

For the purposes of this paper, "extended dynamic" clusters are conceptualized as virtual clusters that transcend location, focus on interregional or international markets, are ITenabled, operate as ad-hoc business networks that can aggregate and reconfigure capabilities from different firms. "Dynamic" clusters can integrate SMEs involved in different production processes or operating in different markets. The advantage is that the resulting "extended dynamic" cluster is much more responsive and enjoys a steep learning curve.

Changes inside the cluster (e.g. changing or adding a key new partner) can bring significant changes in the ability to respond to opportunities in the market. This involves a knowledgetransfer process. Let's consider, for example, a cluster specialized in producing mechanical parts and tools for the automotive sector. They decide to respond to a tender from an aerospace company, and, because they lack some necessary skills, they decide to include in the cluster a supplier operating in the aerospace sector. The added competence of this new partner gives the cluster the possibility not only to go in the new market place, but to learn "by immersion" in a new industrial environment. This "full immersion learning" is learning not only from the new partner, but also from all the players in the aerospace environment, i.e. customers, competitors, suppliers, the regulatory agency, etc. Thus, in a short period of time, the cluster learns and evolves into a "new" type of cluster that now can operate in a new sector. Repeating this process several times improves the dynamic capabilities and thus the flexibility of the cluster to innovate, incorporate new technologies and tackle new markets.

One way to understand the notion of "extended dynamic" clustering is by positioning this new construct against traditional forms of business agglomeration, e.g. industrial clusters, and business networks. The diagram in figure 1 shows the two dimensions that characterize this evolved cluster form.

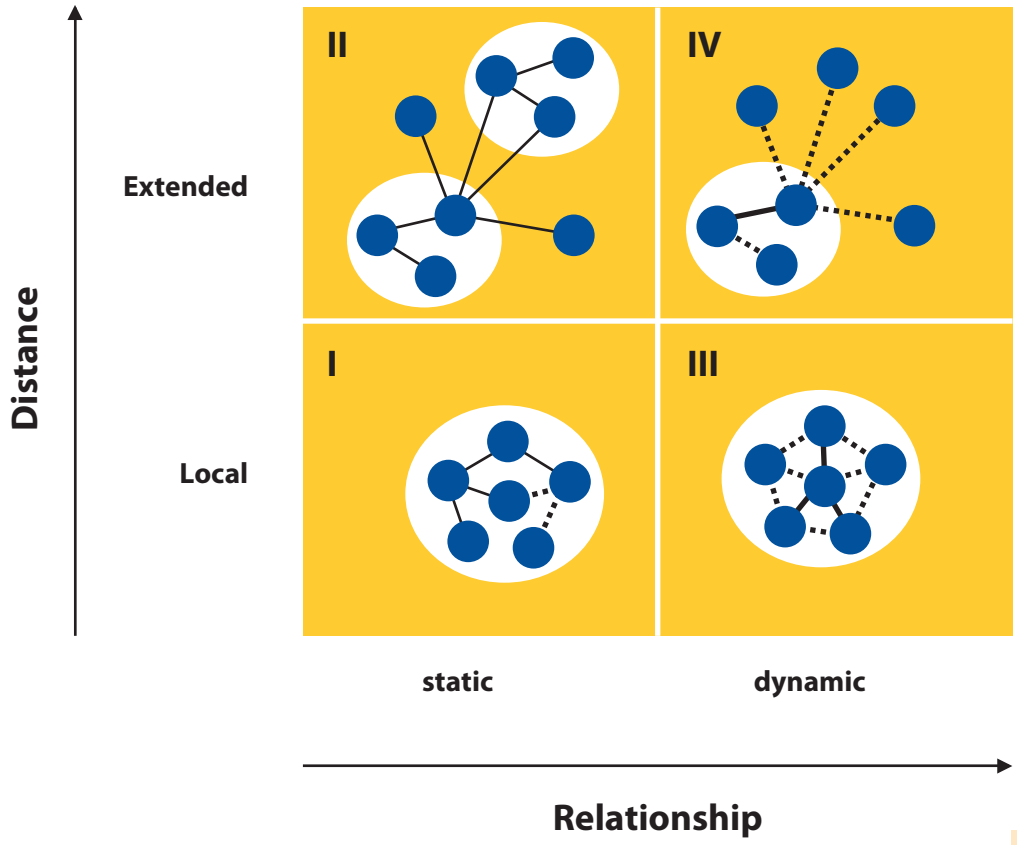

Fig. 1
Clustering typology

The horizontal dimension is based on the typology found in the literature on business networks that differentiates "dynamic" from "static" business relationships. Miles and Snow (1986) introduced their view of enterprise networks as flexible, fluctuating and dynamic structures. They point out that, while some networks bring suppliers, producers, and distributors together in long-term stable relationships (i.e. "stable networks"), other networks are much more dynamic, with components along the value chain coupled contractually for perhaps a single project or product and then decoupled and reconfigured to be part of a new value chain for the next business venture (i.e. "dynamic networks").

The vertical dimension represents the geographic reach of the network, i.e. the space in which a given (extended) cluster operates. This dimension can be operationalized essentially as the average geographic distance between the networked firms. In practice, it may be useful to differentiate between local, regional, national, and transnational domains. This differentiation may be particularly important for network governance. Both governance issues and policy recommendations are likely to differ at local, regional, national and supra-national level.

Capabilities for Dynamic Clustering

The strategic management literature has traditionally focused on analyses of firm-level strategies for sustaining and protecting extant competitive advantage, but has performed less well with respect to assisting in the understanding of how and why certain firms build competitive advantage in regimes of rapid change. To address this problem, researchers have focused on "dynamic capabilities" which are defined as the "ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece et al., 1997).

Dynamic capabilities reflect "the ability to learn new domains" (Danneels 2002). Hence, their value lies in the configurations of functional competencies they create (Eisenhardt and Martin 2000, Zott 2003). For example, by spotting market trends and accordingly revamping functional competencies, dynamic capabilities can prevent rigidities (Leonard-Barton 1992) and competency traps (March 1991). Also, by replacing outdated configurations of functional competencies and architecting more relevant ones, dynamic capabilities can create better matches between the new configurations of functional competencies and environmental conditions (Teece et al. 1997).

Reconfiguration is generally viewed as the ultimate outcome of dynamic capabilities. Most studies in the dynamic capabilities literature stress the importance of reconfiguring existing resources into new configurations of functional competencies. For example, reconfigurability refers to the timeliness and efficiency by which existing resources can be reconfigured (Galunic and Rodan 1998, Zott 2003). It refers also to the concept of 'combinative capabilities' (Kogut and Zander 1992) that describes the novel synthesis of existing resources into new applications. Eisenhardt and Brown (1999) refer to the ability to "quickly reconfigure resources into the right chunks at the right scale to address shifting market opportunities". Applied to extended clusters, the concept of "dynamic capabilities" implies that SMEs networks can re-deploy their existing competencies to build new products or services through innovative, aggregated competencies that better match emerging market and technological needs.

The dynamic capabilities and related literatures describe four processes that drive reconfiguration for innovation:

- Sensing the environment (market orientation): Sensing helps understand the environment, identify market needs, and spot new opportunities (Zahra and George 2002).
- Learning: Learning builds new thinking, generates new knowledge, and enhances existing resources (Zollo and Winter 2002).
- Coordinating Activities: Coordinating helps allocate resources, assign tasks, and synchronize activities (Teece et al. 1997).
- Integrating Resources: Structuring interactions among partners and integrating resources helps implement architectural innovations (Grant 1996, Henderson and Clark 1990).

While dynamic capabilities can reconfigure all resources (Prahalad and Ramaswamy 2004), it is important to stress the role of knowledge as an intangible resource (Galunic and Rodan 1998). Leonard-Barton (1992) argues that as resources become less tangible, but explicitly codified, they will be easier to reconfigure.

The Role of Information technology

Much has been made of the potential of ICT to enable a de-spatialization of economic activity. Cairncross (2001), among others, posits that with the introduction of the Internet and new communications technologies, distance as a relevant factor in the conduct of business is becoming irrelevant. She contends that the "death of distance" will be the single most important economic force shaping all of society over the next half century.

Indeed, the advent of the Internet and overnight delivery reduces the value of localization economies, i.e., access to the lower cost intermediary inputs to production, including parts, services, and information at a distance. Proximity still matters for critical components that are knowledge intensive and depend on interactive research and design or special expertise for assembly or utilization, but many of the sectors included in standard cluster maps are of diminishing economic advantage. Future research will thus have to look at "extended" clusters as geographically proximate complex organizational systems of learning and economic and social activity that are globally networked and enabled by the effective application of IT. These are some of the key questions:

- How will IT affect traditionally perceived needs for physical proximity and introduce "virtual" proximity as a complement to physical proximity?
- Can "virtual" clusters be expected to emerge and/or develop, in part, as a result of the widespread application of IT?

- What combinations of physically proximate and "virtual" arrangements best augment the social and economic performance of networked clusters?

One way to address these questions is by focusing on the processes that enable "extended" and "dynamic" clustering as identified above and envisioning different ways in which IT can play a relevant role. The following sections discuss potential roles of information technology to enable clustering capabilities along the two dimensions identified earlier, i.e. virtual proximity capabilities and dynamic clustering capabilities.

IT and Virtual Proximity

In traditional clusters, the need for physical proximity has led to regional agglomerations. The geographic boundaries of these clusters are set by the distances that those in firms and entrepreneurs are willing to travel for informal face to-face meetings and by how far employees are willing to travel to work. But relying exclusively on physical proximity limits the available talent pool and the access to specialized facilities. So there is a strong case for taking advantage of IT to link to remote professionals and resources, and to other organizations through ties such as alliances, partnerships, and information-exchanges. The underlying assumption here is that geographical proximity, collegiality, and group membership does not bound communication. Indeed, employees rely increasingly on information from outside their group and outside their organization for accomplishing their tasks, (Wellman 2001, Hargadon and Sutton 1997).

These boundary-spanning links make organizations more open systems whose boundaries are more permeable to information from the outside. They function as interconnectors between multiple networks, providing access to new information and more creative problem solving (Jarvenpaa and Ives 1994). For example, Robin Teigland (2000) has shown that boundaryspanning information exchanges led to higher levels of creativity, and information obtained from online communities increased workers' performance.

Some researchers argue, however, that knowledge cannot be shared or absorbed independently of the processes through which it is generated (Roberts, 2000). But, if greater stocks of knowledge can be circulated across electronic networks and used in ways that effectively support learning, then the importance of geographical clustering and physical presence may indeed be reduced.

Figure 3 shows a relationship between the degree of codification of knowledge and the speed and extent of its diffusion within a target population (O'Callaghan and Andreu, 2006). The figure highlights a tradeoff between codification and reach. The shape of the curve indicates that more people can be reached per unit of time with knowledge that is codified (explicit) than with knowledge that remains uncodified (tacit). As the size of the target population that one seeks to reach increases, the message needs to be more highly codified to reach that population quickly, and much of the contextual richness of the message must be sacrificed for the sake of communicative efficiency.

New IT applications can change the nature of this trade-off between loss of context and speed of diffusion. By increasing data processing and transmission capacities, they enable more data to reach more people, whatever the level of codification chosen, as indicated in the figure 2. This is shown by a horizontal shift in the curve.

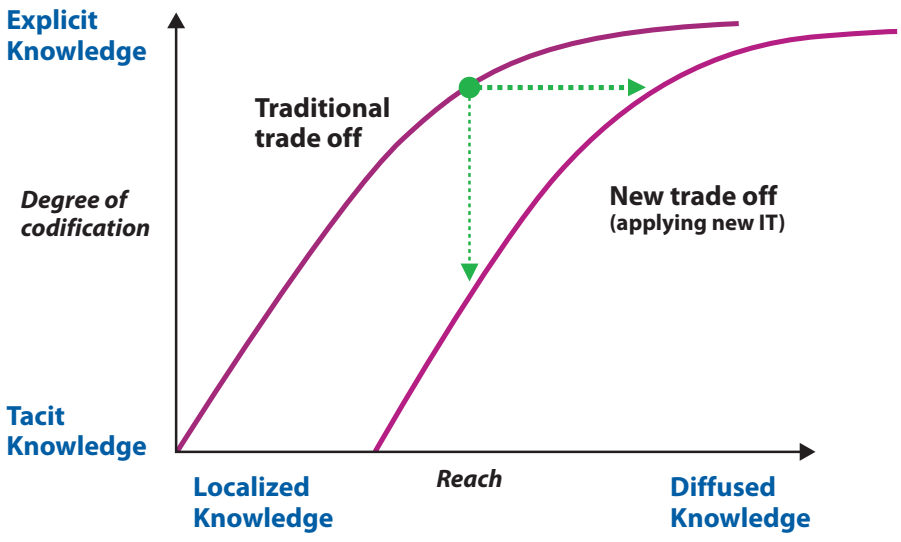

Fig. 2
Knowledge flows, distance and IT impacts

The horizontal arrow shows how at a given level of codification, the population to which a message can be diffused increases. But, the vertical, downward pointing arrow also shows something else: it suggests that, for a given size of population being targeted, a message can be sent at a lower level of codification than in the absence of IT, i.e. the message can transmit more of its context, thus restoring some of the context-specific interpersonal qualities usually sacrificed to codification.

