

VIRTUAL ENTERPRISE IN SME NETWORKS¹

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1. Introduction

The radical changes that have occurred in the competitive scenario in recent years have driven local network of small and medium sized enterprises (SMEs) to seek new development pathways able to cope with the growing complexity of the business environment and ensure access to new sources of competitive advantage (Guerrieri and Pietrobelli, 2004).

The recent literature and business practice have shown that local network of SMEs are seeking new forms of collaborative relationships with a high degree of decisional and operational flexibility in order to satisfy the customer demand faster and at lower cost (Chiarvesio et al., 2004). One of these emerging organisational forms is the Virtual Enterprise (VE). Despite the literature devoted an increasing interest towards this organisational form, there are a number of issues that needs to be clarified and further investigated such as:

1. it is still not clear if the VE model may be considered a possible response to the greater complexity and instability characterising the today business environment;
2. despite a number of definitions of VE have been suggested, it is not clear whether VE assumes single or different type of models;
3. although the existing empirical studies are mainly focused on traditional forms of collaboration among firms (such as supply chain and industrial districts), the evolutionary paths that allow firms to move from tradi-

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tional models toward the VE model have not been fully explored and documented;

4. finally, despite the vast literature dealing with this topic, there is little empirical research investigating VE examples.

In this context, two are the main aims of this paper:

- to ascertain if it is possible to identify a single VE model or a framework that includes multiple VE models through the analysis of recent literature;
- to fill the existing empirical research gap through a field analysis focused on a network of small and medium sized enterprises (SMEs).

The specific objective of this work is to analyse the evolutionary path of a high-tech SMEs network located in the eastern area of Naples and to assess if this network is evolving towards the VE model. For this purpose, a questionnaire survey has been carried out.

The paper is organised into eight sections. This introduction is followed by a review of VE definitions (section 2). In section 3 a conceptual framework is proposed, while section 4 describes the context of investigation. The methodology used to carry out the survey is detailed in the section 5. In section 6, the findings emerging from the empirical analysis are presented and discussed. In section 7, the empirical and theoretical results have been jointly discussed. Conclusions and implications are outlined in section 8.

2. Definitions of VE in the current literature

In the last few years, firms have faced dramatic changes in the competitive landscape. The main changes characterising the business scenario may be summarised as follows:

- *acceleration in the rates of technology diffusion and adoption*, especially Information and Communication Technology (ICT);
- *growing market globalisation and competition* that increase new products introduction in the market and reduce their life cycle;
- *new customer requirements*, resulting from the demand for products with greater degree of customisation, higher quality and lower delivery times;
- *new social conditions* The author wish to thank Giovanni Piombino for the support he provided during the survey questionnaire.

In facing this new scenario, firms have started restructuring processes that are mainly based on two elements. On one hand, firm organisational

structures need to be more flexible allowing swift adaptation to changes under way. On the other hand, firms need to adopt technological tools for knowledge management such as ICT. These technologies enable wider access to information and knowledge and allow firms to manage a more efficient and effective system of collaboration relationships. Businesses are now seriously exploring new organisational models that better fit the conditions of the new competitive scenario. The debate on new organisational forms has suggested the virtual enterprise (VE) as a responsive model to address changing market conditions. Despite the substantial literature on this subject, there is not a shared definition of VE, as shown in table 1.

The first definition of VE was given by Jagdev and Browne (1998). The two authors identified a number of VE characteristics. Firstly, this organisational form is based on temporary relationships and information technology (IT) acts as integrator among the networked firms. Jagdev and Browne assign IT the role of coordinating communication flows within the network. Secondly, the authors argued that the main aim of a VE is to exploit fast-changing market opportunities sharing skills and costs. The third important element in their view is that VE is typically project based and tend to have a relative shorter life span in comparison with the extended enterprises concept.

Park and Favrel (1999) proposed a similar view of VE that is supported by extensive use of ICT to address specific market opportunities. They stressed the following two other elements: i) a VE may be created from parts of two or more different enterprises; and ii) it may be designed to facilitate gathering productive resources quickly, broadly and concurrently.

Table 1 - Definition of virtual enterprise

Year	Definition	Author/s
1998	<ul style="list-style-type: none"> - In the conception of the virtual enterprise, the company is no longer a physical entity with a stable mission or location, but a shifting set of temporary relationships connected by a computer network, phone and fax. - Virtual enterprises usually operate in niche markets, are project based and tend to have, relative to extended enterprises, a shorter life span. They form and reform based on market needs. Information Technology in virtual enterprises acts as an integrator. - The virtual enterprise is a temporary network of independent companies, even erstwhile rivals, who come together quickly to exploit fast-changing opportunities. The business partners are all linked using information technology. - The independent companies temporarily linked by IT networks share skills, costs and can achieve access to each other' s markets. The virtual enterprise is an organization which is distributed geographically, and whose work is co-ordinated through electronic communications. 	Jagdev, H.S.; Browne J.

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1999	<ul style="list-style-type: none"> - Virtual Enterprise is considered as the most advanced and efficient form of modern networked enterprise organizations, and supported by extensive use of information and communication technologies. - Virtual enterprises are created to address a specific market opportunity, made up from parts of two or more different enterprises, and designed to facilitate gathering productive resources quickly, broadly and concurrently. 	Park, K.H.; Favrel, J.
2000	A virtual enterprise is a temporary consortium of independent member companies which come together to quickly exploit fast-changing, worldwide product manufacturing opportunities. Within the virtual enterprise, companies share costs, skills, and core competencies, which collectively enable them to access global markets, with world-class solutions that could not be provided individually.	Zhang, Y.P.; Zhang, C.; Wang, H.P.
	The structure of a virtual enterprise can be seen as a holarchy, i.e. it is a temporary, goal-oriented aggregation of several individual enterprises. Each virtual enterprise is created to pursue a specific business objective, and remains in life as long as this objective can be pursued.	Mezgar, I.; Kovacs, G.L.; Paganelli, P.
2001	The virtual enterprise paradigm is a temporary alliance of enterprises that come together to share skills and resources in order to better respond to business opportunities, and whose cooperation is supported by computer networks, challenges the way the industrial production systems are planned and managed.	Camarinha-Matos, L. M.; Afsarmanesh, H.; Osorio, A.L.
	<ul style="list-style-type: none"> - Virtual Enterprise is a network or loose coalition of a variety of value adding services in a supply chain that unite for a specific period of time for a specific business objective, and disband when the goal is achieved. - Virtual enterprise is a temporary consortium or alliance of companies formed to share costs, skills and exploit fast changing market opportunities. 	Choy, K.L.; Lee W.B.
	This concept has been used to characterise the global supply chain of a single product in an environment of dynamic networks between companies engaged in many different complex relationships [...] It is supported by extensive use of information and communication technology. In a VE, manufacturers no longer produce complete products in isolated facilities. They operate as nodes in a network of suppliers, customers, engineers, and other specialised service functions [...]. The main objective of a VE is to allow a number of organizations to rapidly develop a common working environment; hence managing a collection of resources provided by the participating organisations toward the attainment of some common goals. Because each partner brings a strength or core competence to the consortium, the success of the project depends on all co-operating as a single unit.	Martinez, M.T.; Fouletier, P.; Park, K.H.; Favrel, J.
	A virtual enterprise can be defined as a network of independent organizations that jointly form an entity committed to provide a product or service. Because, from the customer's perspective, as far as that product/service is concerned, these independent organisations, for all practical and operational purposes, are virtually acting as a single entity /enterprise.	Jagdev, H.S., Thoben J.

