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Information and communication technology and geographical clusters: opportunities and spread

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Abstract

The widespread adoption of information and communication technologies (ICTs) characterising the recent competitive scenario has been of great interest to researchers and practitioners. Many studies have been carried out to provide answers to different questions concerning, for example, the impact of ICTs on organisations, the role of ICTs in the economic development, the opportunities given by ICTs' adoption to SMEs.

In this paper, the opportunities provided by the adoption and implementation of ICT solutions in a particular SME-intensive productive environment, the geographical cluster, are examined. To this end, first the ICT capabilities and their effects on the value-creating processes characterising a generic supply chain are analysed. Subsequently, the analysis is contextualised to geographical clusters in order to identify the more appropriate ICTs for cluster firms.

Finally, the actual ICTs' spread within the Italian industrial districts is examined.

Keywords: Information and communication technology; Geographical clusters; E-business models; Value-creating processes

1. Introduction

It is argued that the diffusion of the information and communication technologies (ICTs) is changing the way by which companies compete and succeed, the business models, and the value-creating processes. New opportunities are taking place both to create new ventures and to modify the existing businesses.

These changing processes are due to the ICTs' capability to transfer, collect, manage a great amount of information and to reduce the space and time barriers. Therefore, firms may reduce the transaction costs of information-intensive activities by resorting to ICTs. These opportunities may especially favour small and medium enterprises (SMEs) that in most cases operate in a dense network of inter-firm relationships and consequently manage a great amount of information.

However, recent data on the diffusion and adoption of ICTs show that the ICT penetration is still quite low among SMEs (Eurostat, 2002; IDC, 2000; OECD, 1998, 2001).

This paper explores the opportunities provided by the adoption and implementation of ICT solutions in a particular SME-intensive productive environment: the geographical cluster. The characteristics of this peculiar production model make it particularly appropriate for the use of ICTs and Internet-based solutions. In fact, as stressed by a large number of scholars (Becattini et al., 1992; Enright, 1995; Maillat et al., 1995; Piore and Sabel, 1984; Porter, 1998), clusters base their competitive advantages on two distinctive aspects: (1) the inter-networking processes and (2) the speed and easy circulation of information and knowledge. Thus, a cluster can be seen as an extended enterprise, where the different actors (the cluster firms) are usually specialised in single manufacturing phases, that require intense coordination, flexible relationships, and appropriate supporting tools to manage the networking activities.

Therefore, it may be possible to think that the new economy and ICTs provide geographical clusters with new development opportunities, drawing new possible trajectories of evolution.

The paper in particular is addressed to:

- recognise the opportunities of ICT applications in the value-creating processes;

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- analyse the implications of the ICT adoption for cluster firms, identifying the e-business models and ICT applications that best fit the characteristics of geographical clusters; and
- evaluate the actual trend of adoption and implementation of e-business models and ICT applications within clusters.

According to this, first the ICT capabilities and their role in modifying the processes of value creation are analysed (Section 2). In particular, the focus is placed on the following value-creating processes characterising the supply chain (Porter, 1985):

- logistic and networking, this process groups all the activities involved in three elements of the supply chain, namely the "inbound logistics", "outbound logistics", and "procurement";
- marketing and customer relations, this process groups all the activities involved in two elements of the supply chain, namely "marketing and sales" and "after-sales service";
- innovation development, this process corresponds to the "technology development" element of the supply chain.

For these value-creating processes, on the basis of the literature review, the effects of ICTs are identified.

Second, the strengths and weaknesses of geographical clusters are analysed (Section 3). A qualitative evaluation of the effects of such strengths and weaknesses on the value-creating processes within clusters is presented.

Third, starting from the above analysis, the ICT solutions and e-business models, suitable to both enhance the strengths and reduce the barriers to succeed in the global competitive context, characterising the geographical clusters are identified (Section 4).

Finally, in Section 5, the actual trend of the process of adoption and implementation of ICT applications and e-business models within some real cases of geographical clusters is discussed.