Early generations of knowledge management solutions focused on explicit knowledge in the form of documents and databases, but as the above figure suggests, there is a need to expand the scope of the solutions to integrate technologies that can support tacit knowledge (Marwick 2001). Future applications will have to address the following needs:

- IT to assist teams share experiences: build and share tacit knowledge
- IT to help groups work effectively together: group support and collaboration
- IT for electronic meetings and trust building: e.g. high definition videoconferencing
- IT to identify individuals with the right knowledge: expertise locator
- IT to elicit help from experts and the community: forums and bulletin boards
- IT to tap the knowledge of experts: capture expert judgments via hyperlinks, citations
- IT to support the formation of new tacit knowledge from explicit knowledge: portals, taxonomies, knowledge mapping, etc.

IT and dynamic capabilities

The following paragraphs focus the potential role of IT to enable or support dynamic clustering capabilities. The discussion is structured around the four constructs identified above: market orientation, absorptive capacity, coordination, and collective mind. This is illustrated in figure 3 that depicts a model for IT applications used to overcome distance barriers, enable virtual proximity, and support dynamic capabilities.

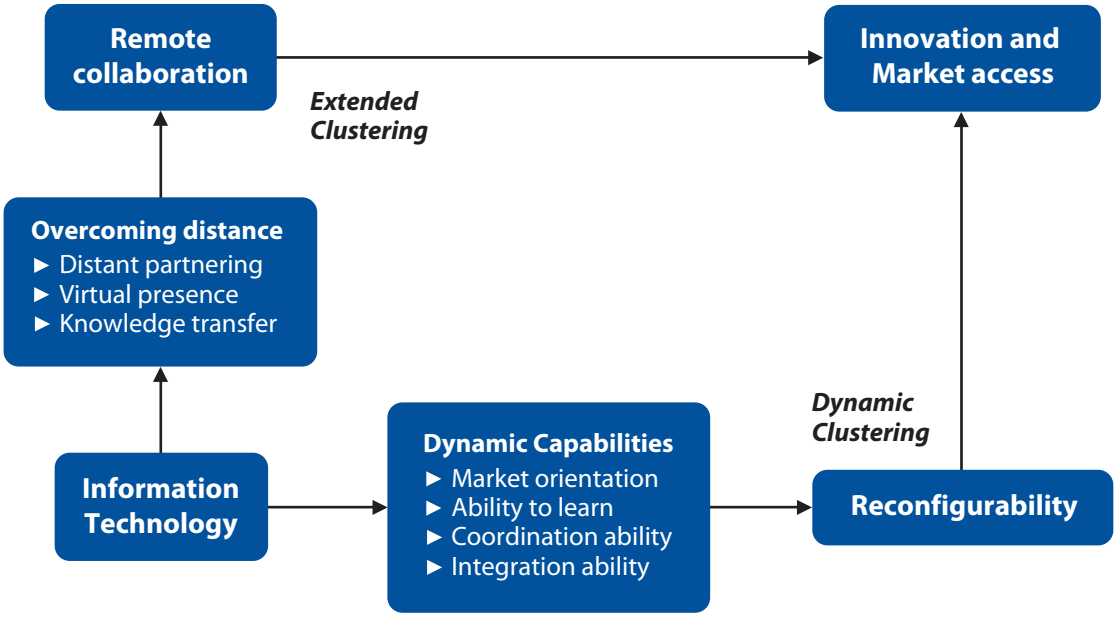

Fig. 3
Role of IT in Extended Dynamic Clustering

"*Market Orientation*" reflects the ability to sense the environment and understand customer needs and competitive dynamics. It is defined as 'the process of generating, disseminating, and responding to market intelligence about customer needs' (Kohli and Jaworski 1990). These processes can be supported with the following IT applications:

- IT for capturing market intelligence, e.g. external communication links for sensing market trends or discover new market opportunities.
- IT for disseminating market intelligence to the appropriate parties in the business network / virtual cluster
- IT for analyzing and interpreting market intelligence
- IT for responding to market trends, e.g. by enabling processes and supporting operations that capitalize on market intelligence

The literature refers to "*Absorptive Capacity*" as the *ability to learn* by identifying, assimilating, transforming and exploiting existing knowledge resources to generate new knowledge (Cohen and Levinthal 1990, Zahra and George 2002). Regarding IT, the relevant IT applications are:

- IT to help acquire or "broker" knowledge
- IT to help assimilate knowledge (e.g. knowledge articulation and codification)
- IT to help transform knowledge, (e.g. in supporting new thinking, brainstorming, experimentation, and problem-solving)
- IT to help exploit knowledge (e.g. in new projects, identifying new solutions)

Coordination capability reflects the ability to manage dependencies among resources and tasks to create new ways of performing a desired set of activities (Crowston 1997, Malone and Crowston 1994). Pertinent IT applications are:

- IT for allocating resources (including distribution of knowledge)
- IT to help assign tasks among partners
- IT for appointing the right person to the right unit or project
- IT to help synchronize activities among collaborating partners
- IT for reaching synergies among tasks and resources

The literature refers to "*Collective Mind*" as the "*ability to integrate* disparate inputs through heedful contribution, representation, and subordination into a group system" (Weick and Roberts 1993). "Collective Mind" can also be conceptualised as the *architecture* for the whole system. In this respect, it helps implement a set of complex activities by specifying the organizing principles by which individual knowledge is integrated (Grant 1996). The IT related questions are:

- IT to model and help structure the cluster/ network
- IT to monitor how partners fit in, interact, and their activities affect others
- IT to interrelate diverse inputs (including knowledge) from constituent firms to execute the collective activity of the cluster / network
- IT to help individual inputs contribute to the group outcome
- IT to support the sharing of knowledge among partners
- IT to keep network managers informed

Policy implications and future research

The research advocated in this paper calls for the development of a theoretically grounded framework for "Extended Dynamic Clustering" (EDC) in order to investigate how ICT infrastructures, collaborative systems, governance structures and other factors can influence clustering across borders and improve SMEs' ability to innovate and access global markets.

The Extended Dynamic Clustering (EDC) paradigm may provide a new perspective for policy research and practice. To apply the EDC concept to policy, instruments have to be developed to identify extended dynamic clusters (or clusters that have EDC potential), as well as tools for improving inter-organizational structures and processes that facilitate dynamic clustering. Research should identify extended dynamic clusters in some countries or regions, and establish whether the regional / national economies can be effectively examined through the EDC lens; and, if so, whether policy makers can more accurately identify market imperfections of existing clusters, and determine what interventions might have the greatest impacts. To this effect, potential research products could include:

- Conditions for an outward-looking perspective on clusters with emphasis on the traditional economic strengths of regions but also on dynamic capabilities to respond to rapid economic changes and global competition.
- Conditions for reconfiguring clusters as 'hubs' and roles of institutions in helping build regional economic capacity (in terms of dynamic capabilities, networking and international connections) to enable regional SMEs to confront the challenges of being 'hubs' between a global economy and a regional business ecosystem.
- The effects of open-source IT platforms and tools that may support new methods of collaboration, and process integration within, between and across regional networks incorporating SME's and large contracting organizations, as part of an end-to-end supply chain.
- Domains for policy intervention in terms of regulation, legal measures, technology policy at supranational, national and regional levels for the creation and facilitation of dynamic clustering.

Extended dynamic clusters differ from traditional clusters in their extra-territorial reach, dynamic capabilities and the enabling role of IT. Information technologies provide a new means of linking up local places and regions within networks of organizations. Inclusion in the network requires an adequate local technological infrastructure, a system of ancillary firms and other organizations providing support services, a specialized labor market, and a system of services required by the professional labor force. Research outcomes should include guidelines for policy makers and civil society organizations in order to facilitate the transitioning of SMEs to extended dynamic clusters as well as the adoption and usage of related ITs. Research results could also inform, for example, ways for SMEs to reconfigure themselves from being simple members of a local cluster to being important nodes of a global network of business partners.

The new industrial spaces of today are complex networks with multiple nodes. They can be seen as geographically proximate, complex organizational systems of learning and economic activity that are globally networked with other systems. The spread of global, national, regional and local IT networks and information flows may fuel an "innovation ecosystem" (cross regional and trans-national), and act as a catalyst for social learning processes that give rise to successful economic and social development. If public policy makers proactively encourage the integration of advanced information technologies through "digital ecosystems" to link geographically clustered firms with other organizations within and beyond their immediate regional surroundings, there might be opportunities for a departure from the conventional pattern of regional development and a catalyst for growth.

Social and economic aspects of ecosystems: The next chapters

The next chapters in this book develop different aspects of "digital business ecosystems" (DBE), including economic, social, regulatory and trust-related issues. Darking's chapter discusses the role of "governance" in ecosystems, and proposes six different "dimensions" of governance: 1) constitution and balance of interests, 2) culture of communication, 3) credibility, attunement and trust, 4) organization and synchronization, 5) licensing and regulation, 6) technological dimension. Cutting across organizational, regulatory and technological frameworks, these dimensions provide inter-related concepts for further research and discussion. The chapter of Rivera Leon provides a framework for assessing the cost and benefits of DBE with the aim to raise awareness among policymakers and encourage them to implement DBE in their regions. In another chapter, Berdou discusses two important characteristics of networks and communities of practice (knowledge and structural embeddedness) and indicates how they relate to the sustainability and scalability of Digital Ecosystems. Knowledge embeddedness relates to the dependency of knowledge on social context. Structural embeddedness refers to embeddedness of economic action in social relations and the way "the quality and network architecture of exchange relations influence economic activity". In the last chapter, Tsatsou and Elaluf-Calderwood summarize research on the factors contributing to trust amongst small- and medium–sized enterprises (SMEs) in Digital Business Ecosystems. They describe a regulatory framework based on three building blocks: 1) Privacy and consumer protection, 2) e-signatures and security, and 3) jurisdiction and consumer protection, and discuss the development of the "Knowledge Base of Regulatory Issues" which is important in the context of the development of Free Software/Open Source (FS/OS) for commercial use within the European Union countries.

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2 Understanding the Role of Governance in the context of Digital Ecosystems

Mary Darking
Department of Media and Communication,
London School of Economics and Political Science
http://www.lse.ac.uk
m.l.darking@lse.ac.uk

Abstract

In this chapter, key characteristics of digital ecosystems are described and developed as 'dimensions of governance'. Governance can have far-reaching and fundamental consequences with respect to the way relationships are constituted within a given social context. Understanding the role of governance in the context of digital ecosystems requires consideration of the social, regulatory and technological aspects of ecosystem-based technologies and social networks. It also involves understanding governance as a spectrum of working practices that include both formal and informal working arrangements. In this chapter, social science research contributions from the digital business ecosystem project are drawn upon to develop a preliminary framework for supporting discussion and further research around this topic.

Introduction

The policy vision for digital ecosystems is to use the latest developments in technology infrastructure design, to create a framework for innovation that will enable small and medium-sized enterprises (SMEs) to cross the digital divide, thus stimulating regional development. The innovation and diversity inherent in the business models and practices of SMEs has the potential to provide Europe with a groundswell of new products, ideas and services. However, for this source of innovation to be fully mobilised, the right regulatory, technological and social conditions need to be created. However, in seeking out the 'right' regulatory, technological and social conditions, a central paradox is opened up. Diversity is contextual in that environments that are themselves varied and distinct nurture it. In this respect, what constitutes 'ideal conditions' for growth in one environment may prove obstructive in another. Therefore, formulating a template for governance that puts in place the 'right' conditions for ecosystem-based innovation and which also supports the diversity inherent in the business practices of European SMEs constitutes a significant challenge.