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2001	<p>The VE is a form of joint venture but with important differences. It is designed to be a temporary alliance of member companies who join to take advantage of a market opportunity. It is expected that the VE will possess almost no employees or inventoried resources. Each member organisation provides its own core competencies in organisational functional areas such as marketing, engineering and manufacturing. Only a small headquarters staff is required, to deal with the administrative and management details, with the actual work being performed by geographically separated shareholder companies, subcontractors, and partners joined through computerized hardware and software. When the market opportunity has passed, the VE is dissolved</p>	<p>Presley, A.; Sarkis, J.; Barnett, W.; Liles, D.</p>
2002	<p>The VE is an organisation which is distributed geographically, and whose work is co-ordinated through electronic communications. [...]The business partners are all linked in a dynamic network in order to share their skills and to exploit the fast-changing opportunities.</p>	<p>Mikhailov, L.</p>
	<p>- Essentially, these are micro-enterprises that have managed to profit by the advantages of the information infrastructure and, in particular, one of its components, the Internet. They have chosen the Internet as their sole instrument for sales, promotion, logistics and distribution, and as the tool for their financial transactions. They are called "virtual" because the end user does not necessarily know where they are located geographically and probably will never need to meet any of their staff members.</p> <p>- Virtual enterprises (also known as "extended enterprises") are also brought to birth by multinationals that are responsible for complex products and also act as product integrators. In its most complex form, a virtual is the (often temporary) grouping of several actors, all operating on the same informational platform and working together while a project lasts or to create a given product. These actors do not generally belong to the same enterprise and are not necessarily on the same continent.</p>	<p>Lefebvre, L.A.; Lefebvre, E.</p>
	<p>The goal of a VE is to share skills or core competencies and resources so that a new product can be developed without additional capital investment for resources.</p>	<p>Wu, N.Q.; Sun J.</p>
2003	<p>A VE is a dynamic alliance of member companies (tenderer and tenderers), which join to take advantage of a market opportunity.</p>	<p>Ip, W.H.; Min, H.; Yung, K.L.; Dingwei Wang, B.</p>
2005	<p>A virtual enterprise can be defined as a network of independent organizations that jointly form an entity committed to provide a product or service.</p>	<p>Hao, Q.; Shen, W. M.; Wang, L.H.</p>
	<p>- The virtual enterprise (VE), which is in general the collaborative partnership between business partners in value chains, has become a key factor for survival in the competitive business environment. A VE is a temporary organization which is created according to a business opportunity and is dissolved when the business opportunity no longer exists.</p> <p>- In order to realize the common business goal which is to secure business opportunity, the VE is an active collaborative organization structure which is temporarily made up of value chains. Each value chain consists of loosely-coupled business processes of distributed business partners who offer the core complementary functionality and resources.</p>	<p>Kim, T.Y.; Lee, S.; Kim, K.; Kim, C.H.</p>

2006	VE can be viewed as headed by a major firm that distributes the manufacturing tasks among a number of manufacturing partners sharing enterprise and resources.	Fenga, D. Z.; Yamashiro, M.
2008	VE is based on developing partnerships based on core competencies for achieving agility in a supply chain environment.	Gunasekaran, A; Lai, K.H.; Cheng, T.C.E.

The VE definition provided by Zhang, et al. (2000) does not significantly differ from the two detailed above as the authors claimed that the main components of a VE are its temporary life span and its main objective is quickly to exploit fast-changing, worldwide product manufacturing opportunities. Zhang, et al. also stressed that in a VE context companies share costs, skills and core competencies.

Mezgar et al. (2000) suggested that a VE may be considered as a hierarchy considering that it is a temporary and goal-oriented aggregation of several individual enterprises. The authors also underlined that a VE is created to pursue a specific business objective, and it remains in life as long as this objective has been pursued.

The VE view suggested by Camarinha-Matos et al. (2001) is quite similar to most of the definitions analysed above as they stress similar elements such as: i) temporary alliance of enterprise; ii) sharing skills and resources in order to better respond to business opportunities; iii) the supporting role of computer networks.

Choy and Lee (2001) introduce the concept of VE as a network of value adding services in a supply chain that unite for a specific period of time for a specific business objective, and disband when the goal is achieved. As several other authors, they argued that VE is a temporary consortium or alliance of companies formed to share costs, skills and to exploit fast changing market opportunities.

Martinez, et al. (2001) also shown how VE concept may be used to characterise the global supply chain of a single product in an environment of dynamic networks between companies engaged in many different complex relationships. The focus of this definition is on manufacturing companies that no longer produce complete products in isolated facilities but they operate as nodes in a network of suppliers, customers, engineers, and other specialised service functions. In their view, the main objective of a VE is to allow organisations to rapidly developing a common working environment and managing a collection of resources provided by the participating organisations toward the attainment of common goals. Hence, the VE success depends on all co-operating as a single unit.

Jagdev and Thoben (2001) also highlighted that the independent organisations participating in a VE are virtually acting as a single entity/enterprise.