2. Information and communication technology capabilities

Recently, the development and widespread adoption of ICTs has given rise to an increasing number of theoretical and empirical studies on this field (Child, 1989; Davenport, 1993; Gurbaxani and Wang, 1991; Laubacher and Malone, 1997; Malhotra, 1993; Malone et al., 1987; Malone and Smith, 1988; Porter, 2001). These studies have dealt with different and complementary aspects, such as:

- the evaluation of the ICT effects on the organisations, the inter-organisational relationships, the market, and the social-economic systems;
- the ICT classification;
- the analysis of the organisational and managerial actions required to support the ICT adoption; and
- the interpretation of the enabled opportunities.

Regarding the studies focused on the evaluation of the ICT effects, three different streams of study can be identified: the organisational, the economic, and the strategic.

The first stream of study traces back the analysis of the ICT effects to the analysis of the ICT impact on the coordination mechanisms (Child, 1989; Malone et al., 1987; Malone and Smith, 1988). The economic studies deal with the impact of ICTs on the transaction costs (Gurbaxani and Wang, 1991). Finally, the studies adopting a strategic approach analyse the impact of ICTs on the value chain and on the value-creating processes (Porter and Millar, 1985; Rayport and Sviokla, 1995).

Regarding the ICTs' classifications, the literature proposes several ways to classify them, each one based on different and complementary aspects of ICTs (Albino, 1998; Bartezzaghi et al., 1994; Ciborra, 1989; Rullani, 1997).

Particularly useful for this paper seems to be the classification that distinguishes ICTs into:

- *coordination technologies*: they help in the integration and coordination of the processes supporting the information transfer (LAN, WAN, database, shared elaboration systems, data modelling support systems, information flows modelling support systems, CASE, group working support systems, EDI, groupware, Internet, ERP, DSS, MRP, CAD/CAM, etc.);
- *process technologies*: they concur in the transformation of the inputs in output (CNC, FMS, CAM, AGVS, GT, etc.);
- *knowledge management technologies*: they support the processes of problem solving and organisational learning, as well as the relationships and integration among individuals and among different organisations (Lotus Notes, software agents, groupware, Internet).

Independent of their classification, thanks to the capabilities of reducing the time and costs of processing and communicating information; storing and elaborating great amount of data and information; making the access to data and information easy and fast ; organising and structuring data and information on the basis of the user needs, ICTs allow data, information, experiences, and the knowledge owned by individuals and organisations instantaneously available and enable easier sharing.

In Table 1, the main capabilities of ICTs and the related advantages on the organisational processes are reported (Child, 1989; Davenport and Short, 1990; Malone and Smith, 1988; Timmers, 1999).

Therefore, the adoption of ICTs in the business can improve the performance of the organisational

Table 1
ICT capabilities and advantages—adapted from Davenport and Short (1990)

Capability	Advantages	Examples of ICTs
Transactional/networking	ICTs can transform unstructured processes into routinised transactions	Artificial intelligence, dedicated software, groupware technology, multimedia
Geographical	ICTs allow an easy and fast information transfer along large distance, making processes independent of geography	EDI, Internet (Intranet/Extranet), videoconferencing, telework
Automational	ICTs can replace or reduce human labour in a process	Artificial intelligence, CAD/CAM, CNC, EDI, PLC, search engine
Analytical	ICTs can bring complex analytical methods to bear on a process	Dedicated software, workstations
Informational/multimedia	ICTs can deal with and deliver a great amount of information expressed in several ways: text, graphics, sound, video	CAD/CAM, databases, videoconferencing, audio-conferencing, search engine
Sequential	ICTs can enable changes in the sequence of tasks in a process, often allowing multiple tasks to be worked on simultaneously	Groupware technology, shared databases, Internet (Intranet/Extranet),
Knowledge management	ICTs allow the capture and dissemination of knowledge and expertise	Artificial intelligence, groupware shared databases, data mining, groupware, videoconferencing, chat systems
Tracking	ICTs allow the detailed tracking of task status, inputs, and outputs	Artificial intelligence, CAI, CAM, PLC, sensors, Internet-based applications
Disintermediation/interactivity	ICTs can be used to connect, either synchronously and asynchronously, two parties that would otherwise communicate through an intermediary	CAD/CAM, EDI, Internet (Intranet/Extranet)

and inter-organisational processes and, as a consequence, of the value-creating processes.