In this paper, the role of governance is considered in the context of digital ecosystems and a preliminary framework for supporting discussion and further research around this topic is outlined. Social science research carried out as part of the Digital Business Ecosystems (DBE) project is drawn upon to elicit insights into regulatory, constitutional and technological aspects of digital ecosystems governance. From this, a number of different 'dimensions' are proposed according to which the topic of ecosystems governance can be understood. The significance of these dimensions can only be touched on here, but in developing them, a basis for thinking about and analysing issues of digital ecosystems governance is provided and can be further developed in future research.

Understanding the role of governance

Governance refers to the constitution of relationships between different social groups and the processes of decision-making through which rights and responsibilities are established and defined. Traditionally, the term 'governance' has been used to describe the relationship between a government and its people or alternatively, the relationship between a company and its shareholders - the latter known as 'corporate governance' (Coyle 2003; Benn and Durphy, 2006). Over time, the meaning of governance has been extended to include all aspects of civil society, not simply those pertaining to central government or large companies (Ostrom, 1983). More recently, as understanding has grown of the choices inherent in the design of new technologies, governance is also used to describe technology procurement and the way key technological relationships and dependencies are established between technological products and systems purchased by an organisation (Thomas and Ranganathan, 2005).

One of the analytical challenges of understanding the role of governance is that it is comprised of characteristics that are deeply context specific, yet it focuses attention on principles and dimensions that have a generic or universal quality, such as duties, rights and responsibilities. In addition, the spectrum of decision-making structures, events and routines to which it can refer are far-reaching; from formal voting mechanisms to informal consensus building, governance can be understood to be comprised of a range of different practices and 'working rules' (Mansell, 2006). Together these rules and practices constitute a basis for coordination and an associated culture of meetings and communication (Darking, 2006). At the formal end of the spectrum, legally constituted entities and relationships bind and characterise relationships. However, the significance of informal means of coordination should not be underestimated. Informal environments afford flexibility with reduced organisational overhead and less reliance on formal contracts. In a business context, this flexibility can allow smaller companies to respond to customer needs in an agile and timely way. It can also create conditions of trust that facilitate the transfer of knowledge between companies and co-workers (Gow, Elaluf-Calderwood and Tsatsou, 2005).

Another analytical challenge is that, from a governance perspective, regulatory, technological and organisational frameworks cannot be studied in isolation from one another. Each of these frameworks can alter the basis according to which interactions take place; therefore alterations to one can have consequences for each of the other. It is therefore necessary to consider regulatory, organisational and technological dimensions both respectively and relative to one another, when considering questions of governance.

The digital ecosystems context

There are several key characteristics that have an important bearing on the underlying logics that shape the governance and coordination requirements of digital ecosystems. The most significant characteristic is the policy vision and focus of digital ecosystems, which is firmly centred on SMEs and regional development (Nachira, 2002). This emphasis acts as an organising principle in all decision-making processes relating to the DBE infrastructure. Similarly, the distributed and open source philosophies that are characteristic of DBE technology design and infrastructure development also play a significant role in the ecosystem vision. A further constitutional aspect of the DBE is the membership and participation conditions applied to stakeholders, each of whom have clear yet diverse interests in ensuring the sustainability of the DBE. Guaranteeing a balance of interest amongst diverse stakeholders – especially where those stakeholders are of varying size (i.e. a small company and a large corporation) - is of critical importance if digital ecosystems are to maintain their orientation towards supporting SMEs. For stakeholders to understand themselves as having a voice within governance and decision-making processes, an open, inclusive and transparent culture of meetings and communication needs to be established. Internet technologies and open communication forums offer an important vehicle for achieving such transparency (WGIG, 2005).

Aligning interests around common goals and ensuring that infrastructure development remains attuned to the needs of SMEs and regional development will have a fundamental impact on the level of trust and credibility associated with digital ecosystems. Trust, credibility and attunement were identified as fundamental to the specific e-business

practices involved in using the DBE and in the continuing engagement of SMEs (Darking & Whitley, 2005; Gow, Elaluf-Calderwood and Tsatsou, 2005). These attributes are particularly relevant given that use of the DBE involves a high degree of knowledge sharing with respect to business models and in terms of engagement in open source development. In establishing credibility and ensuring that engagement strategies were attuned to the needs of regions and SMEs, results from DBE regional analysis highlighted the diversity that exists between regions. Identifying relevant sectors, communities and organisations with which to engage was a region-specific task from which individual strategies could be derived, but from which no single model for leadership could be defined (Passani, 2005).

In addition to the coordination of regional engagement, the developer community who are responsible for maintaining and developing the DBE code base also require a basic framework for carrying out their responsibilities. At present, the developers act as a distributed group working under the leadership of two individual 'synchronisers'. This lightweight level of coordination and integration was designed in order to keep organisational overheads to a minimum, thus enabling the sustained, voluntary engagement of developers beyond the end of the project (Darking 2006). The code base also requires the protection offered by licensing, in this case, the General Public and Creative Commons licensing that currently dictates the use of DBE knowledge and code. As well as licensing arrangements relating specifically to the code base, the DBE project also developed a regulatory framework, which aimed to provide basic legal resources necessary to enable SMEs to carry out business via the DBE infrastructure and included an automated process for contract generation. The significance of this framework in acting as a resource to support SME e-business interactions was such that its coordination and design constituted an area of governance research in and of itself.

The de-centralised, distributed design philosophy that underlies the way in which the DBE infrastructure is maintained and developed constitutes another defining characteristic. This 'meta' approach to infrastructure development is designed to reduce lock-in and dependency, pushing choice and decision-making power away from the centre. The role of open source development methodologies and modes of organisation is a central requirement with respect to attaining this end. Finally, one of the most innovative characteristics of digital ecosystems is its use of biologically-inspired algorithms to support the distribution and composition of business services

Dimensions of digital ecosystems governance

Drawing on the key characteristics of the digital ecosystems context outlined in the previous section and the observation that governance involves a spectrum of processes, rules and interactions made in the introductory section, six 'dimensions of digital ecosystem governance' are outlined. Integrating key findings from social science research carried out as part of the DBE project, the table below links characteristics of the digital ecosystem context together with dimensions of governance. Cutting across organisational, regulatory and technological frameworks, these dimensions should be considered as inter-related and at times over-lapping concepts for organising further research and discussion on the topic of digital ecosystems governance.

Characteristic of digital ecosystems	Dimension of digital ecosystem governance
Shared values, common vision, participation and membership expressed in constitutional documents such as manifesto, bill of rights, code of practice	Constitution and balance of interests
Transparency, inclusion, due process, policy, procedure and accountability	Culture of communication
Alliance forming and regional coordination, allowing for diverse governance models and diverse membership	Credibility, attunement and trust
Distributed template, lightweight organisation and synchronisation for aligning codebase infrastructure development; association and alliance forming	Organisation and synchronisation
Knowledge and technology licensing, regulatory framework for digital ecosystems e-business interactions and legal definitions relevant to DBE entity	Licensing and regulation
Choice of software development methodologies, technological directions and infrastructural standards; association and alliance forming	Technological dimension

In order to set in place the policy vision for digital ecosystems, the values and priorities encapsulated by that vision need to be embedded in constitutional documents such as a manifesto, bill of rights or other statement of common

purpose. Defining the constituency to whom the bill or rights or common values apply is another important aspect of constitution building.

In terms of ensuring the operational viability of the infrastructure, there are a number of tangible areas toward which questions of governance can be applied. Questions surrounding the maintenance and development of the DBE code base constitutes one such area. Another tangible area is security; the extent to which identities can be trusted and data securely shared via the DBE infrastructure. Sharing business models is also a significant tangible area that requires constitutional support in the form of a code of practice for SMEs to ensure interests are protected. In addition to these operational questions, governance of the DBE regulatory framework is an extremely influential area of the ecosystems environment, which brings with it specific governance requirements. As a set of processes that involves consequences for the infrastructure as a whole, the evolutionary environment denotes another area that will require some form of governance or coordination.

Conclusion

The purpose of identifying the characteristics and dimensions above is to formulate the outline of a framework for considering issues associated with digital ecosystems governance. As more fully developed in deliverable D32.7, these characteristics and dimensions can be applied to tangible areas that arise as relevant to digital governance and coordination efforts. From a research perspective, this framework could act as a basis for formulating a taxonomical approach to exploring, setting the boundaries and assessing the relevance of issues associated with digital ecosystems governance.

The policy vision for digital ecosystems places specific demands on the creation of a template for governance. Creating organisational channels for participation and collaboration that allow SMEs to define a technological infrastructure and regulatory environment that serves their needs above all others is not straightforward. The diversity inherent in SME requirements and the regional variations as to what constitutes a credible framework for participation indicate that a distributed, de-centralised template would offer the highest degree of flexibility and attunement to local needs. Preserving the diversity of local needs and contexts has the potential to support and inspire innovation offering significant advantages to SMEs, regions and Europe as a whole.

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3 A Cost-Benefit Analysis Framework for Assessing the Net Benefits of Digital Business Ecosystem implementation in Europe

Lorena Rivera León *
T6
http://www.t-6.it
lorena.rivera-leon@t-6.it

Introduction

Knowledge is central for economic development (World Bank, 1998). The movement of ideas within a country or a region and the capacity on which knowledge can produce positive impacts on economic development depends on the effectiveness of its knowledge communication system. The Digital Business Ecosystems (DBE) has the capacity to provide every business entity in Europe with a powerful opportunity to efficiently use knowledge. The ability to be connected and to share and acquire knowledge is a contributor to reduce the information gaps and to lower power asymmetries between Large Enterprises (LEs) and Small and Medium Enterprises (SMEs). DBE infrastructure can be conceived as a corrective action to solve the lack of access to information among enterprises. Business connectivity allow SMEs to increase their opportunities to integrate themselves into global value chains and provide them with more upgrading opportunities that create further positive impacts on regional development.

DBE implementation has the potentiality to produce positive effects on productivity as knowledge (access and dissemination) enhances the productivity of capital (Stiglitz, 1999)[1]. It also has a potential in inducing regional development through competitiveness enhancement among business. New growth theories consider that the more resources devoted to technical progress (activities that produce innovations), the higher the growth rates (De Castro, 1998). DBE has the potentiality to endogenously impact production, as productivity increases are endogenous to production (Cooke et.al., 2005). Investing in DBE implementation is a long-term investment in knowledge creation and dissemination.

* Lorena Rivera León worked as an stagiaire for the European Commission, DG Information Society and Media, Unit D4 where she developed most of the research included in this paper.

1) It allows access to information and knowledge through business connectivity.

Although the scientific research on the potentialities of DBE has been extensively developing over the last years, there is still a lack of awareness among policymakers and general public on the socioeconomic impacts of DBE implementation. This paper explores these potentialities while proposing a Multiple-Account Cost-Benefit Analysis (CBA) framework to assess them.

This study has two main objectives:

1. to provide an efficiency analysis of the existing pilot projects
2. to promote among policymakers the benefits of DBE implementation.

CBA is a systematic framework to analyse the efficiency of projects, programmes, policies or regulations (Munford et.al., 2000). We believe that by giving monetary values to benefits and costs of DBE implementation we will be able to provide policymakers with valuable information to encourage them to implement DBE in their regions.

Four different accounts are proposed for the CBA for DBE implementation: financial, user/consumer, economic development and social.

The first two accounts (financial and user/consumer accounts) present the actual data of two selected regions that have implemented DBE pilot projects: the region of Aragon in Spain and West Midlands in the United Kingdom (UK). The economic development and social accounts are presented in the form of guidelines, as they are region-specific[2]. The main indicators that should be analyzed by any interested region on DBE are presented. Because current pilot projects are still at an early stage of development we cannot provide concrete impacts on these accounts. Economic theory will provide us with the bases of the likely impacts of DBE implementation.

An ideal business structure for DBE development

DBE can be used by every business entity in Europe, irrespective of the size of the concerned enterprise and its sector of activity. According to the Industry, Trade and Services Statistics of Eurostat (2006)[3] there are more than 17 million SMEs in the European Union 25 (EU-25). SMEs have a main role in the business structure of Europe. In 2003, 99.8% of total enterprises in EU-25 non-financial business economy were SMEs. Micro enterprises are predominant, representing the 91.4% of total enterprises, followed by small enterprises with 7.3% of total and medium enterprises with 1.1%. LEs are only 0.2% of the total[4]. As DBE is especially oriented to support SMEs connectivity[5] it is necessary to study European business characteristics focusing on SMEs.

