Knowledge and capabilities in subcontractor’s evolution: the Italian case

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How are small and medium sized subcontracting firms evolving as globalization and new technologies challenge traditional supply systems in mature industries? This question is critical for industrial buyers who, in order to improve supply chain performance and match sourcing with their business strategies, need to segment their subcontractors and understand how, on top of manufacturing excellence, their marketing and design capabilities evolve. But it is also critical for subcontractors who, in order to survive, need to avoid strategies based on mere cost competition, enlarge their customer base, offer unique, higher quality products, serve their customers with ever higher degrees of flexibility and engage them in durable relationships.

We address this question studying the case of Italian subcontractors. We explore if (and to what extent) Italian subcontractors differ and can be classified on the basis of their design and marketing capabilities. Applying cluster analysis to a sample of 417 Northeast Italian subcontractors, we explore if (and to what extent) Italian subcontractors differ and can be classified on the basis of their design and marketing capabilities. We identify 4 profiles of subcontractors as a function of their design and marketing capabilities: developed, developing, question mark and traditional.

Using this segmentation as a starting point, we also use data from 10 in-depth subcontractor case studies to develop a model of how subcontractors’ capabilities co-evolve over time. We identify typical subcontractors’ evolutionary patterns, showing how the transition from one profile to another takes place. We discuss our findings’ implications in terms of the resource-based and knowledge-based views of the firm. We provide managerial insights on subcontractors’ strategic segmentation and on how to develop design and marketing capabilities.
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ABSTRACT

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Using this segmentation as a starting point, we also use data from 10 in-depth subcontractors’ case studies, to develop a model of how subcontractors’ capabilities co-evolve overtime. We identify typical subcontractors’ evolutionary patterns, showing how the transition from one profile to another takes place.

We discuss our findings’ implications in terms of the resource-based and knowledge-based views of the firm. We provide managerial insights on subcontractors’ strategic segmentation and on how to develop design and marketing capabilities.

Subject Areas: Suppliers’ segmentation, Suppliers’ evolution, Subcontractors’ capabilities, Supply relationships, Supply chain management
INTRODUCTION
The Italian industrial system is known worldwide for its high fragmentation, its organization around geographically coupled supply systems (industrial districts or geographical clusters) and the prevalence of small and medium sized firms, vertically specialized in one or few phases of a supply chain (Porter, 1990). Hence, the evolution of the Italian economy largely depends on the evolution of these supply systems within the relevant supply chains.
Traditionally, Italian subcontractors have grown in “protected” environments, embedded in well defined geographical clusters (for example, many firms embedded in industrial districts have started their activities as spin-offs of their main customer). They have tended to depend on a few, main, co-located customers, and such “quasi-captive” demand has usually saturated their production capacity and capabilities. Furthermore, embeddedness and geographical proximity have facilitated the development of relational contracts and mutual learning between buyers and suppliers. Within this context, subcontractors usually have not scaled and have become highly specialized in single production stages. They are mostly family owned and run businesses, often undercapitalized, and lack managerial capabilities. Their core competence has historically been manufacturing, while marketing, design and engineering activities and capabilities are underdeveloped. As regards these functions, subcontractors have almost completely depended on their customers, who interact with final markets.
However, during the last decade, Italian supply systems have undergone major structural and strategic changes, partly losing their historical peculiarities (Grandinetti and Bortoluzzi, 2004). On the one hand, the largest firms, usually assemblers/buyers located in the downstream sections of supply chains, have changed sourcing policies, reducing their dependence from their local supplier bases and actively seeking for low cost sources in such emerging areas as East Europe.
and East Asia. On the other hand, also some of the small and medium sized suppliers have opened up, diversifying their businesses, moving from subcontracting to direct business, and reducing their dependence on few, local main customers.

This transformation is the response to the new challenges posed by globalization and new information and communication technologies, and tries to address some structural weaknesses of the Italian industrial model uncovered by these challenges (Camuffo, 2003).

Increasing competition from producers located in low cost Countries and ever new, more powerful information and communication technologies decrease the importance of geographical proximity as a competitive advantage factor. In order to survive, local suppliers/subcontractors have to change their strategies and adapt their structures. Above all, they need to develop appropriate design and marketing capabilities (Esposito, Lo Storto, 1991; Esposito, Raffa, 1994; Nassimbeni et al. 1996).