In the following, the effects of the ICT on three main value-creating processes, namely logistic and networking, marketing and customer relations, and innovation development, are analysed. Furthermore, examples of new business models triggered by the ICT are identified.

2.1. Logistic and networking

According to Malone et al. (1987), the impact of ICTs on networking processes is due to three main effects: (1) the electronic communication effect, (2) the electronic brokerage effect, (3) the electronic integration effect.

The first one is due to the possibility of communicating more information in the same amount of time and decrease the costs of this communication, making communication independent of the geographical proximity. This means that ICTs enable the firms to enrich the content of the information transferred within a client–supplier relationship in the global market. As an example, ICTs (CAD/CAM, 3CAD, etc.) can support the exchange of complex product models among parties located far away (Porter, 2001).

The electronic brokerage effect is due to the possibility of creating an "electronic broker" that electronically connects a large number of potential buyers and suppliers through a central database, filters the different alternatives, and helps to match one party to the other, thereby reducing the need for buyers and suppliers to contact a large numbers of alternative partners individually. Thus, ICTs (Internet, software agents, databases, search engines, etc.) increase the number of alternatives that can be considered, increase the quality of the alternative eventually selected, and decrease the cost of the whole selection process (Malone et al., 1987). Low cost and fast expansion of the number of relationships enable the development of new business models based on networking processes as, for example, the electronic auction.

Finally, the electronic integration effect allows suppliers and procurers to create joint, inter-penetrating processes at the interface between value-adding stages. This effect is due to the combination of different ICT capabilities, such as tracking, sequential, and automational, which enable to link one activity with the others and make real time data created in one activity available both within the company and with outside suppliers, channels, and customers (Porter, 2001).

The ICTs exploiting this effect (Internet, Extranet, ERP/CRM/SCM systems, CAD/CAM, etc.) allow the supplier and the procurer's inventory management processes to be linked, reducing total inventory costs; the connection between sales activities and order processing as well as manufacturing processes and inventory levels of multiple suppliers, optimising the supply chain; the integration of the new product development phases carried out in different teams or organisations; and check the status of a payment or a shipping process.

2.2. Marketing and customer relations

Overcoming the geographical constraints and creating time independence, ICTs enable the companies to get access, promote and sell goods and services (e-commerce) in a global market.

The global spread of the Internet networking and the 24-h availability of a web server create time and geographical independence and enable customer service to be decoupled from supplier availability (Timmers, 1999).

Dealing with and delivering great amount of information in different ways (text, graphics, sound, video), ICTs enrich the opportunities for the promotion of goods and services and for the provision of in-depth information.

Supporting application-to-application as well person-to-person and person-to-application interactions, ICTs allow the direct interaction and continuous links with customer. This in turn provides opportunities for better targeting goods and services as well as accelerates and redefines the possibilities of remote product or service experimentation (Venkatraman and Henderson, 1998).

The new intelligent agent software helps to identify the customer profile (taste and characteristics) and the pattern of purchases. All the information can be easily organised and stored in a database that supports customer service, marketing, and new product development processes.

According to Timmers (1999), Internet technology and the related trading models (business-to-business and business-to-consumer) provide supplier assets and customer benefits, namely lower transaction costs, better prices, reduction of time to market, affirmation of brand image, market share and access to markets, customer orientation, customer choice increasing, and customer-driven design.