More than 65% of all SMEs in EU-25 are concentrated in 5 countries: Italy (22% of total), Spain (14%), France (13%), Germany (10%) and the United Kingdom (9%). Italy and Spain together have more SMEs than 20 other countries in the EU-25. In average, in 2003 there were 38 SMEs per 1,000 population in the EU-25. Countries above this average are Italy, Spain, the Czech Republic, Portugal, Hungary, Slovenia, Cyprus and Luxembourg. Some of these countries are different from the countries that concentrate most of SMEs mentioned above, indicating that the industrial structure of a country is determinant for SME proliferation. We expect that DBE implementation will be largely beneficial for countries whose sectors and economic structure are dominated by small firms.

Data from the Observatory of European SMEs[6] shows that the countries with the largest concentration of SMEs have seen their number of SMEs decrease considerably over the last 10 years, evidencing a large SME mortality rate. DBE also would help SMEs to reduce their vulnerability by creating networks among them.

2) "Region-specific" in the sense that the social context and the economic (and institutional framework) setting vary from region to region

3) Although otherwise stated, all the indicators presented in this section are built from data of the Industry, Trade and Services Statistics of Eurostat. Raw statistical data can be found on the Eurostat website.

4) A micro enterprise is an enterprise that has 1 to 9 employees. Small enterprises have between 10 and 49 employees. Medium enterprises employ between 50 and 249 persons and large enterprises employ more than 250 persons.

5) SMEs could be connected with other SMEs but also with large enterprises around Europe.

6) This data is taken from the CD-ROM of the Observatory of European SMEs. It gathers data from SME statistics from Eurostat and from the ENSR Enterprise Surveys. The online version is accessible at: http://www.eim.nl/Observatory_Seven_and_Eight/start.htm

European SMEs serve a variety of different sectors. They are mainly concentrated in two sectors: services and trade. Service SMEs[7] are mainly located in Germany, the UK and Italy, while trade SMEs[8] are dominant in Italy, Germany and Spain. Manufacturing industry SMEs are less important in number but are very relevant in terms of value added and employment. Manufacturing industry SMEs are mainly located in Italy, the UK and Germany[9]. Construction SMEs are mainly located in the United Kingdom, while most of the wholesale and retail trade SMEs are located in Italy. Hotels and catering SMEs are widely present in France, Italy and Spain; while the majority of business services SMEs are located in Italy, Germany and the United Kingdom. On analyzing the economic impact of DBE implementation it is important to understand that different outputs can be expected according to the "weighted importance" that the concerned sector has on the regional economy. It is necessary to underline that expected outcomes are region-specific, but they could be also sector specific according to the deployment strategy and the approach to DBE[10] adopted by each region.

An important facilitator for DBE implementation is SME's engagement in e-business. The European Commission E-business survey 2006 shows that there are big differentials in the use of e-business applications between large enterprises and SMEs (EC, 2006). The overall e-business Index[11] (based on firm-weighted data[12]) in 2006 reveals that there are approximately 50 SMEs engaged in e-business for every 100 LEs. The European Commission (2005) underlines that ICT and e-business offer SMEs an improved access to market information at low cost. Nevertheless, as fixed costs for technology implementation tend to be relatively higher for small companies, there is still a weak use of internal applications and supply-side e-business activities among SMEs.

In contrast, there are no differences between small and large enterprises when receiving orders from customers online[13]. The sectors connecting and receiving orders from customers online more frequently for small enterprises are tourism, Telecommunications and the Pulp and Paper sector. This reveals that connectivity with customers and cooperation networks with other SMEs is crucial for them while competing in the marketplace. Nevertheless, there is a gap between the percentage of SMEs receiving at least some orders online (26%) and those that have special software for doing so (11%). This confirms that SMEs use rather "simple" forms of e-commerce: receiving orders by e-mail without any system integration of the related information and document flow.

Benchmarking ICT adoption and e-business by country is a complex exercise, since results could reflect other factors such as the industrial structure. However, Nordic countries are in general the most active users of e-business among SMEs. Differences are not pronounced and not clear among countries like France, Germany, Italy, Spain and the UK.

The results of the benchmarking suggest a pronounced digital divide between small and large firms. For example, in Italy, sectors dominated by small firms are much more prevalent than in other countries. This structure is reflected in the score of Italy in the benchmark. The DBE, as a 'non-traditional' application of ICT for business, could help the sectors (and SMEs) of these countries to overcome the digital divide.

The Digital Ecosystem has a big potentiality in helping SMEs to connect with potential customers both in Business-to-Business (B2B) transactions and in Business-to-Customers (B2C) transactions. In average, only about 11% of SMEs use software solutions or internet-based services for e-procurement. There is also a massive gap between the percentage of SMEs placing at least some orders online (53%) and those that use special software for this (11%). Companies without a special software place orders mainly through websites or extranets of suppliers, revealing that the digital back-office integration of procurement related processes is not advanced in these cases.

7) Actvities performed by service SMEs are: Hotels and catering; transport and communications; banking, finance or insurance; business services and other service industries.

8) Trade SMEs include wholesale trade and retail trade SMEs.

9) Manufacturing industry SMEs located in Italy produced the largest value added in the EU in 2000 (European Communities, 2003). DBE implementation in this industry could create large impacts on Italian economy.

10) See Shelton (2006) and section 3.

11) The e-business Index is drawn under a Balanced Scoreboard approach. It consists of 16 component indicators which are aggregated into 4 sub-indices that represent major application areas of e-business: Access to ICT networks, e-process integration, Supply-side activity, and Marketing and sales. The four sub-indices can be aggregated into an overall e-Business Index.

12) Firm-weighted data expresses e-business adoption as "% of firms within a size-band with a certain activity".

13) 26% of both, small and large enterprises receive orders from customers online.

Cost-Benefit Analysis and Digital Business Ecosystems: a Multiple-Account Analysis[14]

Decision-makers at the regional level are most of the time devoted to the economic development of their region, and are interested in those projects whose implementation produce society gains. Economic efficiency is at the core of CBA. Its aim is to address the question on what the net balance would be between economic and social benefits of projects implementation (Shaffer et.al., 2003). It gives monetary values to benefits and costs in order to express the aggregate change in individual well-being from policies or projects (Munford et.al., 2000). In this effort, we are interested in measuring incremental benefits and costs (our baseline will be "no-adoption" of DBE). In CBA, economists value benefits and costs by comparing "willingness to pay" (WTP) to "opportunity costs" (OC). WTP is defined as the maximum amount SMEs or large enterprises (DBE's users/consumers) are prepared to pay for DBE implementation. OC are the costs to the region of implementing DBE instead of implementing any other project (the next best alternative that is foregone whenever a decision-maker decides to adopt DBE). It would be also really useful for some regions, policymakers and users to analyse WTP and OC using the baseline 'DBE adoption'. In this case, OC are the costs to the region/policymakers/users of implementing any other project instead of implementing DBE. In both cases, the aim is to analyse what are the net benefits of DBE implementation and/or what are the net costs of no implementing DBE.

A Multiple Account CBA is proposed. Four evaluation accounts are being designed to provide an overall assessment (Shaffer et.al., 2003). The use of different accounts is done in order to present a clear description on what the consequences and trade-offs from DBE implementation will be. This methodology recognizes that it is very difficult to assign a Euro-value to all different impacts and to aggregate them into a measure of net benefits[15]. The lack of any precedent on DBE implementation (apart from the pilot projects) makes us recognize the uncertainty of the outcomes. A wide range of outcomes may occur due to the regional and sector-specificity of projects. This specificity might contribute to greater (or lower) success from DBE implementation. The accounts developed in the next sections are an overview on how the analysis should be developed[16]. They will provide interested regions with an initial screening of the net benefits from DBE implementation.

The four evaluation accounts are[17]:

- **Financial account.** This account looks at the expected revenues and expenditures from DBE implementation. Its aim is to explain the financial cost of DBE, in order to determine if the project is efficient from a private market perspective[18] (Campbell et.al., 2003). It also looks at the OC of the projects funding.
- **User/Consumer account.** The account describes the net benefits to users and direct beneficiaries from DBE implementation. It values the user's maximum WTP for DBE in comparison to the baseline of DBE "no-adoption". It is meant to evaluate net impacts in terms of productivity, competitiveness, efficiency, business connectivity and innovation.
- **Economic Development account.** Two key questions are addressed in the economic development account. First, it looks at the amount of income and employment (incremental effects) that is likely to be generated from DBE implementation. Second, and more important for CBA, it analyzes the significance that these effects have on the regional economy.
- **Social account.** The account looks at significant community and social impacts (externalities) from DBE implementation. The aim is to understand the positive legacies to societies on using DBE. We are particularly concerned on how DBE contributes to reduce income inequality between the concerned region and the country and between the country and the rest of Europe.

The final overall assessment is not meant to answer whether DBE should or should not be implemented in a particular region. It is to policymakers (and general public to some extent) to make the final decision (Shaffer et.al., 2003).

14) I would like to thank Dr Marvin Shaffer, former Senior Lecturer at the University of British Columbia in Canada that provided me with general guidance in developing the methodology for the CBA framework on DBE implementation.

15) This difficulty has been specially recognized by the research team, the project managers of pilot projects and the current users.

16) Time and data constraints preclude a more detailed analysis.

17) Further development on the accounts is presented in the sections that follow.

18) The future streams of benefits and costs are converted into equivalent values today using a discount rate (net present value).

Cost efficiency of DBE projects: the financial account[19]

Regional authorities and institutions are frequently dealing with budgetary restrictions. One of their main concerns is the financial cost of projects. This section includes the main results from an empirical exercise done with the project managers of two selected regions running DBE pilot projects: Aragón and the West Midlands. We believe that presenting the results of an *ex-post* analysis on this account will be useful for every policymaker interested in DBE[20]. Three types of costs have been identified and analyzed[21]. Fixed costs (1) include the costs of the digital ecosystems infrastructure; research and development costs; and other fixed costs. Variable costs (2) include training costs, training travel, research costs and other variable costs. Operating costs (3) include human resources costs, infrastructure maintenance costs and SMEs service integration costs (deployment). Table 1 summarizes the financial costs for both regions.

Table 1

Total financial costs for pilot implementation of digital ecosystems in the West Midlands and Aragón (November 2003 – January 2007)

Cost Type	West Midlands		Aragón	
	thousand Euros	% of total costs	thousand Euros	% of total costs
Fixed Costs				
Cost of Digital Ecosystem infrastructure	4	1	4	0
Research and developement costs	0	0	120	10
Other fixed costs	0	0	0	0
***Total Fixed Costs** *	***9***	***1***	***124***	***10***
Variable Costs				
Training Costs	10	2	174	15
Resesarch travel	7	2	22	2
Training travel	26	6	16	1
Other variable costs (events, conferences etc.)	0	0	32	3
Total Variable Costs	***43***	***10***	***244***	***21***
Operating Costs				
Human resosurces costs (admin, management and R&D)	277	65	110	9
Infrastructure manteinance costs	0	0	10	1
SMEs services integration costs (deployment)	100	23	700	59
Total Operating Costs	***377***	***88***	***820***	***69***
TOTALS	**429**	**100**	**1188**	**100**

* In the case of the West Midlands, total fixed costs include an audit and balancing item equal to 5K euros: this value represents 1% of total financial costs for the region

Source: DBE questionnaire to pilot project managers, 2006

Total financial costs of DBE pilot projects are very different in absolute values in both regions (429K Euros in the West Midlands and 1,188K Euros in Aragón), but are distributed in the same pattern according to cost type. The largest proportion of total costs is operating costs, followed by variable costs, and fixed costs. Pilot projects data shows that between 2.20% and 10.40% of total costs are fixed costs. Surprisingly in this distribution is the low participation of the digital ecosystems (DE) infrastructure in total costs. DE infrastructure represents only 0.90% of total costs in the West Midlands (3.88K Euros in absolute values) and 0.29% in Aragón (3.50K Euros). Scientists have expressed that there is an overall belief among policymakers that DE infrastructure is 'expensive' and in consequence "unreachable" for their regions. Evidence in our sample pilot projects does not leave place for this argument. In contrast, our analysis shows that between 10% and 21% of total costs are variable costs (mainly training costs and training travel); and more

19) I would like to thank Rod Shelton, Javier Val and Nagaraj Konda for their hard work and disposition to participate in this exercise. Paolo Dini and Francesco Nachira provided valuable inputs and comments.

20) The analysis covers the period from November 2003 to January 2007.

21) Every interested region on DBE should expect to incur in (at least) these costs for DBE implementation.

than 70% of total costs are operating costs, including human resources costs and SMEs service integration costs (deployment). Most of these costs are certainly an investment on regional development, as resources are allocated in knowledge creation and dissemination. Policymakers should compare financial costs with benefits produced in the user/consumer account and social accounts when assessing the net benefits of DBE implementation.