For Presley et al. (2001) the VE is a form of joint venture that is characterised by a number of relevant differences such as: i) it is designed to be a temporary alliance among the member companies for taking advantage of a market opportunity; ii) each member organisation provides its own core competencies in organisational functional areas such as marketing, engineering and manufacturing; iii) a small head quarters staff is required to deal with the administrative and management details; iv) geographically separated shareholder companies, subcontractors, and partners are joined through computerized hardware and software; v) when the market opportunity has passed, the VE is dissolved.

For Mikhailov (2002) a VE is an organisation which is distributed geographically, and whose work is co-ordinated through electronic communications. He also stressed that business partners are all linked in a dynamic network in order to share their skills and to exploit the fast-changing opportunities.

Lefebvre and Lefebvre (2002) pointed out that VE are micro-enterprises that take advantage from the information infrastructure and, in particular, the Internet as the sole instrument for sales, promotion, logistics and distribution, and financial transactions. For the authors, the end user does not necessarily know where the VE participating companies are located geographically. It is interesting to note that in their view VE is also known as "extended enterprises" and it is created by multinationals companies that are responsible for complex products and also act as product integrators. They also stress that a VE is often a temporary group of several actors, all operating on the same informational platform. These actors do not generally belong to the same enterprise and are not necessarily located on the same continent.

Wu and Sun (2002) defined a VE an organisational structure that is aimed at sharing skills or core competencies and resources so that a new product can be developed without additional capital investment for resources.

Ip et al. (2003) stressed the VE model as an alliance of member companies (tenderee and tenderers) with a dynamic nature designed and implemented to take advantage of a market opportunity.

Hao et al. (2005) simply defined a VE as a network of independent organizations that jointly form an entity committed to provide a product or service.

For Kim et al. (2005) VE is characterised by a number of features such as: i) collaborative partnership between business partners in value chains; ii) its life span is temporary; iii) it is created according to a business opportunity and is dissolved when the business opportunity no longer exists; and iv) each participating company offers their core complementary functionality and resources.

Fenga and Yamashiro (2006) view a VE as headed by a major firm that distributes the manufacturing tasks among a number of manufacturing partners sharing enterprise and resources.

Finally, Gunasekaran and Lai (2008) argued that a VE is based on developing partnerships based on core competencies for achieving agility in a supply chain environment.

3. The conceptual framework

The above analysis highlights a number of shared issues that have been retrieved in almost all the definitions considered. These issues relate to the main aims of VE creation, the objectives on which the partnership is based, the stability of the virtual organisation, the characteristics of partnership and the coordination and communication tools (see Table 2). *These five shared issues may be considered the common foundations of the theoretical concept of the VE model.*

Table 2 - Shared issues characterising the VE model in the current literature

Issues	Description
Main aims	<ul style="list-style-type: none"> • Exploiting fast-changing, worldwide market opportunities; • Acting as a single entity / enterprise
Partnership objectives	<ul style="list-style-type: none"> • Short time span • Sharing costs, risks and core competencies for specific projects or products / services
Organisation stability	<ul style="list-style-type: none"> • Dynamic network organisation of participating companies
Partnership characteristics	<ul style="list-style-type: none"> • Temporary and dynamic • Collaborative • Independent companies
Coordination and communication tools	<ul style="list-style-type: none"> • Strong emphasis on ICT and information infrastructures (e.g. the Internet)

Nevertheless, some other critical issues appear not included in the above definitions. Firstly, the role of coordinator (or coordination unit) seems to be underestimated by the current literature. Secondly, firm size is not considered at all in any definition analysed. This seems a lack that needs to be addressed as many industrial systems in developed countries are populated by a large number of small company aggregations, as in the case of the Italian industrial districts. Thirdly, it is not clear what the VE organisational structure is. In other words, there is not a clear view about the prevalence of vertical or horizontal relationships in VE model. Fourthly, the current literature seldom refers to the increasing important role of knowledge and knowledge management system in the context of VE model. Finally, it isn't clear the relationship with market and which

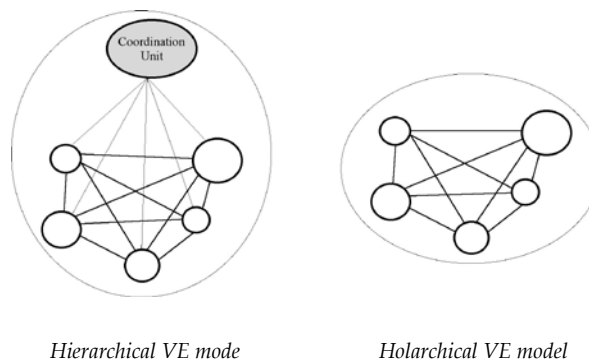
specific participating company has the direct relation with the final user of the product/ service realised by the VE (see table 3). These five not shared issues may be considered as the distinctive characteristics of specific VE models. Summarising, the literature analysis indicates that *it is not possible to identify a single organisational VE model as there is a variety of VE forms that share a number of issues.*

Table 3 - Issues not addressed/shared by the current literature

Issues	Description
Coordination unit	<ul style="list-style-type: none"> • There is not a shared view about the presence of coordinator and mechanisms of coordination (coordination unit Vs. self organisation)
Firm size	<ul style="list-style-type: none"> • It is not clear the role of firm size in VE arrangements (large multinationals Vs. SMEs)
Organisational structure	<ul style="list-style-type: none"> • The VE organisational configuration is underestimated (vertical Vs. horizontal relationships)
Knowledge	<ul style="list-style-type: none"> • There are few references to the mechanisms of knowledge circulation in the VE model • There is not a shared view about the presence of a knowledge management system in the VE
Market	<ul style="list-style-type: none"> • The literature does not clearly identify the member company that manages the relationship with customer

Elaborating on the above definitions and considering both the shared and not shared issues, two models of VE may be identified: Hierarchical and Holarchical VE (see figure 1). In the case of Hierarchical VE, a leader company (generally a large multinational firm) assumes the task of coordinating the entire network of firms (Lefebvre and Lefebvre, 2002; Fenga and Yamashiro, 2006). This company also acts as product integrator. In addition, it is responsible for the final product/ service and manages the relationship with customer.