2.3. Innovation development

The ICT tools supporting knowledge management (i.e. groupware, videoconferencing, Intranets, Extranet, etc.) are basically aimed at facilitating the inter-connection and integration among individuals through the fast and effective exchange of information and knowledge. These ICTs allow the communication of non-codified knowledge between contextualised actors. They use the digitisation only to transmit information, avoiding the contents' modification. In this case, the codification regards only the transmission of signals across space and time and not the content of information. Then, the knowledge management technologies allow interactive communication even when it regards not codified and contextual knowledge. Besides, thanks to the virtual abolition of the distance, the communication of such kind of knowledge, which has been always limited within a bounded territorial system or a business unit, can now spread in meaningful way (Rullani, 1997).

All these ICT functionalities fit the team-working organisation, facilitate the inter-organisational exchange, and help the processes of collective learning, underpinning the innovation processes.

Furthermore, CAD/CAM, 3CAD, e-mail, and other ICTs can be used in the new product design and development, whether within or between firms, to shorten the development cycle, increase the number of alternative designs considered, reduce development and manufacturing costs, and produce an higher quality product (Malone et al., 1987).

Finally, it is argued that the customers contribute greatly to the development of new products. Also, listening to the customers and, beyond that, engaging them in a dialogue and listening to their comments on the products are important means of obtaining input for sustained innovation. To that end, companies are now regularly using besides traditional means, e-mail response addresses, FAQ lists, discussion forums and online questionnaires. Information for innovation can also be obtained by monitoring online the customer behaviour (by tracking visits and downloads) (Timmers, 1999).

The adoption and implementation of ICTs and Internet technology allow the implementation of completely new forms of business models. In Table 2, the most relevant e-business models are listed and their main characteristics are identified.

3. Geographical clusters: strengths and weaknesses

Geographical clusters are highly complex entities configured in many different ways. Studies carried out on this topic have generated a large number of definitions to identify the geographical clusters. Each of them stresses different and complementary aspects characterising geographical clusters. For example, Becattini et al. (1992) looking at the Italian experience defines industrial districts (IDs) as a social–territorial system characterised, within a specific geographical area, naturalistically and historically

Table 2
E-business models

E-business models	Implications
E-procurement	Tendering and procurement on a global scale; automation of the tendering and procurement processes; additional outlet; electronic forms of collaboration and negotiation (electronic implementation of bidding mechanisms) on a global scale
E-shops	Promoting on a global scale an industry sector's products and services; industry sector market space
E-mall	Promoting on a global scale a company's products and services; additional outlet
Electronic customer community	Direct access to a wide community of customers that express their needs and give feedback; targeting and customisation
Professional virtual community	Direct access to a wide community of professional expertise; extended network of complementary competencies
Collaboration platforms	Electronic business process cooperation, e.g. collaborative design

well defined, by an active copresence of a people community and a population of firms.

Based on experiences in the US, Porter (1998) defines a cluster as a geographically proximate group of interconnected companies and associated institutions (for example, universities, standards agencies, and trade associations) in particular fields, linked by commonalities and complementarities (they compete but also cooperate).

The GREMI group (Camagni, 1989) introduces the concept of "milieux innovateur", defined as a complex network of informal relationships in a limited geographical area that enhances local innovative capability through "synergistic and collective learning processes".

Analysing the definitions presented in the literature on geographical clusters, some key common features characterising this specific production model can be identified, namely:

- the geographical proximity of small and medium sized firms;
- a dense network of inter-firm relationships, in which the firms cooperate and compete at the same time;
- a dense network of social relationships, based mainly on face-to-face contact, which is strictly inter-connected with the system of economic relationships;
- the presence within the area of complementary competencies and skills;
- a high degree of specialisation of both the firms and the workforce.

The presence of all these features within a cluster contributes to the strength of clusters. In particular, the literature stresses that the success of geographical clusters can be traced back to: (1) the specific production model, defined by Piore and Sabel (1984) "flexible specialisation model"; (2) the system of social and economic relationships of informal nature based on trust, which is the origin of what Marshall (1920) called "industrial atmosphere"; and (3) the learning processes, which produce what has been called (Bellandi, 1989) the "widespread innovative capacity".

The specific production model characterising clusters enables cluster firms to capitalise on the benefits of the economies of scale and production efficiency, characteristic of the large firm, and to gain the typical advantages of small sized firms, such as the adaptability and flexibility (Garofoli, 1981; Rabellotti, 1995).