Important in this analysis is the role of the regional catalysts in cost allocation. We believe that costs are determined by the regional priorities and regional catalysts leadership initiatives on innovation. Shelton (2006) has identified three different approaches to DBE according to the regional catalyst organisation: the government funded approach, the local association approach and the public company approach. The DBE approach chosen by the interested region will directly affect the CBA financial account[22]. Our empirical study highlights that in the early stages of project implementation regions focus on SMEs service integration, training and dissemination of the concept of DBE among regional SMEs. Regions allocating more financial resources to these activities will see their costs on the CBA financial account increase, but this change might be more than compensated by the benefits gained under the other three accounts. For instance, the region of Aragon, following the government funded approach, has been really active in developing SMEs service integration[23]. The government funding has been accompanied by an active participation of the concerned SMEs in R&D (equal to 484K Euro in the period), creating a feeling of entrepreneurship among SMEs. This scheme could further develop into a public-and-private partnership (PPP), whose non-marketed benefits are difficult to value.

Costs projections show that an average cost reduction of 19% is expected for both of the studied regions by the end of 2007 (costs are expected to decrease by 23% in the West Midlands, and by 16% in Aragon). Benefiting from economies of scale, further costs reductions are expected as projects reach maturity.

The financial costs described above are generally financed by three different sources: European Commission (EC) funds, regional contributions (funding from the regional government), and private contributions (funds by the regional private sector, i.e. the concerned SMEs). The sources of funding and its participation in total costs will vary according to the approach to DBE chosen by the region, but also by sector and stage of project (Shelton, 2006). Figures for the West Midlands and Aragón are presented in table 2. In both of our studied regions most of the funding come from EC funds (79% of total costs in the West Midlands, and 46% in Aragon), followed by regional contributions in West Midlands (21% of total costs) and private contributions in Aragon (41% of total).

Table 2

Source of funding in the West Midlands and Aragón (November 2003 – January 2007)

Source of funding	West Midlands		Aragon	
	thousand Euros	% of total costs	thousand Euros	% of total costs
European Commission Fund	338,91	78,92	548,85	46,19
Regional contributions	90,54	21,08	155,00v	13,05
Private contributions	0	0	484,25	40,76
TOTALS	**429,45**	**100**	**1188,10**	**100**

Source: DBE questionnaire to pilot project managers, 2006

Policymakers should be careful while analysing the costs related to public funding. OC of public funds are central in a CBA. In principle, as Shaffer (et.al., 2003) states "*more spending in the (DBE) project would […] reduce the amount of regional government (institutions) spending available for other initiatives in the region*". A proper CBA must recognize that if undertaking DBE while involving a net flow of public funds, the deadweight loss (DWL) associated to the collection of these funds should be attributed as a cost of DBE implementation. In the same way, if DBE implementation involves a net inflow of public funds, the project must be credited with the DWL of raising these funds in another way (Campbell, et.al., 2003). In all cases, the fall in the CBA financial account net benefits will be matched by an equivalent (or more than equivalent) rise in the net benefits in the other three CBA accounts.

Again, higher financial costs do not imply cost-inefficiency, as evidence shows that these costs are related to the regional engagement with innovation. We would expect that if costs are incurred in the short-run (paid by the regional

22) As a consequence of the chosen approach, further indirect effects on the user/consumer account and social account might be expected.

23) The region has assigned 155K Euros from November 2003 to January 2007 for SMEs service integration, and has already committed 157K Euros for these activities after January 2007.

effort of the current generation), the benefits of investing in innovation are expected in the long-run, favouring a broader range of population due to secondary benefits and multiplier effects that innovation is expected to create on the regional economy. While analyzing this future stream of benefits we must take into account the net present value (NPV) of the benefits. NPV is also central in CBA. This concept expresses Euro values in different years in equivalent terms, recognizing that 1 Euro spent today is more costly than a Euro that will be spent in one year's time. The NPV is calculated using a discount rate. The lower the discount rate, the greater the emphasis policymakers give to long term benefits (DEAT, 2004). Regional authorities and policymakers devoted to the development of its region should easily realise that the financial costs incurred from DBE project implementation will be more than compensated by the benefits stemmed by the other CBA accounts to be analyzed below.

The net benefits to DBE "users": the user/consumer account

This account explores the net benefits to users/consumers as what DBE implementation provides them. Users/consumers are mainly SMEs, but large enterprises are not excluded[24]. There are 44 SMEs currently connected through the DBE infrastructure in the West Midlands and 35 SMEs in Aragón, serving a variety of sectors[25]. Different net benefits are expected according to the roles of SMEs in the market. Shelton (2006) has identified four types of SMEs characterized by their different roles in the market: early adopters, implementers, discoverers and users. Early adopters focus on new approaches to software development, while implementers SMEs apply the original work of the early developers in a particular sector of business. Large benefits are expected to driver SMEs (early adopters) and implementers. As these SMEs focus on software development, the formation of software communities in the regions is favoured. The West Midland's SMEs (drivers and implementers) have expressed that one of the main attractors that made them participate on DBE was to be at the forefront of research into software development with world leaders and other university partners (Shelton: 2006). This reveals a real 'entrepreneur' attitude towards innovation. Discoverer SMEs are those SMEs that are willing to adopt a service in their business (and work with the implementers) but do not wish to involve themselves in activities that require high-level technical abilities. These SMEs would be benefiting from connectivity with other SMEs. They would also experience some innovation while adopting a service in their business. 'User SMEs'[26] would be implementing aspects of DBE in their business model (without being involved in technical software issues), and then benefiting from connectivity with suppliers and customers. For them, DBE will help to connect them with potential customers in B2B and in B2C transactions. In all cases 'DBE users' will be benefiting from improvements in productivity and competitiveness of their business.

Monetary valuations for these benefits are hard to conceive. We recognize the uniqueness of DBE and in consequence the difficulty to assess its impacts. We believe that until 'critical mass' is reached the range of possible outcomes from DBE implementation will remain wide. For 'user SMEs' incremental sales (or reduced costs) could help in the effort of valuation[27]. Incremental profitability (increased producer surplus) of concerned SMEs could be used as an indicative variable to measure WTP. Until now, pilot projects have not benefited from sales increases from DBE implementation[28]. This is understandable due to the early stage of the projects. The region of Aragón has expressed that the reason for no quantifiable benefits include platform instability and DBE applications not been yet applied in real business. SMEs in West Midlands have expressed that being connected has helped them in developing new enhanced services at lower cost and with greater market reach.

Most of the benefits to DBE users/consumers described above are not traded, and in consequence, no market prices for them exist. But this does not mean that these benefits (goods) have no value. According to DEAT (2004), the values of non-marketed goods can often be inferred from economic behaviour and from the study of related markets. The study of these related markets is region-specific. Available information provided by pilot projects is limited. Generalising these effects (and benefits) to other European regions is not possible. It is for every interested region in DBE to assign

24) In the West Midlands, four large enterprises-SMEs linkages have been formed or are forming.

25) The West Midlands pilot project has been addressed to five sectors: tourism, manufacturing, business services, nanotechnology and bio-sciences. The Aragón project has been focused on the tourism sector, but other related services include taxi float management systems, ERPs, access control, e-commerce and accident management systems.

26) 'Users SMEs' should not be misunderstood with 'DBE users/consumers'. The latter includes the four types of SMEs identified by Shelton (2006), plus large enterprises.

27) The baseline is 'DBE no-adoption'.

28) One exceptional case has occurred in the West Midlands, where a transaction between a driver company and an implementer valued in 40,000 GBP has been agreed for additional services due to their relationships on DBE.

value to these benefits. If it becomes impossible to measure them, or if the measurement is subject to large errors, Campbell (et.al., 2003) suggests to summarize the net benefits in a form of Impact Statements (IE), by identifying the qualitative effects to 'DBE users' from DBE implementation. A disadvantage of this approach is that these qualitative net benefits are not comparable with the costs and benefits raised under the CBA. Nevertheless they will be effective in providing policymakers with a complete view of what the net benefits to the users/consumers will be.

Digital Business Ecosystems and economic efficiency: the economic development account[29]

Regional development is at the core of DBE. The economic development account will valuate the amount of income and employment that is likely to be generated from DBE implementation. Policymakers should first look at the business structure of their regions. They must identify the employment structure of the sectors applying DBE and should then assess what is the value added that these sectors produce on the regional economy. As we are just interested on the incremental generation of employment and in incremental income generation, we expect that net benefits on this account will be shown in the long-run. As the idea of DBE is conceived on the regional level in the first stages and on the European level further on, policymakers might want to value the impact on trade from DBE implementation in the long-run. The NPV of these impacts must be also calculated. As stated before, higher net benefits can be expected in those countries applying DBE to the sectors where the industrial structure favours SMEs proliferation.

CBA is also concerned about the economic significance of job and income generation. We are particularly interested in the "multiplier effects" of DBE implementation. Multiplier effects are the effects caused by the linkages (indirect) that the project creates with the rest of the economy (regional, national and global). Nevertheless, these effects will only appear once the scale of DBE deployment reaches 'critical mass'.

Digital Business Ecosystems and human well-being effects: the social account

The social account looks at community and social impacts produced from DBE implementation. Policymakers deciding whether or not to implement DBE should analyse all the costs on surrounding communities that DBE implementation could arise in their regions. Positive and negative externalities might appear. Positive externalities are legacies to societies. A positive externality in the social account could be the training of workers involved in DBE (knowledge acquisition) and their increased productivity while working somewhere else[30].
If the scale of DBE implementation increases, there should be an interest in knowing how DBE implementation could contribute to reducing income inequalities between the concerned region and the country, and between the country and the rest of Europe.

DBE implementation decision-making: the overall assessment

The summary of the evaluation of DBE implementation presents the welfare effects measured in monetary terms. Economic theory assumes that human well being is determined by the capacity of people to fulfil their preferences (Munford, et.al, 2000). The approach developed here should allow policymakers to take a decision on DBE implementation, as it provides all valuable information on the project in order to facilitate the decision.

As many of the benefits and costs expected to be generated by DBE are hard to measure, the regional commitment to innovation and economic development of political leaders will be crucial on the decision making. The results presented in this paper are preliminary conclusions based on the existing DBE pilot projects.

29) The next two accounts (economic development and social) present just some general ideas to guide a deeper analysis on DBE implementation. A further study to appear in 2007 will valuate more precisely these two accounts by using an empirical analysis on the existing pilot projects. Time constrains have forced me to reduce my analysis to what is presented here.
30) Workers and SMEs receiving training financed by DBE will keep this knowledge for a long time. In case these workers apply this knowledge elsewhere, positive externalities will be generated.

Evidence showed us that financial costs will be mainly variable costs and operating costs. Regions investing in DBE are investors in knowledge creation and capacity-building. Policymakers must also realize that digital ecosystems infrastructure costs are really low as a proportion of total costs. Although, costs will be determined by regional priorities and regional catalysts leadership initiatives, evidence shows that after the implementation of a pilot project (40 months in average) costs can be expected to decrease in between 15% and 20%. Further costs reductions are expected as projects reach maturity. We encourage policymakers to compare financial costs with benefits produced in the economic development account and social account, as high financial costs do not necessarily imply cost-inefficiency.

Finally, we would like to underline that once the "critical mass" is reached, a complete range of net benefits will become available. The velocity to reach this critical mass is in the hands of policymakers.

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4 A Critical, inward and outward, View of Digital Ecosystems' open, collaborative Communities: interdisciplinarity, sustainability and scalability at the intersection of gift and exchange Economies

Evangelia Berdou
Department of Media and Communications
London School of Economics and Political Science
http://www.lse.ac.uk
e.berdou@lse.ac.uk

Abstract

The idea of "community" represents a central notion in the body of knowledge emerging as part of the Digital Ecosystems (DEs) research and philosophy. This chapter draws from two deliverables produced for the DBE in order to highlight two important characteristics of communities and networks of practice, their knowledge and structural embeddedness. Knowledge embeddedness refers to the context specific frames of meaning and signification as indicated by the difficulties of translating knowledge across different communities. Structural embeddedness refers to the intertwining of socio-economic structures as expressed by the frequently overlapping character of digital, social, economic and professional networks. It is argued that these two aspects of embeddedness are crucial for the sustainability and scalability of Digital Ecosystems.