Figure 1 - Two extreme models of virtual networks



The Holarchical VE model is characterised by a self-organisation (Mezgar et al., 2000). Due to the lack of a coordinating unit, the success of the virtual enterprise strictly depends on all partners co-operating as a single unit.

4. The context of investigation

The East Naples high tech network is an association of 25 SMEs founded in March 2007. The main objective of this association is to integrate resources and competences of the firms to seize the opportunities of the local market. The total number of employees is about 3,000 people and the total turnover is about 400 million Euros. The East Naples high tech network mainly consists of SMEs as shown in table 4. In the table, the latest EU definition of SMEs proposed by the EU Commission has been used (European Commission, 2005).

Table 4 - The East Naples high tech network firms' breakdown by employees

Employees bands	N.	%
0-9	3	12
10-49	10	40
50-249	11	44
≥250	1	4
Total	25	100

Network firms operate in different high-technology manufacturing and service sectors as shown in figure 2.

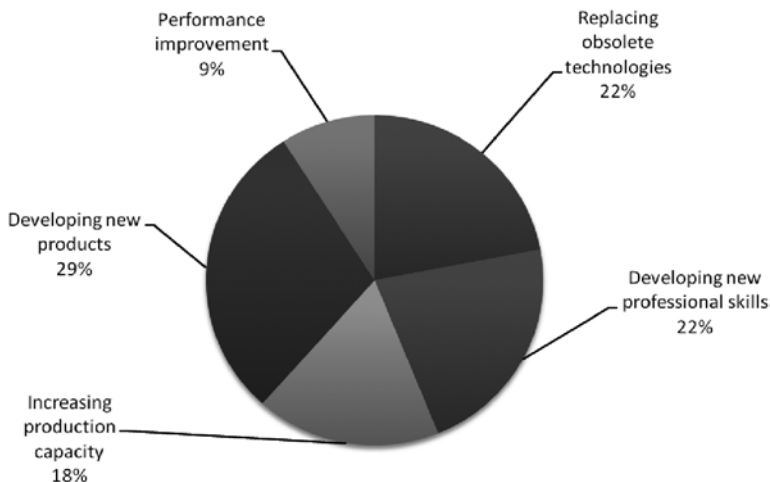
Figure 2 - East Naples high tech network: company sectors

Manufacturing companies	Aerospace	1	Aermec Sud
		2	ARM
		3	ASTRO Ind.
		4	Fox-Bit
		5	K4A
		6	Magnaghi Aeronautica
		7	Vulcan Air
	Engineering	8	Farina Impianti
		9	Mecfond
	Transport (lines, infrastructures and equipments)	10	AET

Service companies	Aerospace (Research & Development)	11	MARS
	ICT	12	Euro.Soft
		13	Intecs
		14	ITS
		15	Kell
		16	Naosys
		17	Null Pointer
		18	SRSe
	Management training and consulting services	19	Form & ATP
		20	Mater
		21	Protom
		22	Tecno-In
	Transport (system and service)	23	Ansaldo Segnalamento Ferroviario
		24	Lead Tech
	TLC	25	Canale Otto S.p.A.

The most part of companies are involved in aerospace and ICT sector. The total turnover increased by 28% in the period 2004-2007 and this led to a growth in investment by 21% in the same period. These investments are mainly aimed at developing new products/services or new professional skills as shown in figure 3. Other relevant investment objectives consist of replacing obsolete technology, while increasing production capacity and performance improvement play a limited role in motivating company investment.

Figure 3 - East Naples high tech network main investment objectives



5. Questionnaire survey methodology

After reviewing the current literature on VE a questionnaire survey has been conducted. The literature review allowed a better understanding of the relevant aspects to be analysed in the questionnaire survey. The main aim of the survey is to assess whether the East Naples high tech network is evolving towards the VE model. The survey methodology has been organised into the following five steps:

- a) *Definition of basic survey objectives and preparation of the draft questionnaire.* In this phase a draft version of the questionnaire has been prepared together with the basic survey objectives.
- b) *Establishment of focus groups.* In order to test the suitability of the basic survey objectives and the comprehensibility of the draft questionnaire a focus group involving 8 experts with different competences and professional background was established. The focus group has been developed in three different phases. Firstly, the topic investigated has been presented in order to make focus group participants familiar with it. Secondly, the draft questionnaire has been submitted to the panellists in order to get their useful feedback and comments. Finally, panellists' remarks have been discussed in a plenary session.
- c) *Re-focussing of survey objectives and questionnaire.* On the basis of feedback received during the focus group discussion, the questionnaire has been finalised. Most of the questions included in the questionnaire are based on a Likert scale ranging from 1 to 9. Some other questions allow more qualitative answer in order to allow respondents to express their own personal opinion.
- d) *Test of the questionnaire.* In this step, the final version of the questionnaire has been tested through 3 pilot interviews carried out in East Naples high tech network firms.
- e) *Survey implementation.* The survey has been conducted in spring 2008. The total number of respondents is 18 out of 25 companies with a response rate of 72%. The questionnaire has been submitted during face-to-face interviews involving at least two managers with different skills and role (e.g. a manager involved in the strategic firm decisions making process and a manager involved in the operation management). This allowed obtaining both strategic and operational perspectives.

In order to have a more comprehensive picture of the East Naples high tech network, information from complementary sources (e.g. company websites, company reports and industry magazines) have been collected and analysed.

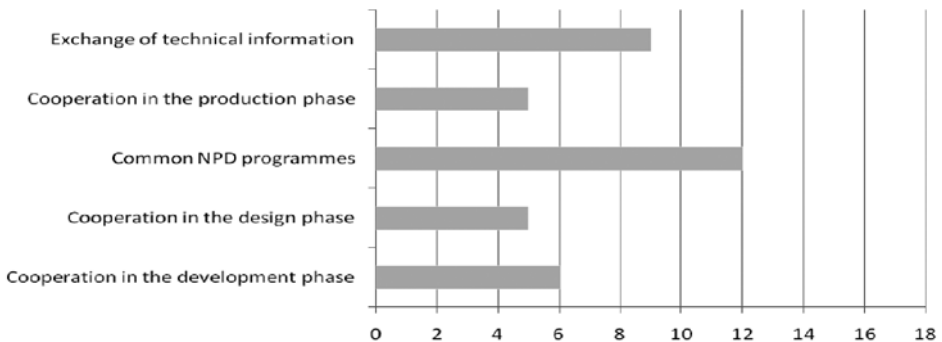
6. Survey findings

This section presents findings emerging from the empirical survey. In particular, the findings presented here are related to the questionnaire sections analysing firm relationships and knowledge management practices. Subsequently, these evidences have been compared with the findings emerging from the literature review carried out in section 2 and 3.