The economies of scale and the production efficiency are due to: (i) the high specialisation of firms, which allows them to optimise the use of both equipment and labour; and (ii) the great dimension of the buyer–supplier exchanges, which allow the suppliers to increase their production volume, maximising the use of their equipment (Silvestrelli, 1984).

The cluster adaptability and flexibility are due to the vertical division of labour, the specialisation of firms, and the dense network of relationships, because each task can be re-organised with a different mix of specialised producers (Gandolfi, 1988; Paniccia, 1999).

The industrial atmosphere results from the system of economic and social relationships within the cluster that create a knowledge-sharing environment and common values, languages, identity, and beliefs. The industrial atmosphere plays a fundamental role in the creation of the entrepreneurial culture within clusters, stimulating the continuous formation of new firms, which expands and strengthens the cluster itself (Porter, 1998). Furthermore, the industrial atmosphere helps to keep low the transaction costs associated to the opportunistic behaviours, which are deterred by the strong reputation mechanisms, the shared system of values, and the trust characterising clusters (Barney and Ouchi, 1986; Carbonara et al., 2001). The industrial atmosphere also contributes to generate positive externalities that favour the spatial concentration of other firms and other industries (Marshall, 1920).

Different types of learning mechanisms can be identified within clusters. These are activated at the individual level, learning by doing and learning by using, at the firm level, learning through specialisation, and at the level of system, collective learning, learning by localising, interactive learning and cross-fertilisation (Carbonara, 2003). Thanks to the combination of these learning mechanisms, cluster firms generate continuous product and process innovations.

Although there are several examples of successful clusters, which stress how important are the above factors to gain competitive advantages, some weaknesses are intrinsically associated to this production model. Such weaknesses could have their origin in the inherent nature of clusters and are particularly critical in the recent competitive scenario, deeply affected by the internationalisation process, the adoption of new technology, and the presence of new competitors and new competitive factors, such as quality, customisation, and innovation (Carbonara, 2002; Corò and Grandinetti, 1999).

In particular, first the local nature of clusters and the small size of firms can lead to the closure of clusters towards the external environment. In fact, it is easier and less expensive for the cluster SMEs to keep the supply relationships inside the local area, with the same well-known clients or suppliers, than overcoming the geographical boundary of the cluster. This closure to the external environment reduces the capabilities of increasing the market share, controlling the external distribution channels, meeting the needs of new customers and/or the requirements of new supply markets, overcoming the difficulties of competing in the global market (Amin, 1993; Bramanti and Maggioni, 1997; Grabher, 1993). Furthermore, the small size of cluster firms represents a constraint to increase the contractual power over the global supplying marketplaces and, especially, over raw materials supply markets. Such a constraint

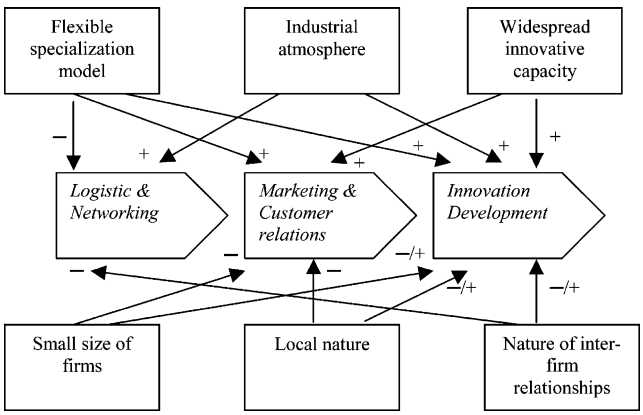

Fig. 1. Impact of cluster strengths and weaknesses on the value-creating processes.

is exacerbated when the firms do not cooperate horizontally, creating, for example, buying groups.