Introduction

Cooperation between epistemic communities is regarded as a crucial element for the realization of the DEs ambitious interdisciplinary research agenda. At the same time, the sustainability of emerging DEs largely hinges upon the cultivation of their ties with existing Free/Open source (F/OS) software communities. Within the context of the research these two types of communities along with other groups of DE stakeholders, such as Small and Medium Sized enterprises (SMEs), were examined as communities or networks of practice (CoP)/(NoP), that is, more or less tightly knit communities formed through the pursuit of a shared enterprise which act as repositories of experience and knowledge (Wenger E. and J. Lave, 1991).

The aim of this chapter is to highlight two important characteristics of networks and communities of practice: their knowledge and structural embeddedness and to indicate how they relate to the sustainability and scalability of DEs. Knowledge embeddedness relates to the dependency of knowledge on social context, which makes it difficult to translate across different CoP, domains and networks. Structural embeddedness refers to embeddedness of economic action in social relations and the way "the quality and network architecture of exchange relations influence economic activity" (Uzzi B., 2001:208). This chapter is organized as follows. After elaborating on the concepts of knowledge and structural embeddedness, the findings of two associated studies conducted for the DBE project are presented. The last section outlines why and how the two concepts are related to wider issues of scalability and sustainability of DEs.

The first study that is drawn upon is an internal report 'In the Cocoon: translating complexity across communities and networks of practice in a collaborative open source project' (Berdou E., 2005) and the second, deliverable D18.3 titled 'Report on the Socio-economics of Free/Open Source: Working together at the intersection of the gift and exchange economies: sustainability and scalability in F/OS' (Berdou E. and P. Dini, 2005). Both studies examined dynamics of collaboration between different groups of actors involved in the project and in the wider, envisioned ecosystem. In particular, the internal report focused on the dynamics of cooperation and the implicit decision making processes of three groups of stakeholders internal to the project: regional catalysts, SMEs and BML (Business Modelling Language) designers. On the other hand, deliverable D18.3 provided a framework for critically understanding the main socio-economic dynamics of F/OS from the perspective of the interrelated activities of three groups of actors involved in the, wider, F/OS process of development, deployment and adoption: volunteer communities, businesses and public institutions.

Knowledge and structural embeddedness

The concept of knowledge embeddedness is closely linked with the view of learning, working and innovation encapsulated by the CoP perspective. The community of practice (CoP) perspective was originally developed to account for forms of learning and patterns of socialisation that take place within and across the boundaries of traditional organizations.

The theory has its roots in social constructivism, a perspective that emphasizes the importance of culture and context in understanding what occurs in society. Lave and Wenger (1991), the two theorists who first elaborated the term, argued that a society's knowledge is situated in relations among practitioners, their practices, and their social organization and political economy. Communities of practice, which may include such disparate groups as a team of fire-fighters, office secretaries and hackers, arise mainly through the pursuit of a shared enterprise. The socially embedded character of knowledge, however, which makes CoP very effective in organizing and sharing knowledge among their members creates considerable difficulties when attempting to codify and communicate this knowledge across this groups boundaries. In essence, the COP perspective argues that:

- Practice is highly localized and knowledge is inextricably connected to the social processes that create and maintain it,
- knowledge exchange and communication between and across different communities and networks of practice are not straightforward. In addition to the difficulties created by the loss of context that the codification of knowledge entails, there are additional barriers that may hinder cooperation, such as that of diverging agendas.

The concept of structural embeddedness was first developed by the American Sociologist Mark Granovetter. In his seminal article on 'Economic Action and Social Structure: The problem of embeddedness' (1985) Granovetter argued that "continuing business relations often become overlaid with social content that carries strong expectations of trust and abstention of opportunism" (1985:490). Granovetter defined economic embeddedness as the: "argument that the [economic] behaviour and [economic] institutions to be analysed are so constrained by social relations that to construe them as independent is a grievous misunderstanding" (1985:482).

Granovetter developed this idea partly as an answer to what he regards as "undersocialized" and 'oversocialized' accounts of human action. The first, is consistent with the perspective of neoclassical economics that: "disallow by hypothesis any impact of social structure and social relations on production, distribution and consumption."(Gran ovetter, 1985:483). The second type of accounts is more common in some branches of sociology and emphasizes, for example, the importance of social processes, norms and values, at the expense of the political and economic structures permeating many aspects of economic life. If the concept of knowledge embeddedness argues for distinctiveness, the idea of structural embeddedness emphasizes connections that are expressed through the frequently overlapping character of digital, social, economic and professional networks. These ties need to be taken into account as they shape the landscape of Digital Ecosystems and can therefore influence their development.

Internal Report: "In the Cocoon: translating complexity across communities and networks of practice in a collaborative open source project"

In this report the points of contact and departure of the strategies of regional catalysts, early SMEs adopters (software producers) and DBE's designers at the beginning of the project were mapped and some concrete recommendations on how to improve DBE's bootstrapping process were offered. In this research 15 interviews were conducted with representatives from each group. revealing some of the difficulties that arise through the construction and translation of social complexity into business and computing models and practices.

a. In relation to regional catalysts (RC) the results indicated that: regional catalyst representatives were assigned responsibilities primarily related to DBE adoption and dissemination. Although their specific goals were clearly identified in the DBE project's Technical Annex, the way that these activities were pursued in practice was largely influenced by the specific dynamics of the region and by their networking capacity and skills make-up. The gradual elaboration of the SME recruitment strategy and the specification of the opportunity spaces helped to structure and focus the related activities. However, the initially underdeveloped business message of the project created significant challenges for RC partners who needed to translate the scientific and technical vision of the DBE into concrete business opportunities for SMEs. In addition to their primary tasks, RC representatives also had to coordinate contacts between SMEs and the various research teams in the project. Besides drawing attention to the difficulties of brokering knowledge between practitioners and researchers and of creating bridges between these two different modes of engagement, the interviewees also pointed to the moral implications of SME engagement and the way that their activities transformed them and informed their views of what being a regional catalyst meant.

b. In relation to early SME adopters, the results indicated that although the productive capacity of the DBE in terms of supporting the development of new services and applications was frequently acknowledged, the SME interviewees who were engaged during this period perceived the DBE primarily as a conduit for networking and for marketing their existing services and applications. At the same time, the technological and business aspects of the DBE were perceived and discussed nearly always in relation to each other. As their attitude to open source shows, this is characteristic of the problem-solving, hands-on engagement approach of SME representatives that focuses on the immediate opportunities and implications of the DBE technology and design for their businesses. There are several indications that this might also be their attitude in relation to the scientific aspects of the DBE, for example, the automated recommender of services. This poses some interesting challenges for the project. As the technological and scientific aspects of the DBE were translated into perceived opportunities or hindrances from the perspective of SME drivers, the DBE researchers were faced with the task of: a) clarifying their own assumptions about business and (re)aligning them with the realities of business practice b) maintaining a balance between the needs and requirements of SMEs and the scientific, technological and political vision of the DBE.

c. BML designers aimed to develop in essence a tool that would allow the integration of collaboration between software developers and software users and that would foster the creation of new value chains within and across traditionally defined business domains. In order to achieve their goals, the team of developers initiated a methodology that aimed to combine top-down and bottom-up design approaches. During the first phases of the project, however, the development of the BML was predominantly guided by the top-down design approach which involved the examination of existing standards. This involved balancing the requirements of the platform against the dynamics of the industry and networking with organizations such as OMG. The two major turns in BML development involved the decision to adopt a lighter and more abstract meta-model and to adopt an emerging standard (SBVR) that would allow business participants to specify their needs without any technical knowledge of UML modelling techniques.

The wider implications of these actors' strategies for the sustainability of the DBE were also investigated and some concrete recommendations for improving the bootstrapping process were made. The study highlighted:

a. some of the challenges involved in setting up the network of regional catalysts (RC) that, in addition to the business perspective, it is necessary to take into account:
- ► where the RC intermediaries are located in the economic and political-industrial spectrum of each region; and
- ► their technological or business orientation.

b. the importance of SME recruitment strategy for the process of bootstrapping the DBE. In particular it was argued that one of the ways of reaching out to open source communities is through the involvement of SMEs

with experience in open source (OS) development community processes from the early stages of the project. It is possible that the engagement of OS communities will become increasingly difficult if the DBE is developed at the level of applications using proprietary standards.

c. The long term implications of aspects of the BML implementation, mainly:
- ► how the adopted and/or imported ontologies and standards used by different business communities within the same domain will scale up within the context of the project; and
- ► how the various vocabularies will be integrated and maintained across different

This challenge is amplified if we consider that different interpretations of domain models are not just a result of diverging viewpoints, but are often linked to competing interests associated with the use of specific standards and domain models.

Report on the Socio-economics of Free/Open Source. Working together at the intersection of the gift and exchange economies: sustainability and scalability in F/OS (D18.3)

This deliverable drew on a doctoral research study (Berdou E., Forthcoming 2007), adopting a holistic view of the F/OS process that took into account the intersecting activities of volunteer communities, businesses and policy. It was suggested that a twofold strategy for involving F/OS communities in the DBE would be an important aspect of the DBE project. More specifically, this study indicated that:

a. Volunteer communities display both mundane and unique characteristics of software development and social organization. Community managed F/OS projects are often structured in ways that remind us of traditional processes of software development in terms of use of technical tools, negotiating goals and priorities, editing and reviewing. However, they are also underlined by unique dynamics such as the intensive modularization of tasks, the parallelization of the debugging process and a highly developed sense of shared ownership and responsibility. At the same time, the social foundations of communities, such as their purely meritocratic basis, have been revised as a result of studies that develop more elaborate frameworks of membership and participation.

b. The boundaries between the gift economy, the purview of communities, and the exchange economy, where proprietary development takes place, are more permeable than was originally assumed. The interconnections between the two value systems are intensified by the progressive commercialization of F/OS. Examples include companies contributing to community development and volunteer developers exchanging their reputational benefits for higher and better paid positions or improved access to venture capital.

c. The business appropriation of F/OS raises more general issues with respect to software business models. In addition, there seems to be a considerable gap between the rhetoric about the business potential of F/OS and the barriers to formulating and implementing strategies that leverage it. Copyright concerns and lack of know-how regarding social and technical aspects of F/OS development are considerable barriers to its adoption by SMEs. Some of the most prominent business models are based on combinations of F/OS and proprietary code. However, companies that appropriate F/OS often do so without contributing back to the communities and without revealing code. The virtuous cycle between business and F/OS code that is often envisaged within the discourse is therefore rarely realized in its idealized form, that of a synergistic relationship between companies and communities.

d. The sustainability and scalability of F/OS are dependent on a wide range of policy issues that involve most prominently patents and reverse engineering legislation. At another level of policy intervention, public institutions have shown in recent years an increasing interest in F/OS and a commitment towards open standards, but lack in many cases the social, technical and legal know-how to participate fully in the F/OS process. F/OS is leveraged both as an instrument for industrial development and as an integral part of the provision of e-Government services for administration, businesses and citizens. However, the policy framework concerning public support of F/OS is considerably fragmented. This is largely due to the way the issue is framed within the policy domain. On the one side, the debate concerning the welfare benefits of F/OS software is dominated by neoliberal arguments that consider public support as having the potential to distort the basis for competition in the software market. On the other, there are those who argue that the benefits of F/OS are not strictly economic, but are connected with the opportunities it offers for improved provision of and access to products and services for businesses, administrations and citizens.

Based on the above two strategies for involving F/OS communities in the DBE were suggested.

a. The first strategy, predicated on the distinctive characteristics of community development and their knowledge embeddedness, argued that the DBE should aim to facilitate the learning process for volunteer developers in order for them to become familiarized with the project's code base and to cultivate a sense of shared ownership. Since it was impossible to involve communities from the early stages of the project, providing high quality documentation, maintaining active task lists and providing support on mailing lists and IRC channels would encourage the participation of volunteers.

b. The second strategy, following on from a recommendation in the internal report, was predicated on the embeddedness of F/OS in the commercial world. It aimed to take advantage of the overlapping networks of contacts and partnerships between companies, public organizations and volunteer communities. Given the limited timeframe of the DBE project this strategy is likely to be the most viable of the two. The involvement of companies with ties in the F/OS world would additionally create multiple entry points for communities to become involved in various aspects of the DBE's development, both at the level of the applications and at the level of the platform.

Knowledge and structural embeddedness and the question of sustainability and scalability of Digital Ecosystems

DEs encompass a large number of different public and private actors operating across different regions, industrial sectors, knowledge domains and institutional settings. These actors may have divergent agendas and the complexity of bootstrapping and establishing a functional ecosystem requires a coordinated effort on many levels of policy and intervention. Unlike emerging open collaborative communities, like F/OS or epistemic communities, which have an established framework for negotiating the requirements of the gift and exchange economies and in the light of competing notions of practice and meritocracy, DEs need to find their own balance in cultivating these relations across a complex cultural, geographical, socio-economic and institutional landscape.