As concerns design, suppliers/subcontractors need to take on more responsibilities, abandon a mere productive role and undertake proactive behaviors towards customers. With respect to this, a requirement, for subcontractors, is the development of specific product and/or process technologies, to be incorporated in the customer’s products and/or processes as integrative part of their value propositions.

As concerns marketing, suppliers/subcontractors have to be able to offer innovative products, processes or services, to navigate autonomously the global market, to position in new, more defendable niches, to find out new segments and opportunities, to serve and manage more demanding and differentiated customers, and to develop their own brands.
Marketing capabilities can alleviate subcontractors’ dependence from local demand and facilitate diversification and internationalization processes. Design capabilities are the pre-requisite to establish more valuable and balanced relationships with a wider array of customers.

Within this worrisome situation, common to other European Countries than Italy, the critical question is: how small and medium sized subcontracting firms are evolving as globalization and new technologies challenge traditional supply systems in mature industries?

It is critical for industrial buyers who, in order to improve supply chain performance and match sourcing with their business strategies, need to segment their subcontractors and understand how, on top of manufacturing excellence and beyond cost efficiency, their marketing and design capabilities evolve. But it is also critical for subcontractors who, in order to survive, need to avoid strategies based on mere cost competition, enlarge their customer base, offer unique, higher quality products, serve their customers with ever higher degrees of flexibility and engage them in durable relationships.

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The paper is organized as follows. Section two presents a review of the literature on subcontractors’ segmentation and evolution. Section three proposed a subcontractors’ segmentation as resulting from the cluster analysis. Section four illustrates an evolutionary model for subcontractors’ evolution as derived from the multiple case study analysis. Section five discusses our findings’ implications in terms of the resource-based and knowledge-based views of the firm. It also provides managerial insights to industrial buyers on subcontractors’ strategic segmentation and to subcontractors on how to develop design and marketing capabilities.

**THEORETICAL BACKGROUND**

Subcontractors’ strategies, development and role within supply system is a research topic located at the crossroads of a variety of managerial and economic disciplines such as strategic management, operations and supply chain management, organizational design and behaviour and industrial organization.

Two different perspectives have been used in approaching this topic. The first perspective takes a static approach to propose subcontractors’ segmentations on the base of industry, subcontractors’ or relational characteristics. The second perspective takes a dynamic approach to propose evolutionary models of subcontractors and industries where they operate. In the remainder of the section we provide a literature review for each perspective.

**The static perspective: subcontractors’ segmentation**

In purchasing and supply management literature, authors often build on the concept of supplier segmentation based on industry, suppliers’ characteristics or relational characteristics. Generally speaking, the segmentation of suppliers into different tiers of sourcing help to prioritize and
differentiate supply management practices among different suppliers (Dyer, Cho and Chu, 1998; Petroni and Panciroli, 2002).

Kraljic’s (1983) seminal work uses two classification criteria to develop a portfolio model of suppliers. One is the importance of the purchased item, the other is the complexity of the supply market. Out of these two dimensions, he identifies four categories of materials and components: a) non-critical; b) leverage; c) bottleneck; and d) strategic.

Since Kraljic’s (1983) groundbreaking work, a number of studies have developed models of supplier segmentation. For example, Van Weele (2000) builds on Kraljic’s (1983) and Olsen and Ellram’s (1997) models and proposes two dimensions to segment suppliers: a) supplier's impacts on buyer’s financial results; and b) how risky the supplier relation is. He derives four types of suppliers (strategic, leverage, bottleneck and routine suppliers) and associates to them four different sourcing strategies: a) partnership with strategic suppliers (i.e. market leaders, specific know-how, and balance of power may differ among buyers-suppliers); b) competitive bidding - leverage suppliers (i.e. many competitors, commodity products, and a buyer dominated segment); c) securing continuity of supply - bottleneck suppliers (i.e. technology leaders, few - if any - alternative suppliers); and d) systems contracting - routine suppliers (i.e. large supply, many suppliers with dependent position, and a reduction in the number of suppliers).

Studying relational contracts in the Japanese auto industry, Asanuma (1989) identifies three types of suppliers/subcontractors on the base of their involvement in the product development process of the core firm: drawings supplied vendors, drawings approved vendors and marketed goods vendors.