Second, the organisation of the production process, which is fragmented among different small firms, as well as the nature of inter-firm relationships, which is mainly informal and unstructured, keeps the communication costs and the logistics costs high. The former are the costs of exchanging information among the supply chain partners, the latter are the operations cost, mainly holding and transportation costs, and the service costs, which include backorder and customer service costs (Carbonara et al., 2001).

The above mentioned characteristics of clusters and, in particular, the small size of firms, the local nature of clusters, and the nature of inter-firm relationships can negatively affect the introduction of complex innovation and the performances of new product development processes, in terms of time to market and degree of innovativeness. In fact, first, the low level of investments in R&D and marketing, characterising the small firms, reduces the ability to develop radical and complex innovations and customised products and services (Carbonara, 2003). Second, the closure of clusters to the external environment raises the inertia and rigidity to accomplish radical changes and innovations (Grabher, 1993; Porter, 1998). Third, the informal and unstructured nature of inter-firm relationships cannot support effective and efficient processes of codesign and codevelopment (Carbonara and Schiuma, 2003).

In Fig. 1, the effects of cluster strengths and weaknesses on the three value-creating processes, namely logistic and networking, marketing and customer relations, innovation development, are shown.

4. The role of ICTs within geographical clusters

Geographical clusters work as "enlarged companies", being the locus of a dense network of relationships, trades, material and immaterial flows. As a consequence, the performances of such production model are strictly related to the level of integration and coordination among multiple competencies and multiple economic actors along the supply chains within clusters. In order to enhance the integration and coordination within clusters, the efficacy and the effectiveness of the information exchange have to be raised. With this aim, it is important to increase the amount and richness of the exchanged information and automate the information processing activities. As described in Section 2, ICTs help to accomplish the above parameters.

Therefore, ICTs can follow the existing system of inter-firm relationships characterising clusters so as to implement and automate a number of activities involved in the value-creating processes carried out across the supply chains, such as vendor seeking, ordering, inventorying, delivering, codesign, etc.

However, the ICT's infrastructure for geographical clusters should be properly designed to fit the existing system of inter-networked firms. In fact, the ICT's adoption and implementation should be aimed at reinforcing intra-cluster relationships without losing the advantages of loyalty and trust characterising those relationships (Belussi, 2002; Di Maria and Micelli, 2000).

The opportunities offered by the adoption and implementation of ICTs in geographical clusters lie not only in the improvement of the processes carried out at a local level, but also in the possibility of carrying out the same processes on a global scale independent of the firm size. In particular, referring to the three value-creating processes, the implementation and adoption of ICTs within clusters can allow the following positive effects:

- reinforcing the existing relationships among cluster firms and external firms, helping the integration of the economic actors operating along global supply chains (business-to-business, electronic data interchange, Extranet, etc.);
- providing the cluster firms with new and more opportunities of networking with firms located outside the cluster, not necessarily aimed at defining stable and collaborative relationships[1] (business-to-business, electronic auctions, etc.);
- expanding the business boundaries of cluster firms (web sites, electronic portals, etc.);
- managing the relationships with the end-markets, offering new services and new ways to create value (electronic commerce, on-line marketing, etc.);
- supporting both the joint innovation processes developed by cluster companies and companies located outside the cluster and by the adoption of exogenous innovations.

[1] The supply of raw materials for the geographical cluster firms could mainly gain from a distributed technology platform. An intermediary actor, which assumes the role of market broker, can manage the purchase on behalf of cluster firms by using the electronic-auction model.

Table 3
ICTs and e-business models for geographical clusters

	ICTs	E-business models	Opportunities for clusters
Logistic and networking	Extranet, Intranet, ERP, EDI, etc.	E-procurement	Access to a global marketplace where cluster firms can buy components and raw materials and sell parts and component by using different forms of negotiation
Marketing and customer relations	CRM, Internet, web site, shared databases, etc.	E-mall collecting cluster firms	Create a cluster marketspace on a global scale
		Electronic customer community	Profiling the cluster customers and targeting the cluster products and services
Innovation development	Groupware, CAD/CAM, 3CAD, Internet, shared databases, virtual team platforms, desktop collaboration, etc. information-sharing tools	Professional virtual community	Create a virtual space of interaction and learning that gathers local expertises and enables to transfer tacit knowledge across cluster boundaries
		Collaboration platform	Create an information environment and virtual space to support the collaboration among cluster firms

According to the above analysis, Table 3 reports the main ICTs and e-business models that best fit the characteristics of geographical clusters, and the related opportunities offered to the three value-creating processes carried out within clusters.