As the two deliverables indicated, knowledge and structural embeddedness have multiple implications for the sustainability and scalability of DEs. For example, the difficulty of knowledge codification associated with the socially embedded character of knowledge is an important consideration:

- for understanding the opportunities and barriers associated with leveraging Information and Communication Technologies (ICTs) for improving knowledge codification (Steinmueller E. W., 2000). This is especially important for the design of Business Modelling Language.
- for understanding the difficulties involved in developing a policy framework aiming to translate the lessons learned at the level of distinct CoP to the level of institutions. This is also relevant for the development of the DE's governance framework.
- for understanding the challenges involved in the communication and coordination between widely different communities and network of practice with divergent priorities.

The issue of knowledge embeddedness is associated with the challenges involved in balancing the local characteristics, knowledge and practices of specific CoP with the global requirements of DEs. The notion of structural embeddedness is useful in mapping the socio-economic and institutional landscape which DEs will intersect with and in understanding difficulties associated with reproducing or fostering similar types of cooperative ties within the context of the ecosystem. Deliverable D32.4 'Locational Issues for the implementation of the Knowledge base' focused on the creation of a regulatory framework for building trust.

As Uzzi notes (2001), however, overembeddedness can have ambiguous implications for actors' abilities to adapt to changes in their partner network. For instance a contractor that has become highly skilled at working with a certain manufacturer's fabric, design specifications and building schedule, may be put at risk when this manufacturer moves offshore. DEs are expected to help SMEs adapt to these changes by supporting the creation of cooperative ties across geographical boundaries. The notion of structural embeddedness is therefore useful for understanding:

- How DEs are embedded in an existing socio-economic landscape and how their development is framed by existing cooperative dynamics.
- How DEs affect this landscape in their own right and, in particular, whether and how they disembed existing cooperative relations from their established networks of collaboration.

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5 Trust among SMEs in Digital Business Ecosystems: Theoretical and Methodological Foundations for Establishing Trust through a Knowledge Base of Regulatory Issues

Silvia Elaluf-Calderwood
Department of Media and Communications
London School of Economics and Political Science
http://personal.lse.ac.uk/elalufca/
s.m.elaluf-calderwood@lse.ac.uk

Panayiota Tsatsou
Department of Media and Communications
London School of Economics and Political Science
http://personal.lse.ac.uk/tsatsou/
p.tsatsou@lse.ac.uk

Abstract

The aim of this chapter is to summarise research on the factors contributing to the establishment of trust amongst small- and medium–sized enterprises (SMEs) in Digital Business Ecosystems. This chapter describes the development of a Knowledge Base of Regulatory Issues that are important in the context of the development of Free Software/Open Source (FS/OS) for commercial use within the European Union countries. The Knowledge Base of Regulatory Issues arising from SMEs' participation in Digital Business Ecosystems is discussed in the wider context of the Digital Business Ecosystems initiative to indicate the results of initial research, to highlight aspects of the change of paradigm associated with ecosystems which involve trust, and to emphasise the need to confront conceptual research on technological change with empirical examination of the real-life contexts in which these ecosystems are developing.

In order to achieve this aim, in part 1 the core theoretical issues are identified and examined in terms of the engagement and participation of SMEs in Business to Business (B2B) collaborations within ecosystems. Issues of trust were identified in the early phase of the research as having the potential to constrain SME participation in e-business initiatives. Part 1 presents a conceptual analysis of the layers of trust required for increasing SME participation. Part 2 presents an illustration of the rationale leading to the methodology used to establish a taxonomy framework for addressing the regulatory issues. In part 3 a three-dimensional taxonomy framework is presented, together with a discussion of the Knowledge Base of Regulatory Issues that emerged as being of critical importance for developing trust among SMEs involved in ecosystems, that is, privacy, e-signatures and security, jurisdiction and consumer protection.

The conceptual framework was examined empirically by interviewing SMEs with respect to their views and concerns about the Digital Business Ecosystem vision and their experiences during the DBE project. The results of the interviews were used as a means of testing the validity of the taxonomy framework and the Knowledge Base that was developed. The validity of the Knowledge Base was verified and new insights into the importance of the Knowledge Base for SME engagement with Digital Business Ecosystems in the European Union were obtained. Part 4 summarizes the main empirical findings and overall conclusions are presented in part 5.

Trust: Why Does It Matter in Digital Business Ecosystems?

The adoption of new forms of e-commerce and e-business in the European small and medium enterprise (SME) sector has been identified by policy makers as a key priority for fostering innovation and competitiveness of the European SMEs in global markets (European Commission, 2005). The aim of Digital Business Ecosystems is to overcome existing barriers and to promote innovative forms of software creation, knowledge sharing and community building, thereby enabling long-term growth and competitiveness of the European SME sector. As envisaged by Nachira (2002), the Digital Business Ecosystem is intended to foster new and flexible modes of co-operation and networking through the dynamic aggregation and self-organising evolution of organisations by means of an open-source infrastructure. The control of the infrastructure and the dialectic between Open Source infrastructure and the regulatory issues arising in the ecosystem in the light of SMEs' perceptions, attitudes and understandings and as a result of their experience of specific services offered in the ecosystem are key issues to be addressed.

The Digital Business Ecosystem vision contrasts radically with business ecosystem concepts based on proprietary software, where control over infrastructure can be tightly managed. For example, the Digital Business Ecosystem vision does not include software development hierarchical frameworks as in the case of those developed by firms such as SAP, Novell or Microsoft, in which a main controller or owner of the software code rights is clearly responsible for development. Within a proprietary model, these elements are produced, transferred, and implemented in a managed process, usually with important checks and balances in place to ensure quality of service and compliance with policy and regulatory environments within which the systems will operate.

The Digital Business Ecosystem vision does, nevertheless, present some unique challenges that are difficult to manage, insofar as the vision embraces an open source model. An open source model suggests a decentralized undertaking, open to a diverse range of participants across many locations, making quality control more difficult to achieve. Issues such as favouritism, risk of exclusion or flaming, peer review mechanisms, problems in measuring team performance, effective correction of software errors and management of human resources have all been highlighted in the literature as potentially creating difficulties in open source environments (Raymond 1999; Bezroukov 1999). The aim of achieving self-organization in Digital Business Ecosystems suggests the need for a higher order capability to reproduce components with minimum intervention of human agents, thereby creating additional challenges for quality control.

The aim of the research reported in this chapter was to take an initial step toward the understanding of the regulatory requirements of Digital Business Ecosystems through the creation of a knowledge base of relevant generic regulatory issues. In attempting to identify and assess the key regulatory domains that have implications for the Digital Business Ecosystem vision, the thematic notion of trust was chosen as the point of departure. Trust relationships are central to e-business activities because any kind of economic transaction requires a level of confidence between the parties involved in a given transaction.

The regulatory domain is central to building trust relationships. This is evident in the characterization of 'trust' as an indicator of the confidence required by two or more parties if they are to enter into economic exchange. A trust relationship may be described in the following manner:

The willingness of a party to be vulnerable to the actions of another party based on the expectations that the other party will perform a particular action important to the trustee, irrespective of the ability to monitor or control that other party (Mayer, Davis and Schoorman 1995).

Trust is understood to enable action by establishing confidence among those parties with an interest in the expected outcomes of current or future transactions (Clarke 2002; Dutton and Sheppard 2004). One important prerequisite of confidence is a degree of 'certainty' which is a core issue for SMEs operating in a complex regulatory environment. In the e-business context envisaged by the Digital Business Ecosystem, a degree of confidence or 'certainty' is relevant to trust in each of the three facets that Nachira (2002: 14) identifies as necessary attributes of a digital ecosystem:

- Trust in services and technological solutions
- Trust in business activities
- Trust in knowledge

First, trust in services and in technological solutions may be regarded as a measure of confidence expressed in terms of security and reliability. This facet of trust comes close to the notion of 'technological trust' (Rosenbaum 2003) or the 'belief that technologies will perform reliably and will not be used for untoward purposes'. For trust relationships to develop within the Digital Business Ecosystem, developers and users need to have confidence that both the basic layer of the system and supported applications provide the necessary degree of security and that risks to the reliability of services provided using the DBE platform are minimised.

Second, trust in business activities may be regarded as a measure of confidence expressed as the mutual recognition of accepted practices and procedures for specific sectors and local contexts. This aspect of trust is related to the notion of 'institutional trust' or to a collective expectation that the procedures needed for carrying out transactions successfully will be facilitated and followed (Pavlou 2002). For companies to successfully to adopt and continue using DBE services there trust relationships need to be established in relation to the expected patterns of behaviour and organisational practices adhered to within the Digital Business Ecosystem. Without a shared understanding and the existence of supporting structures to facilitate the creation of trust relationships, cultural and organisational differences are likely to inhibit the formation of business relationships within the ecosystem environment.

Third, trust in knowledge may be conceived as a measure of confidence expressed in terms of symmetric access to information. Because knowledge is a critical asset in e-business activities (Fahey et al, 2001), differences in access to knowledge and information of relevance to e-business activities can lead to unequal advantage for parties operating within the business ecosystem environment. Hence, facilitation of symmetric knowledge-sharing and equal access to information are important for establishing trust relationships between companies participating in the ecosystem.

The next part (2) presents a review of the methodology applied in developing a Knowledge Base of Regulatory Issues. This is followed by a discussion of the taxonomy framework for the Knowledge Base which was created to link the concept of trust to specific regulatory issues as viewed from different operational perspectives (s.3). Finally, part 4 presents an overview of the empirical findings on the extent to which SME interviews confirm the conceptual aspects of the research.

Methodology for Understanding Trust in Digital Business Ecosystems: A Knowledge Base of Regulatory Issues

The Rationale

The rationale adopted in building a Knowledge Base of Regulatory Issues in Digital Business Ecosystems aimed to draw on key regulatory issues linked to engagement and participation of SMEs in B2B collaboration within this ecosystem. The issues identified as being important are the domains of the regulatory environment that should be given priority when developing e-business initiatives. They are referred to as "building blocks of the regulatory framework" and are as follows:

PRIVACY AND CONSUMER PROTECTION

The regulatory building block of privacy and consumer protection refers to regulatory issues with respect to the processing, control and distribution of personal and consumer data using electronic formats, taking into account the individual rights and freedoms of the e-business users.

E-SIGNATURES AND SECURITY

This regulatory building block refers to the issues associated with the sharing of information using digital media. The concern is to ensure autonomy and cross-border interoperability through mechanisms for authentication, non-repudiation, and ensuring the integrity of data.

JURISDICTION AND CONSUMER PROTECTION

This regulatory building block refers to the issues resulting from the cross-border nature of many e-business services and the associated challenges associated with contractual relationships between goods or service providers and customers, such as jurisdictional issues and the means for resolving cross-border disputes.

Specific Issues Arising from a Trust Perspective

The foregoing regulatory domains were considered to be important for establishing trust relationships in e-business (Berkey, 2002) and were examined in the light of their implications specifically for Digital Business Ecosystems. These specific considerations are explored in greater detail below.

PRIVACY AND CONSUMER PROTECTION AS TRUST DETERMINANT

Privacy issues are closely linked to consumer rights and existing legislation comprehensively covers business to consumer (B2C) transactions, whereas in the case of B2B contracts, the existing legislation is less stringent. In the context of Digital Business Ecosystems, issues concerning the management of databases shared between members of the ecosystem are important, as these databases are likely to contain information to which privacy measures are applicable as well as information that may facilitate the process of developing inferences about commercial activity derived from commercially sensitive data patterns. Other concerns include the relevance of information and access rights to the database, accuracy in the use of data, measures to enable evaluation of data sensitivity, and, finally, the need for a policy with respect to the rights of companies to prevent or allow the transfer of sensitive data.

The data privacy and consumer protection issues raise questions about the degree of trust established among businesses. The framework of the Digital Business Ecosystem plays the role of mediator and gate-keeper between interested parties.

E-SIGNATURES AND AUTHENTICATION AS A TRUST DETERMINANT

The regulatory domain of e-signatures and authentication is closely related to security issues in the e-business context. Regulatory considerations are especially important in the areas of authentication, digital signatures, electronic invoicing and payments. Authentication mechanisms support access rights to different information resources; they provide a means for identifying malpractice; and they provide an audit trail of transactions that is necessary for resolving disputes.