6.1 Firm relationships

In this section the relationships among the firms are analysed. Such relationships have a dynamic nature due to the collaborative projects undertaken by East Naples high tech network firms. The survey investigated the nature of relationships among firms belong to the network. Findings are shown in Figure 4 where each bar represents the number of firms out of the 18 respondents that are engaged in a particular type of collaboration.

Figure 4 - Nature of relationship



Relationships in the production, design and development phase account for only a limited percentage. The most important forms of relationships are the involvement in common shared new product development (NPD) programmes and the exchange of technical information.

In order to provide a more detailed picture of collaboration within the East Naples high tech network, a sample of projects currently undertaken

is shown in table 5. In such projects, the proposer not always assumes the role of coordinator. Sometimes the coordination of the project is committed to another firm involved in the partnership.

Table 5 - East Naples high tech network collaborative projects as potential VEs

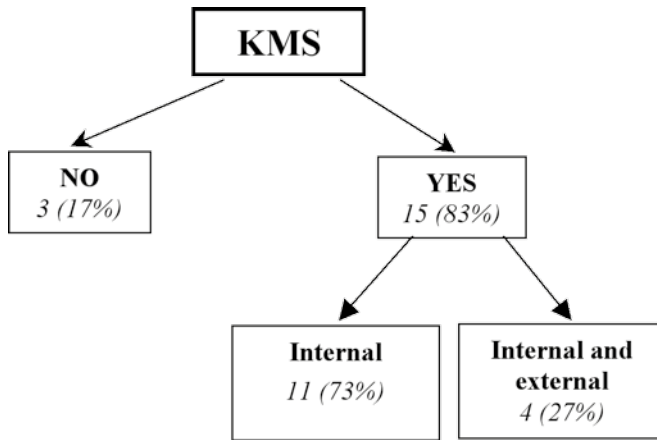
Project name	Project Description
Electric aircraft	Mixed electric propulsion aircraft
KA-2H	Innovative helicopter
SAC	Composite anti-crash system for helicopters
SAEG	Steering electric innovative system
RTA	Advanced coverings for aircraft industry
IRENE	Space capsule for picking up cosmic dust
SPA	Advanced system for satellite antennas polymerisation
HM&M	Health monitoring and management system for space aircraft
FSL-EC	Study of human - computer interaction systems
Liquid bag buffers	Development of liquid bag buffers systems for innovative bearing
HPF	Heat pipes for spatial vehicle control
3D Modelling	Real time capture system of 3D models
Tele-medicine	System for the application of telemedicine and remote-medicine using satellite system
SIGRI	Information system for monitoring and control of forest fires

According to the competencies required, each project listed in the above table may be a potential VE involving East Naples high tech network firms. The development of collaborative projects is the main objective of the partnerships in the VE model. This makes the East Naples high tech network a context for the creation and implementation of VEs. For this reasons, the East Naples high tech network may be considered a potential pool of VEs.

6.2 Knowledge management

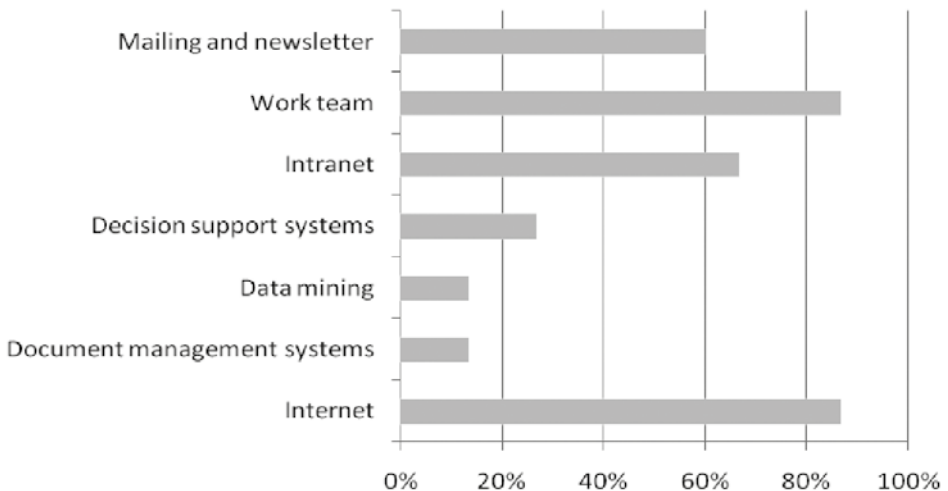
In order to develop collaborative projects, companies generally tend to adopt knowledge and information management tools. For this reason, the usage of Knowledge Management System (KMS) has been explored. Firstly, the survey indicated that 83% (15 firms) of the sample firm have a KMS in place (see figure 5). 73% of these companies (11) adopt an internal KMS.

Figure 5 - KMS adoption in East Naples high tech network



The most widespread tools of internal KMS implementation (see figure 6) are the Internet website (87%), work teams (87%) and intranet (67%).

Figure 6 - Internal KMS implementation tools



The high importance attached to work teams demonstrate that, in high technology sectors, interactions and interpersonal relationships are a fundamental tool for problem solving. In this context, it is worth to distinguish between service and manufacturing firms. On the one hand, service firms

operating in the telecommunications, ICT, and aerospace sectors generally tend to use advanced and structured KMS equipped with a document management system, data mining, decision support systems, and dedicated work team. On the other hand, manufacturing firms working in the aerospace sector as sub-suppliers, use a less structured KMS finalised to management control and business resource management.

Although only 4 firms use internal and external KMS, each single firm investigated claimed for wider KMS embracing the entire East Naples high tech network. For this reason, the benefits of a KMS serving the entire firm network have been analysed (see figure 7). In the figure the average value of answers for each expected benefit is reported.