In the next section, the case of Italian geographical clusters, called industrial districts (IDs), is discussed. In particular, the analysis aims to evaluate the ICT spread within IDs.

5. ICT spread within geographical clusters: the case of Italian industrial districts

A recent survey carried out on 51 Italian IDs (Rur-Censis, 2001) highlights that the process of adoption of ICTs within IDs is still in the early stage. A big gap exists between Internet connectivity and e-business models adoption and, more in general, between the possession of new ICTs and their actual exploitation.

In particular, the survey points out that the connection to the Net does not support the unstructured and informal communication processes within IDs. For example, the utilisation of e-mails for the inter-firm relationships or for intra-firm informal communications is very limited. In 15% of IDs, there are no significant experiences of informal exchanges of e-mail, in 35% of IDs, less than 10% of firms communicate via Internet (Fig. 2). These percentages are even lower in the case of other forms of ICT-based interactions, such as mailing list and discussion forum.

However, there are experiences of inter-firm web sites (district portals) testifying that the connection to the Net is used to support the networking processes within IDs. These are aimed at creating a virtual space supporting the collaboration among firms and/or at promoting the district on a global scale and/or at opening the ID firms across the district boundaries. In particular, 36% of IDs have implemented inter-firm web sites aimed at supporting the networking processes, exchanging information for the customers seeking, and creating purchasing groups.

Even higher is the percentage (40%) of IDs that have developed web sites aimed at promoting on a global scale the single firm, using specific business windows and informative spaces.

Significant is the presence (28%) of inter-firm portals aiming not only at promoting the ID firms but also at trading on line their products (business-to-business and business-to-consumer).

Yet, a low level of diffusion characterises the most advanced ICT solutions, such as the adoption of shared

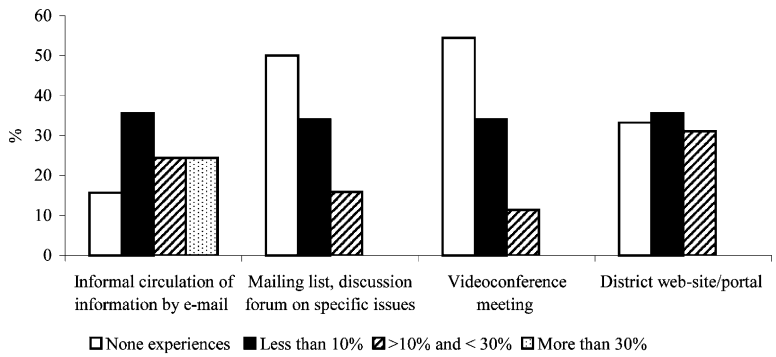

Fig. 2. ICT utilisation in the inter-firms relationships within Italian IDs (%).

Table 4
Utilisation of ICTs in the inter-firms relationships within Italian IDs (%)

Telecom network among firms		Web site for the information exchange	
No initiatives	51.2	No initiatives	29.3
Started	37.2	Started	36.6
Planned	11.6	Planned	34.1
Shared database		District portal for client–supplier contact	
No initiatives	45.3	No initiatives	34.1
Started	21.4	Started	40.9
Planned	33.3	Planned	25.0
Development and sharing of software		District portal for e-commerce	
No initiatives	60.5	No initiatives	45.2
Started	13.2	Started	28.6
Planned	26.3	Planned	26.2

database or the development of shared software for the inter-organisational processes integration and the supply chain management (Table 4).