Donaldson (1996) differentiates suppliers as a function of the intensity and complexity of the relationship. He proposes a three level typology: a) personal relationship between buyer’s and
supplier’s representatives; b) structural relationship between the buyer’s purchasing and the supplier’s sales organizations; and c) strategic partnership.

Dyer, Cho and Chu’s (1998) comparative analysis of supplier-automaker relationships in the U.S., Japan and Korea suggests that firms have to think strategically about supplier management and abandon “one-size-fits-all” approaches. Rather, firms should strategically segment suppliers and assess how they contribute to the core competence and competitive advantage of the buying firm.

Bensaou (1999) builds on relational contracting theory and develops a typology based on the nature of the supplier relationship. He uses the specific investments made by buyers and suppliers in the relationship as segmentation criteria, identifying four relationship categories: a) market exchange; b) captive buyer; c) captive supplier; and c) strategic partnership. Within this segmentation he considers suppliers’ technological capabilities as one of the three constituents (along with product characteristics and market characteristics) of the contextual profiles for the management of supplier relations.

Using technology and cooperation as segmenting dimensions, Kaufman et al. (2000) classify suppliers in commodity providers, collaboration specialists, technology specialist, and problem-solvers, and explain performance and structural variation among various types of suppliers.

Masella and Rangone (2000), building on Nydick and Hill (1992) and Narasimhan (1983), develop a supplier segmentation system based on two dimensions: the time frame (i.e. short-term versus long-term) and the content (i.e. logistic versus strategic) of the buyer-supplier relationship. They identify four different types of suppliers, grounding this typology on an analytic hierarchy process framework, on different sets of measures, and on a resource-based view of suppliers’ strategy.
These studies share the belief that, in order to be meaningful and predictive, suppliers’ segmentation ought to rest on criteria related to suppliers’ capabilities (rather than to other suppliers’ characteristics) and should specify the nature of the relationships (rather than of the purchase) to be developed.

**The dynamic perspective: subcontractors’ evolution**

Though the static perspective gives some conceptual and empirical tools that can be used for segmenting subcontractors, it fails to provide an understanding of the dynamics within and between different subcontractors’ segments. Indeed, comparatively fewer studies have focused on the topic of evolution of the subcontractors.

Lamming’s (1993) groundbreaking work on suppliers’ evolution identifies nine factors (e.g. competitive pressure, adoption of information sharing and negotiation practices, supplier integration in new product development and logistics) that need to be considered in the analysis of buyer-supplier relationships. On the basis of these factors he proposes evolutionary patterns that mark the transition from traditional subcontracting to partnership relationships.

Several Italian studies also analyze subcontractors’ evolution, too.

Some of them model the evolution of subcontractors analyzing the characteristics of the relations between them and their main contractors. For example, Zanoni (1991) identifies an evolutionary pattern (from traditional subcontracting into partnership) contingent on the evolution of some characteristics of the supply relationship (i.e. information sharing, technological integration, early supply involvement in new product development).

Some others emphasize knowledge transfer as the main determinant of subcontractors’ evolution. For example, Esposito and lo Storto (1992) first identify four components in the technological
knowledge of a subcontractor: machines (e.g. computerized numerical control (CNC) tools), individual skills (e.g. design, engineering, testing), formal documentation (e.g. drawings, specs) and organizational routines (quality manuals and procedures); then they argue that changes in one or more of these components entail the evolution of the subcontractor. Esposito and Raffa (1994) subsequently develop this point suggesting that several knowledge transfer mechanisms (technical help, on-site support, resident engineers, training, exchange of document/equipment/machines) can induce changes in the equilibrium among the four components of technological knowledge, thus triggering subcontractors’ evolution. Their findings provide evidence that Italian supply systems are moving towards supplier relations characterized by more intense technological knowledge transfer, stronger inter-firm collaboration and increasing subcontractors’ involvement and responsibilities in design. Moreover, they find that, although subcontractors still focus on few customers (on average the first two customers account for 70% of the total sales of the subcontractors), they tend to diversify their customer portfolios leveraging on their growing technological knowledge.

All these studies illustrate how subcontractors evolve and how their relationships with customers change, but do not explain the dynamics underlying these evolutionary processes. They describe the elements involved in the evolution process (the “what” of subcontractors’ evolution) but they do not explain the reason why these elements evolve and what are the interactions occurring among these elements overtime (the “why” of subcontractors’ evolution).