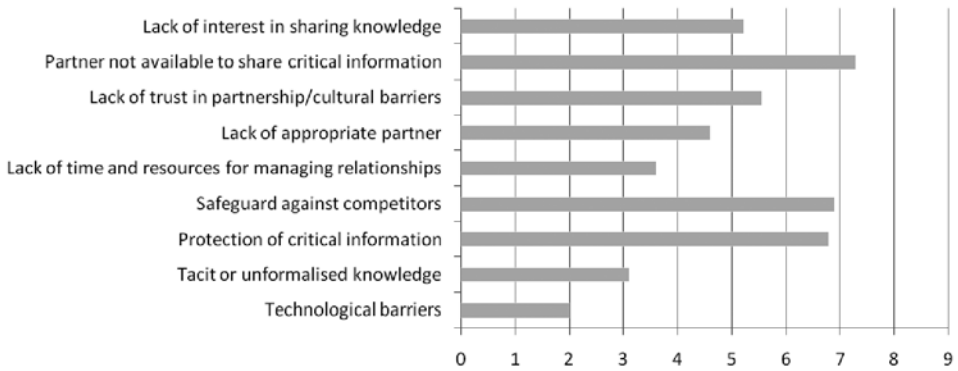
Figure 7 - Expected benefits of the KMS



The figure interestingly shows that a KMS serving the entire East Naples high tech network may have a positive impact not only on the innovation and the operational management, but also to better understanding of the marketplace. This feature further clarifies the potential support that a KMS can provide to VEs. In fact, the main aim of a VE is to exploit market opportunities using the competencies of member companies.

However, there are a number of barriers to implement KMS in the East Naples high tech network (see figure 8). The unavailability of partner to share critical information, the safeguard against competitors and the need to protect critical information are the most relevant barriers. This suggests that companies seem oriented to preserve their own intellectual assets from the opportunist behaviour of potential partners. Such obstacles may be overcome through increasing mutual trust. This objective may be achieved stimulating the collaboration among firms.

Figure 8 - Knowledge-sharing barriers



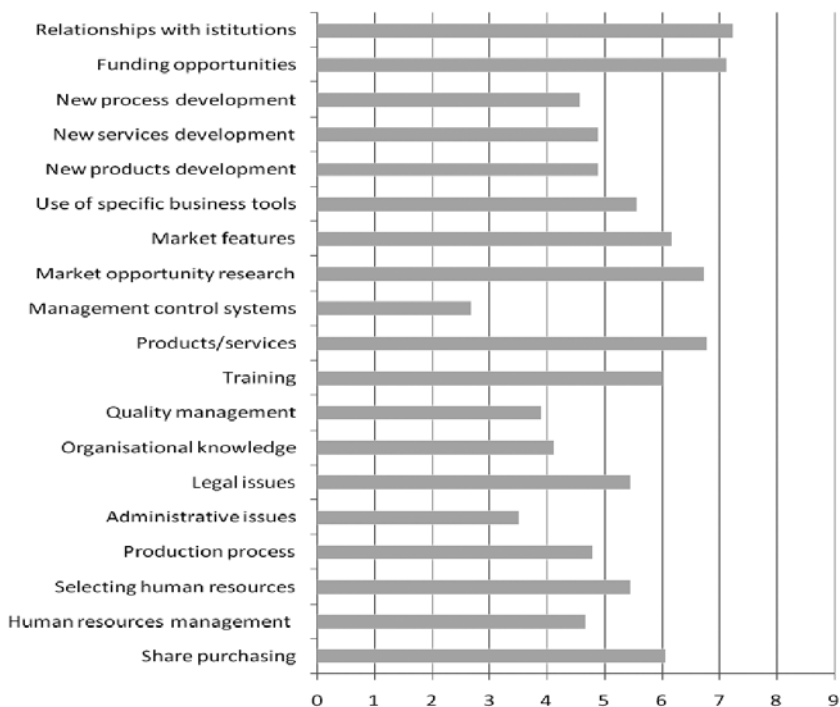
Another aspect investigated relates to information that firms are willing to share (see figure 9) and obtaining (see figure 10) through the use of a KMS platform serving the East Naples high tech network. In both figures the average value of answers for each possible item is reported.

Figure 9 - Information which firms are willing to share through a KMS platform



Simultaneously analysing figures 9 and 10, it emerges that firms show a strong appreciation about the implementation of a KMS platform to facilitate the diffusion of information on products/services. Other relevant information that firms are willing to share and obtain from a KMS concern market features and market opportunities. It is worth noting that firms show a special interest in sharing information on market opportunities. This is a common VE feature that literature has put in evidence (see table 1). The most relevant difference in the two figures above relates to information on relationships with institutions and funding opportunities. In fact, considering these two items it emerges that firms view the KMS of the East Naples high tech network as a platform for mainly obtaining information.

Figure 10 - Information which firms need to obtain from a KMS platform



7. East Naples high tech network as a pool of VEs

In this section, the findings emerging from the questionnaire survey have been matched with the main results of the literature review. The aim is to verify if the system of relationships among ENS firms is evolving towards the VE model. It is important to outline the working mechanisms of the East Naples high tech network. On the basis of a specific market oppor-

tunity, a firm proposes a project, launches a call for adhesion and creates a network. The participating companies select a coordinator and develop the project. Usually, the proposer of the project is chosen as coordinator. In same other cases, the role of coordinator is played by another firm participating in the project. In both cases, the coordinator is not the hierarchical leader of the project, but just the “primus inter pares”. In this way, East Naples high tech network is characterised by a set of peer temporary relationships orientated to specific projects. It is a dynamic network in which project collaboration relationships are continuously formed and reformed.

The comparison has been organised into two steps. In the first step, the issues covered by the current literature have been compared with the issue emerging from the questionnaire survey (see table 6).

Generally speaking, it appears that the empirical evidences fit most of the shared issues covered by the current literature. Nevertheless, there are some relevant differences. Differences emerge in relation with the main aims in creating VE. In particular, the partnerships created within the East Naples high tech network target local market opportunities. For this reason, the member companies are strongly interested in sharing information about new market opportunities. Other differences appear in relation to coordination and communication tools where it emerges an emphasis on interpersonal relationships and information systems that are mainly internal oriented and not fully integrated.