Another empirical research carried out on 18 Italian IDs (Ordanini, 2001) gives further information on the current state of Internet spread within IDs. The first column of Table 5, which reports the current and expected spread of Internet-based solutions using a scale rising from 1 (low) to 9 (high), clearly shows that IDs are lagging in the use of Internet. Currently, Internet is used as a simple means of communication and, in particular, it is used more for communication with firms outside the district rather than inside. However, it is expected that ID Intranets will further spread (4.1%).

Other interesting information on the spread of ICTs within IDs have been collected through a survey carried out on seven IDs localised in Piemonte (region in Northern-West Italy). In particular, Table 6 (Ragazzi and Rolfo, 2002) shows the data on the adoption of the main advanced managerial software tools. By analysing the data, it clearly emerges that the degree of diffusion of these technologies is still quite low. These technologies require in fact relevant investments and, above all, the business processes re-engineering. This aspect, more than the economic one, represents a great barrier to the adoption for the greater part of ID firms, which consider the traditional way of operating as a distinctive competitive asset.

Table 5
Current and expected spread of Internet within Italian IDs (%)

Internet-based applications	Current	Expected
B-to-B activities between companies within IDs	1.8	4.1
B-to-B activities with companies outside IDs	2.8	4.6
B-to-B activities with commercial companies	2.7	4.7
B-to-C activities with on-line sales	1.7	3.2
Promotional sites able to accept orders	2.9	4.9
Communications and e-mail	5.9	6.9

Table 6
Spread of managerial software tools within Italian IDs (%)

Industrial districts	Groupware	EDI	ERP	Other managerial software tools
Biella	28.3	16.3	12.0	35.9
Valenza	14.3	2.4	2.4	35.7
Omegna	0.0	9.1	18.2	9.1
Canelli	12.5	0.0	0.0	100.0
Cusio	18.6	5.7	5.7	85.7
Chieri	13.3	0.0	0.0	100.0
Torino	35.7	19.0	40.5	21.4
Total	22.2	10.1	12.1	51.7

6. Conclusion

The paper contributes to the debate on the role of ICTs within geographical clusters. The widespread development and diffusion of ICTs, on one side, and the competitive success of geographical clusters, on the other, raise the following questions:

1. What are the main opportunities offered by the ICT to geographical clusters?
2. Are all the ICTs and e-business models suitable for geographical clusters?
3. Does the ICT adoption modify the geographical cluster structure?

The analysis carried out in the paper and the data collected for the Italian IDs do not allow exhaustive answers to be given. However, some indications arising in the paper can help answer the above mentioned questions.

Regarding the first question, it is possible to state that the adoption and implementation of ICT solutions within geographical clusters can offer the following main opportunities to cluster firms:

- improving the communication with the external environment. ICTs, in fact, allow the formation of open networks inter-connecting cluster firms with the global market;
- favouring interactions and information exchanges among firms within the cluster;
- optimising the production processes performance by redefining the relationships with customers and suppliers. In fact, shared databases, integrated information systems, and Internet-based applications supporting the marketing and logistic activities greatly improve the efficacy and efficiency of the key supply chain business processes (namely, customer relationship management, customer service management, demand management, order fulfillment, manufacturing flow management, procurement, product development and commercialisation).

Regarding the second question, it seems that the available technological supply does not completely fit the cluster firms' demand. The ICT demand expressed by

cluster firms, in fact, presents specific features that are strictly related to the nature of clusters. In particular:

1. the small size of firms requires shared technological infrastructures;
2. the fragmentation of the production process requires integrated technological infrastructures;
3. the local specificity requires dedicated technological solutions, enabling the valorisation of those cluster features on which the competitive success of this production model has been based.

Finally, with regard to the possible effects of the ICT adoption on the geographical cluster structure, two main future scenarios can be conceived. One in which the ICTs' implementation will not cancel out the local rooting of cluster firms that will continue to coexist with new and different groupings of firms, some of which may be inter-networked via ICTs. On the contrary, the second scenario posits the disappearance of social and cultural values embedded in the local environment with the consequent affirmation of *virtual clusters* characterised by SMEs located all over the world and inter-connected through a complex ICT-based network.

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