Despite their descriptive nature, these studies provide a fundamental insight: subcontractors’ evolution is driven by a) subcontractors’ capability development (i.e. how subcontractors learn to do better different activities) and b) the nature of the supply relationships in which subcontractors are engaged (i.e. what kind of customers, what they ask, how they manage the relationship).
Providing a synthesis

Our theoretical contribution rests on blending the static and the dynamic perspectives in an attempt to overcome the limits of a mere descriptive approach. Following Olsen and Ellram (1997), we build on the fundamental intuitions provided by the two streams of research briefly reviewed in the previous sections, i.e. that subcontractors’ diversity and evolution derive from the capabilities they are able to develop as well as from the type of buyer-supplier relationships they are into.

In order to do so, first we propose a segmentation of Italian subcontractors, identifying different profiles of subcontractors as a function of their marketing and design capabilities. Indeed, as highlighted in the introductory section, Italian subcontractors lack these capabilities, which are also likely to become even more critical in the future, if they want to survive international competition.

Then, using this segmentation as a starting point, we develop, with the support of an exploratory analysis based on multiple case studies, a model of subcontractors’ evolution that explains how subcontractors evolve, i.e. how transition from one profile to another takes place. This general model highlights a) the capabilities, in addition to design and marketing, that are involved in subcontractors’ evolution, b) the interactions overtime among these capabilities and c) the impact of this interaction on subcontractors’ products/process and customer diversification.

ITALIAN SUBCONTRACTORS’ SEGMENTATION. A CLUSTER ANALYSIS

Data and variables

As part of a broader research project on the evolution of Italian subcontracting relationships conducted in 2003 and 2004, we used an online questionnaire survey to gather a wide array of
data regarding, among other aspects, the marketing and design capabilities of subcontractors located in Friuli-Venezia Giulia, in the North East of Italy. The data source is the Regional Center for Subcontracting of Friuli Venezia Giulia, an agency within the Pordenone Chamber of Commerce.

We gathered data on 417 firms, operating in several industries. Even if the subcontractors involved in the research are located only in the Region of Friuli Venezia Giulia, the dataset is representative of the Italian subcontracting system as a whole. Indeed, a recent research based on a database of 5262 Italian subcontractors located in several Italian Regions shows that our sample is aligned (in terms of size, industry and basic skills distributions) with the characteristics of the whole Italian subcontracting system (this research was conducted by the national center for subcontracting, for more details see www.subfor.net).

In accordance to our theoretical framework, our intent is to provide a segmentation of subcontractors on the basis of their design and marketing capabilities, i.e. to identify clusters of subcontractors that share similar basic marketing and design capabilities profile. Thus, we perform cluster analysis on our data. We keep our analysis as simple as possible, using cluster variables associated with relatively objective and easy to understand research constructs. We then use other variables from our dataset to complement the analysis and better characterize each cluster.

**Construct 1: Marketing capabilities (MC).**

The capabilities included into this category relate to the ability to face growing competition and environmental complexity. As already noted, these capabilities relate to the ability of the subcontractor to monitor the market, to seek and identify new opportunities and market niches, to
develop interactive relationships with its customers and to adopt customer relationship management (CRM) practices. The last two types of capabilities are often indicated as “relational capabilities” in the industrial marketing literature (Hakansson and Snehota, 1995).

Hakansson and Snehota (1995) maintain that marketing capabilities have a positive impact on the subcontractor’s ability to: a) diversify its customers’ portfolio; and b) to internationalize its sales. Thus, we use the degree of diversification of the customers’ portfolio and the degree of internationalization of sales as proxies for marketing capabilities.

More specifically, we use two variables to capture subcontractors’ MC: the degree of diversification of the customers’ portfolio (CPD) and degree of the sales internationalization of the subcontractor (SI).

We use the number of the customers served by each subcontractor during the last fiscal year (the dataset provides the following ranges of customers: 1-2; 3-5; 6-9; 10-19; 20-49; >50) as the measure for the first variable and the percentage of export sales on the total sales as the measure for the second variable.