Table 6 - Comparison between shared issues emerging from literature review and empirical findings

Issues emerging from the literature review	Issue emerging from the field survey
Main aims <ul style="list-style-type: none"> • Exploiting fast-changing, worldwide market opportunities • Acting as a single entity / enterprise 	Main aims <ul style="list-style-type: none"> • Pursue mainly local market opportunities • Strong interest in sharing information about new market opportunities
Partnership objectives <ul style="list-style-type: none"> • Short time span • Sharing costs, risks and core competencies for specific projects or products / services 	Partnership objectives <ul style="list-style-type: none"> • Short time span • Sharing costs, risks and core competencies for specific projects
Organisation stability <ul style="list-style-type: none"> • Dynamic network organisation of participating companies 	Organisation stability <ul style="list-style-type: none"> • Stability of the overall ENS network • Formation and reformation of temporary organisation according to projects need

continue...

...continue

Partnership characteristics <ul style="list-style-type: none"> • Temporary and dynamic • Collaborative • Independent companies 	Partnership characteristics <ul style="list-style-type: none"> • Temporary and dynamic according to projects needs • Collaborative • Independent companies
Coordination and communication tools <ul style="list-style-type: none"> • Strong emphasis on ICT and information infra-structures (e.g. the Internet) 	Coordination and communication tools <ul style="list-style-type: none"> • Strong emphasis on interpersonal relationships • Information systems mainly internal oriented and not integrated

In the second step, issues not fully addressed by the current literature have been compared with the empirical evidences obtained (see table 7). Some specific features of the partnership have been highlighted. They particularly refer to the following elements:

- in some projects, the proposer act as coordinator;
- in some other projects, the coordination is assumed by the product integrator;
- most projects involve SMEs;
- the organisational configuration is hybrid in comparison with the other two found in figure 1 due to different existing coordination mechanisms;
- there is not a KMS serving the entire East Naples high tech network;
- the need for a shared KM platform is recognised by the surveyed companies;
- the companies involved in the project have a clear visibility of the target market;
- it is the proposer and/or the product integrator that manages relationship with the customer.

Summarising the above, the empirical results suggest that the East Naples high tech network is a potential pool of VEs. In fact, the East Naples high tech network is characterised by a set of dynamic networks of collaboration in which collaborative relationships are continuously formed and reformed.

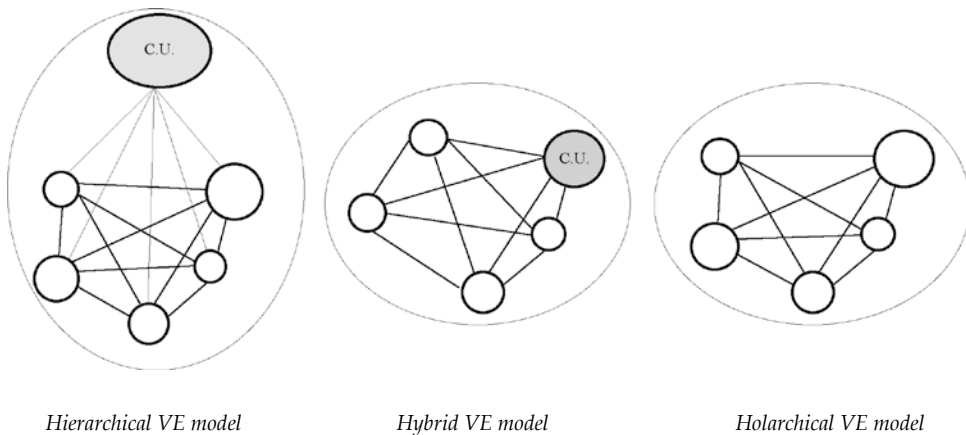
Table 7 - Comparison between issues not addressed by the literature review and empirical evidence

Issues emerging from the literature review	Issue emerging from the field survey
Coordination unit <ul style="list-style-type: none"> • There is not a shared view about the presence of coordinator and mechanisms of coordination (coordination unit Vs. self organisation) 	<ul style="list-style-type: none"> • In some cases, the project proposer act as coordinator • In some other projects the coordination is assumed by the product integrator

<p>Firm size</p> <ul style="list-style-type: none"> • It is not clear the role of firm size in VE arrangements (large multinationals Vs. SMEs) 	<ul style="list-style-type: none"> • Most projects involve SMEs
<p>Organisational structure</p> <ul style="list-style-type: none"> • The VE organisational configurations is underestimated (vertical Vs. horizontal relationships) 	<ul style="list-style-type: none"> • Hybrid organisational configuration due to different coordination mechanisms
<p>Knowledge</p> <ul style="list-style-type: none"> • No reference to the mechanisms of knowledge circulation in the VE configurations There is not a shared view about the presence of a knowledge management system in the VE 	<ul style="list-style-type: none"> • There is not a KMS serving the entire ENS • The need for a shared KM platform is recognised by the surveyed companies
<p>Market</p> <ul style="list-style-type: none"> • The literature does not clearly identify the member company that manages the relationship with customer 	<ul style="list-style-type: none"> • The companies involved in the project have a clear visibility of the target market • The proposer and/ or the product integrator manages relationship with the customer

Moreover, it emerges that these specific VEs created in the context of the East Naples high tech network assume a hybrid form between the two extreme VE models identified above (Hierarchical and Holarchical) (see figure 11). This Hybrid model has some characteristics in common with the two forms identified in figure 1.

Figure 11 - A possible taxonomy of VE models



In particular, the Hybrid model shares the relationships among peers with Holarchical model, and the presence of a coordinating firm with the Hierarchical VE model. Moreover, the Hybrid VE model presents a specific characteristic that relates to the fact that the coordinating unit may not be the leader of the project, but just the “primus inter pares” (the first among peers).

8. Conclusions and implications

This paper attempts to analyse the possible forms that VE may assume and provide empirical evidences about the diffusion of this new organisational model in SMEs networks.

From the theoretical point of view, it emerges that it is not possible to identify a unique VE model, but there is a framework that includes a variety of VE models. These models are characterised by a number of shared issues (main aims of VE creation, the objectives on which the partnership is based, the stability of the virtual organisation, the partner relationship and the coordination and communication tools) and other specific issues (coordination unit, firm size, organisational structure, knowledge management and market relations). In particular, two extreme VE forms have been identified: the Hierarchical and the Holarchical models. In the case of Hierarchical VE, a leader company assumes the coordination of the network, and it generally manages market relationships acting as product integrator. On the other side, the Holarchical model is characterised by a self-organisation in which the success of the virtual enterprise strictly depends on all partners co-operating as a single unit.