In the Digital Business Ecosystem vision, relationships between participants lead to payments and various types of transactions and issues related to e-signatures and authentication are important for establishing and sustaining trust between partners. In addition, considerations with respect to the interoperability of electronic invoicing systems and the traceability of processes within these systems are important factors in ensuring successful collaboration between partners.

JURISDICTION AND CONSUMER PROTECTION AS TRUST DETERMINANT

The regulatory issues in this area arise because of the cross-border nature of many e-business transactions. In the case of the Digital Business Ecosystem the main issues in this area are concerned with cross-border online contracting. Jurisdictional issues create severe limits for digital platforms that aim to bridge geographical distance and industry sectors and to facilitate e-business at the international level.

A Regulatory Taxonomy Framework

The review of the literature concerned with regulatory issues relevant to Digital Business Ecosystems provided the basis for the development of a taxonomy framework and for an examination of the most important regulatory issues from the perspectives of the SME users of the ecosystem environment. Taxonomy provided a framework for capturing the key elements of the overall regulatory environment that is likely to be applicable to the generic layer of a Digital Business Ecosystem.

Taxonomy Framework for the Knowledge Base of Regulatory Issues in Digital Business Ecosystems

Taxonomy framework: a description

The taxonomy framework developed for identifying and classifying regulatory issues relevant to the Digital Business Ecosystem vision draws its working definition from an approach adopted by the ALIVE project on legal issues for virtual organisations (IST 2000-25459):

[A] taxonomy should be regarded as a quest, setting out the boundaries of the main research subject and providing a preliminary framework of guidelines for an in-depth analysis of the [regulatory] issues related to the [project]. The taxonomy... initiates

further research by... pointing out the most problematic legal questions, clarifying and illustrating the significance of certain [regulatory] issues. The taxonomy does not present [regulatory or legal] solutions to these issues (Schoubroeck et al 2001a).

The taxonomy framework served as a tool for directing research on e-business ecosystem regulations. The result is baseline knowledge and a common point of reference for future research on important regulatory issues. The taxonomy framework contributes by guiding 'further discussions and the distillation of findings and existing knowledge' (Schoubroeck et al 2001b). The three-dimensional taxonomy framework is graphically depicted in Figure 1.

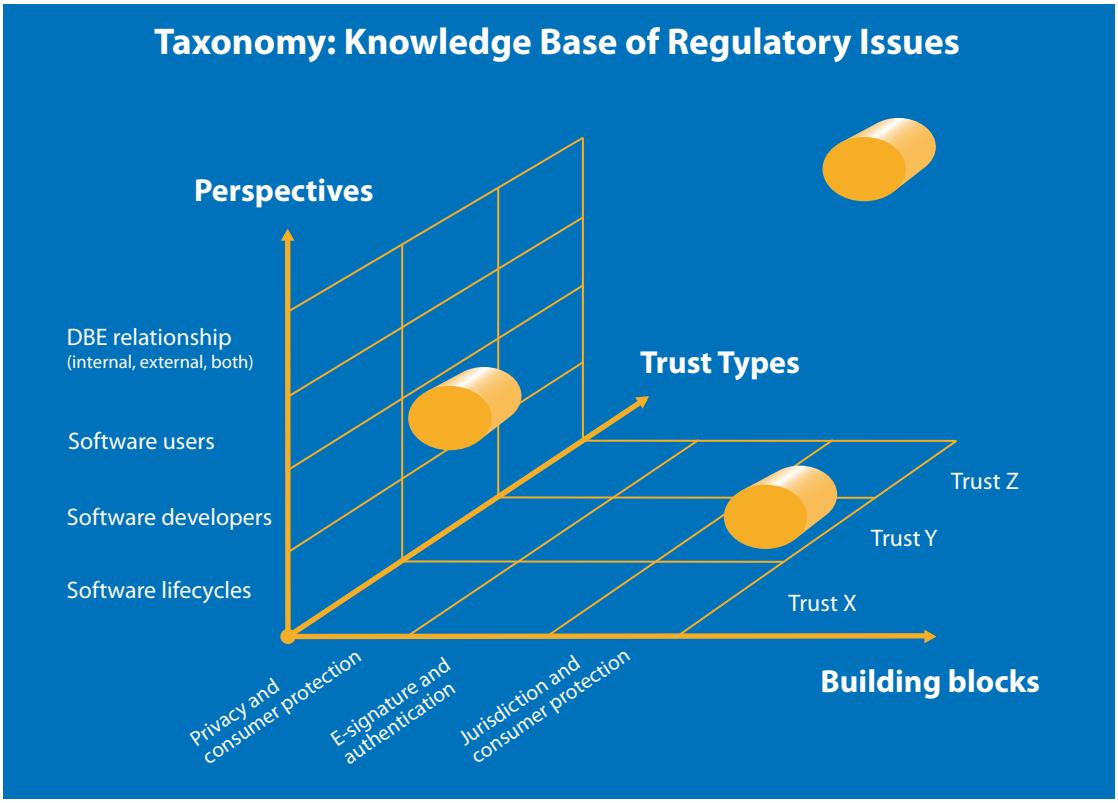

Fig. 1
A three-dimensional representation of the taxonomy

Taxonomy Framework: trust at the core

As Figure 1 shows, three types of trust were identified as initial starting points for the classification of regulatory issues, drawing on the model of trust suggested by Meents, Tan and Verhagen (2003):

TRUST TYPE X

This type of trust refers to trust with respect to the companies joining the Digital Business Ecosystem. From a regulatory perspective, the expectation is that the technical architecture and the basic services will incorporate existing e-business regulations and provide the facilities for carrying out transactions in a way that will ensure compliance with existing laws and norms.

TRUST TYPE Y

This type of trust refers to the expectations on the part of the DBE participants who are the developers of the ecosystem with respect to the companies joining the ecosystem. In order to establish trusting relationships, companies are expected to comply with existing laws and norms and to avoid creating unnecessary risks for the DBE participants.

TRUST TYPE Z

Trust type Z refers to the trust relationships between DBE participants themselves. This type of trust is indicated by confidence in the ability of existing norms and laws to govern the interactions resulting from the self-organisation and evolution of the DBE environment.

Building Blocks of Regulatory Issues and Operational Perspectives

The building blocks of regulatory trust summarised in part 2, representing the domains of the regulatory environment that are of priority concern when developing e-business initiatives are discussed in the light of the taxonomy framework together with issues that arise from an operational perspective.

BUILDING BLOCKS OF REGULATORY ISSUES

The generic building blocks of privacy and consumer protection, e-signatures and security, as well as jurisdiction and consumer protection, do not yield a complete understanding of the complexity of the regulatory environment associated with the Digital Business Ecosystem vision. The specific regulatory issues identified in each of the building blocks need to be examined and refined in the light of particular sector-specific and local settings and with respect to the aim of facilitating e-business among SMEs across Europe and in an ecosystem context.

OPERATIONAL PERSPECTIVES

The taxonomy framework outlined above can be further developed in the light of the operational perspectives of three sets of relationships or actors as indicated in Figure 1 – y axis.

DBE relationships

Regulatory issues can be classified on the basis of the degree of their relevance in the ecosystem environment. Two main types of relationships can be identified in this context:
Regulatory issues classified as internal refer to issues that either

- arise in the ecosystem environment and are specific to the ecosystem setting, or
- are directly linked to ecosystem participants and their activities in the ecosystem environment.

External issues are those that are not within the remit of the ecosystem members or governors to change – i.e. the external regulations applicable to e-business activities such as tax rules, consumer and data protection regulations, contract and competition law provisions, and so on.

In some cases, regulatory issues may be classified as both external and internal**.** For instance, based on an example from the ALIVE project (Schoubroeck et al 2001a), the use of digital signatures by the ecosystem members will be affected by certification mechanisms established within the project and by external certification requirements.

DBE actors

The classification of regulatory issues based on the actors helps to identify issues relevant to particular ecosystem parties and to analyse these issues from the perspectives of different actors. These are as follows[1]:

- SME Service Providers: provide digital (software component) services that use the Digital Business Ecosystem as an infrastructure platform.
- SME Users: use services provided by the Digital Business Ecosystem for their own business needs in the form of "self-consumption" or in order to undertake transactions with other users of the same or compatible services.
- Business Analysts: help users to connect and establish their BML (Business Markup Language) profiles, while helping service providers to integrate into service chains and make services compatible**.**

Software Lifecycles

A software lifecycle perspective highlights regulatory concerns associated with software development, deployment, upgrading, expansion and discontinuation. Although software lifecycles are not specific to Digital Business Ecosystems, their importance for business collaboration is acknowledged in the literature and their role needs to be considered in the context of B2B collaborations within ecosystems as well.

Empirical Verification

The taxonomy framework reviewed in part 3 was developed further by populating it with real life data. Empirical research was conducted with SMEs linked to the DBE project in the EU (Finland, the UK and Spain). SMEs were invited to reflect on the taxonomy framework during interviews. Interviews were conducted with seven SMEs

1) An alternative classification can be based on a technical perspective (see Ferronato 2004) which distinguishes between SME SW Developer, SME Run-time User (Service Provider or Service Consumer) and Business Analyst.

operating in important areas and that had been provided access to the Digital Business Ecosystem platform. These areas included commerce, content management and accountancy.

The results of these interviews confirmed that trust is a crucial issue. In particular interviewees confirmed that trust in the systems architecture and the business solutions that provide DBE services, trust in the institutional arrangements supporting knowledge accumulation, and trust in the context of conducting business between companies, are the most important issues. From the perspective of the SME drivers of the DBE, in any given business sector their participation is influenced by their specific concerns about issues concerning identification, security, privacy and consumer protection, as well as by contractual issues specific to a given business domain.

SMEs can contribute significantly to the identification of issues of critical importance for the establishment of trust in the Digital Business Ecosystem and their views are also helpful in identifying measures that are likely to augment the future business prospects and commercial viability of the DBE framework.

The interviews with SMEs in Finland, the UK and Spain suggested additional critical issues that are likely to affect the Digital Business Ecosystem's future development. An important unresolved issue that emerged is whether the DBE will be legally constituted under European, national or local law. An associated issue is the extent to which the members of a business domain will have a role in the adoption of the DBE legal form in the context of their everyday B2B practices. The interviewees suggested that without a clear definition of the legal aspects, the engagement of SMEs with digital business ecosystems may be affected.

A possible solution to these issues was proposed by the interviewees. It was suggested that an authority could be created that would resolve some of the regulatory issues confronting SMEs. The SME representatives who were interviewed suggested that an authoritative body might reflect on appropriate regulatory principles, drawing on the expertise of an executive committee bringing together representatives from a wide spectrum of DBE partners. The interviewees appeared to favour a means through which the advice of legal experts could be sought officially so that the business interests of the SMEs and the technical potential of the DBE platform could be respected, thereby making the goal of DBE sustainability and trust more feasible to achieve in the future. This may appear to contradict the DBE vision of self-organisation, but it also suggests the need to ensure that the concerns of SME users of the DBE with respect to regulatory issues are addressed.

Table 1 presents a list of key regulatory issues that arise in the context of an examination of trust relationships for SME users of digital business ecosystems.

Table 1

Taxonomy Description: The SME View		
Perspective	**Attribute**	**Method (example)**
DBE Relationship	Internal	Concerns about DBE legal entity
	External	Integration of E-signatures
		Governance issues
DBE Actors	SME Service Provider	Identification
	SME Users	Security
	Business Analysts	Contractual issues
		Commercial incentives
Software Lifecycles	Proprietary Model	IP rights
	Open Source Model	Middleware ownership

This framework could be extended to consider regulatory issues from other vantage points in future research.

Conclusions

Further research is needed to extend the taxonomy framework presented here to other business domains and sectors. The Regulatory Issues Knowledge Base tool was developed through a multidisciplinary collaboration between social and computing scientists and it needs to be extended and validated in a working digital business ecosystems environment. The initial research reported here suggests that it will be very important to investigate the crucial regulatory issues in the context of the further development of governance mechanisms for Digital Business Ecosystems that will need to be developed to ensure their sustainability. The accumulation of a Regulatory Issues Knowledge Base that can be adapted to the specific needs of SME users of the ecosystems will need to be incorporated within future research in this area.

It is likely that issues of integration and compatibility between local, regional and national domains in which Digital Business Ecosystems become operational will need to be addressed in addition to those of trust. These issues will provide a basis for further elaboration of the Regulatory Issues Knowledge Base as a basis for developing and defining SME sector policies.

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