**Construct 2: Design capabilities (DC).**

Design capabilities (DC) relate to the ability to autonomously develop products/services that meet the client requirements. We use the adoption of computer aided design (CAD) systems as a proxy to measure the design capabilities of the subcontractors. We choose this variable for three reasons strictly connected the peculiarities of the Italian subcontracting system. Firstly, other measures of design capabilities suggested by the literature - such as the presence of appropriate product development systems (Liu and White, 1997; Wynstra et al. 1999; Petroni and Pancioli, 2002) – do not seem appropriate in the case of small and medium sized business like those
included in the analyzed sample (35% of the firms has less than 10 employees and 88.5% of the firms has less than 50 employees). Secondly, the implementation of CAD systems is a clear and unequivocal signal of the presence, in the subcontractor’s organization, of specific design capabilities. Given that only 76% of the subcontractors that claim to have autonomous design capabilities have implemented CAD systems, we believe this variable is a more robust measure of the DC research construct.

**Cluster analysis**

Scholars have used cluster analysis techniques to study phenomena of interest in the management of supplier relations (Bensaou and Venkatraman 1995). The three variables (CPD, SI, DC) used as measures for the two constructs defining subcontractors’ design and marketing capabilities were subjected to cluster analysis using SPSS and the two-step cluster analysis based on the aggregation algorithm proposed by Chiu et al (2001). This procedure has two stages and allows dealing with variables that have different nature (in our case CPD is a ordinal variable, SI is a continuous variable and DC is dichotomous variable). The two-step procedure proposes the number of clusters on the base of a sub-procedure that uses the Bayes Information Criterion and the variation of the distance between the clusters (Ketchen and Shook, 1996). The procedure uses a distance measure based on the log-likelihood function to assign each firm to its cluster. It automatically excluded 33 firms (7.9% of the sample) as outliers that cannot be aggregated to any of the clusters. Table 1 provides a summary of the sample characteristics by industry and size.

Table 1 about here
The procedure identifies 4 clusters. Table 2 summarizes the profile of each cluster, providing some descriptive statistics.

Table 2 approximately here

A-type of subcontractors - Developed subcontractors - (n= 93, 24.2% of the sample). They show the highest percentage of export on total sales (23.7%) with a diversified customers’ portfolio (all the firms have more than 50 customers). Almost all subcontractors (94%) adopt a CAD system.

B-type of subcontractors - Developing subcontractors - (n=77, 20.1% of the sample). They have a lower propensity to export than the developed subcontractors (12.2% is the average percentage of export to total sales) and a less diversified customers’ portfolio (the customer range with the highest frequency is 20-49 with almost 55% of the subcontractors). However, all the developing subcontractors have adopted a CAD system.

C-type of subcontractors - Question mark subcontractors - (n=123, 32% of the sample). These subcontractors do not possess design capabilities (nobody has adopted a CAD system), present a low propensity to export (6.7% is the average percentage of export on total sales) but show a certain degree of diversification of the customer portfolio (20-49 is the customer range with the highest frequency with about 39% of the subcontractors falling into this range). The possible evolution of these subcontractors is unclear. They can evolve toward a more developed stage (developed or developing subcontractors) or return to a less developed stage (traditional subcontractors).

D-type of subcontractors - Traditional subcontractors - (n=91, 23.7% of the sample). They have a low propensity to export (6% is the average percentage of export on total sales), a limited customer portfolio (40.9% of the subcontractors have 1 to 9 customers) and no design capabilities (all the subcontractors do not employ a CAD system).
In order to provide a crisper characterization of the clusters, we also calculate, for each of them, further descriptive statistics on other variables/subcontractors’ characteristics of related interest. These variables and data, presented in Table 3, also come from the online questionnaire survey. They confirm the results of the cluster analysis, providing further evidence of the difference between the first two groups (developed and developing subcontractors) and the other two (question marks and traditional subcontractors).

First of all, the first two types of subcontractors are, on average, larger than the others. This seems to suggest that there are some scale effects involved due either to technological indivisibilities and threshold effects in marketing or, alternatively, to complementarities among these activities (Carlaw, 2004).

Moreover, the average proportion of sales coming from exclusive, customer-dedicated shop floor activities to total sales is smaller for developed and developing subcontractors. For example, the average for this variable is 26% for developed subcontractors, 51% for traditional ones. The presence of exclusive, customer-dedicated shop floor activities is a typical feature of the traditional subcontracting relationship, with subcontractors treated as mere “external” capacity, as buffer against demand fluctuations, as pure contractual extension of the customer manufacturing activities. Developed subcontractors seem to have moved away form this kind of attachment to their customers.