The survey conducted on the East Naples high tech network suggests that it may be considered a potential pool of VEs. In fact, such network is characterised by a set of peer temporary relationships oriented to specific projects in which collaborative relationships are continuously formed and reformed. The comparison between literature review and survey findings allows establishing that VEs created in the East Naples high tech network assume a hybrid form between the two extremes identified in figure 1. In comparison with the two above models, the Hybrid model has common characteristics (e.g. the presence of coordinator) and a specific characteristic (e.g. the coordinating unit is the “*primus inter pares*”).

The above discussion allows to draw some managerial and policy implications. From the managerial point of view, the paper suggests that the virtual enterprise may represent an organisational model to face the challenges of the fast changing competitive environment, especially for SMEs. Nevertheless, in order to fully exploit the potential of virtualisation, SMEs need to implement new technological solutions. For this reason, for small businesses it is necessary to sustain their virtualisation process through the adoption of technological platforms that allow managing and sharing information and knowledge more efficiently. A further important point is related to collaboration. One of the foundation concepts of new organi-

sational models is collaboration among network participating companies. Particularly in the VE model, the collaboration issues assume a critical importance as the competitive success may be achieved only if member companies operate as a single unit.

It is well known that in the context of SMEs the setting up of collaborative relationships is a rather difficult process. For this reason, it is necessary to support the SMEs virtualisation process through a number of actions developed by university and local authority.

University should develop technological solutions particularly oriented to meet the need of SMEs. In this context it is crucial to involve SMEs in collaborative projects. On the other hand, the role of local authorities appears also important. Specifically, such institutions should support the SMEs virtualisation processes through a set of policy measures aimed at facilitate the process of innovation and collaboration of SMEs.

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Abstract

Small and medium sized enterprises (SMEs) operating in industrial districts have historically provided an important alternative to the advantages achieved through a larger production scale in the context of the Italian industrial system. However, in recent decades uniform growth in SME networks has come to an end. The industrial district model has often proved to be rather a 'stage' in one of the possible different paths of industrialisation. In fact, small firms are evolving towards a scenario characterised by increasing competition and massive introduction of ICT. These changes have accelerated the search for new organisational forms that allow SMEs facing the growing complexity of the business environment. Furthermore, it is of paramount importance to sustain local SME networks especially during period of economic crisis. One possible way may be to support the virtualisation potential of SME networks and encourage their rapid evolution toward the Virtual Enterprise (VE) model order to seize new development opportunities. Despite increasing academic interest toward the VE, there are a number of key issues not addressed by the current literature such as the possible form VEs may assume and the lack of empirical investigations. This paper tries to fill these voids. Two are the main objectives of this paper. Firstly, to analyse the possible models that VE may assume when participated by SMEs and, secondly, to fill the existing empirical research gap in this field. In order to achieve the above objectives a comprehensive literature review on the subject has been first carried out. Subsequently, an exploratory questionnaire survey has been implemented in a SME network located in the eastern area of Naples city. The literature review allows the identification of two extreme VE forms: the Hierarchical and the Holarchical models. The result of the questionnaire survey suggests that the network analysed may be a potential pool of VEs in which temporary relationships oriented to specific projects are continuously formed and reformed. Finally, the comparison between literature review and survey findings allows establishing that VEs created in that network may assume a hybrid form between the two extreme models identified.

Riassunto

Le piccole e medie imprese operanti nei distretti industriali italiani hanno tradizionalmente fornito un'efficace alternativa ai vantaggi connessi alle grandi dimensioni aziendali. Tuttavia, nel corso degli ultimi decenni il modello distrettuale ha mostrato molti limiti al punto che tale modello è considerato piuttosto uno stadio intermedio nei diversi possibili percorsi di industrializzazione di un paese o di un territorio. Le piccole imprese si trovano infatti in una fase evolutiva molto critica caratterizzata da un'aspra competizione e dalla massiccia diffusione delle nuove tecnologie ICT. Questi cambiamenti stanno spingendo le piccole imprese verso la ricerca di nuovi assetti organizzativi in grado di fronteggiare efficacemente la maggiore complessità ambientale. Inoltre, il sostegno ai sistemi locali di piccole imprese appare ancora più importante in periodi di forte crisi economica come quello attuale. Supportare il potenziale di virtualizzazione dei sistemi locali di piccole imprese e la stimolazione verso l'adozione di modelli di impresa virtuale può rappresentare un possibile percorso di sviluppo in grado di dare una risposta alla complessità dell'ambiente in cui queste imprese operano. Nonostante il forte interesse verso questa nuova forma organizzativa, la letteratura non ha ancora affrontato una serie di questioni chiave come ad esempio le possibili forme che l'impresa virtuale può assumere o l'analisi di tale forma organizzativa attraverso opportune indagini empiriche. Questo articolo fornisce un contributo volto a colmare tale lacuna. L'obiettivo del lavoro è duplice. Da un lato, analizzare le possibili forme che le imprese virtuali possono assumere quando sono partecipate da piccole imprese. Dall'altro, il lavoro intende contribuire a ridurre il

gap di ricerche empiriche esistenti in questo campo. Per poter conseguire tali obiettivi è stata svolta un'ampia analisi delle letterature. E' stata poi realizzata un'indagine empirica esplorativa in un network di piccole imprese ad elevata tecnologia localizzato nella zona orientale della città di Napoli. L'analisi della letteratura ha consentito di identificare due modelli estremi di imprese virtuali denominati Gerarchici e Olarchici. I risultati dell'analisi empirica suggeriscono che il network investigato può essere considerato un "bacino" di imprese virtuali per effetto delle relazioni inter-impresa temporanee che continuamente si creano e si dissolvono. Infine la comparazione tra le evidenze emergenti dall'analisi della letteratura e dall'indagine empirica ha consentito di individuare un modello intermedio di impresa virtuale (denominato Ibrido) che si pone in una posizione intermedia tra i due modelli estremi già individuati.

Jel Classification: L14

Keywords (Parole chiave): Virtual Enterprise, SME networks, Interfirm relationship, Knowledge management, High technology sectors, Questionnaire survey.