Conversely, the adoption and use of advanced production technologies (APT) such as flexible automation, is significantly higher for developed and developing subcontractors than for traditional and question mark subcontractors. Apart from the obvious manufacturing implications, the adoption of APTs is another proxy of the innovative attitude of developed and
developing subcontractors (Petroni and Panciroli, 2002). Innovative capabilities rest in the interaction between technological and organizational processes and represent a powerful driver for the re-shaping of a firm’s competence base. From this point of view, the adoption of APT is a signal of the capability of the subcontracting firm to face more complex and ever changing competitive environments. Other variables, such as the ownership of patents and proprietary technologies, as well as the fact of having obtained quality certification, confirm the presence of significant differences among the 4 clusters, and suggest that developed and developing subcontractors have developed a wider set of capabilities, valuable in relationships other than traditional subcontracting (manufacturing for a local customer). Indeed, as the rest of the paper will argue, it seems as if these capabilities are rooted in the ability to codify tacit knowledge (Nonaka and Takeuchi, 1995).

Finally, there does not seem to be an “industrial district” effect. The fact that a subcontractor belong to an industrial district is not associated with a specific subcontractors’ cluster. This makes perfect sense since some industrial districts (e.g. the wood chair district) are characterized by a dominant presence of traditional subcontractors while other industrial districts (e.g. the knife district) are characterized by a dominant presence of developed subcontractors.

Summarizing, we identify 4 types of subcontractors, diverse in terms of marketing and design capabilities endowment. Given the fact that what clearly distinguishes the first two clusters from the other two ones is the adoption of CAD systems, the development of design capabilities seems to represent the key factor driving suppliers’ evolution and adaptation. However, it is noteworthy that what distinguishes traditional from question marks subcontractors is the degree of diversification of the customers’ portfolio (one of the two measures of marketing capabilities). This makes us wonder if there is any dynamic relationship between design and marketing
capabilities that would explain subcontractors’ evolution and, more specifically the transition from one type to another. The following sections address this research question and propose a model of subcontractors’ evolution.

ITALIAN SUBCONTRACTORS’ EVOLUTION: AN EXPLORATORY STUDY

Methodology and data collection

Using our cluster analysis as a starting point, we want to assess also some of the dynamics going on in Italian supply systems, exploring typical evolutionary patterns for subcontractors. Thus, we conducted ten case studies of subcontractors chosen from those included in the sample used in the cluster analysis. As usually happens in case study research (Yin, 1984; Eisenhardt, 1989), the choice of the research sample was not random (random or statistical sampling) but theoretical (theoretical sampling). Indeed, we chose subcontractors from different industries that belong to different cluster (i.e. 7 developed subcontractors, 2 developing subcontractors, 1 question mark subcontractor).

As suggested by Ellram (1996) and Voss et al. (2002), we collected information through semi-structured interviews, guided by a common case study protocol built on the review of the literature, and on discussions with several operations managers from the firms involved in the study. For each case study, we interviewed CEOs and top managers. The interviews focused on the evolution process of each subcontractor (from foundation/inception to present time). In particular, we looked at the development of their capabilities, we concentrated on the co-evolution of these capabilities and analyzed the outcomes of such co-evolution in terms of technological and market endeavors. On the whole, we interviewed 18 persons and each
interview took about 2 hours. The interviews were taped and written up. Transcripts were used for the subsequent within-case and cross-case analysis.

Table 4 summarizes the key information about the ten subcontractors of the sample.

Table 4 approximately here

A model of subcontracting evolution

From the cross-analysis of the case studies and after a series of iterative cycles of data gathering (Westbrook, 1995; Coughlan and Coghlan, 2002) it emerged an interpretative framework (figure 1) that explains subcontractors’ evolution (due to space constraints we do not report the longitudinal within-case analysis of each of the subcontractors).

Firstly, the framework identifies the capabilities involved in the evolutionary pattern of a subcontractor. These capabilities are both the design and marketing capabilities, previously used as the base for the cluster analysis, and two other types of capabilities:

- supply management capabilities: the ability of the subcontractor to manage, develop and design its upstream supply network (Fine, 1998);
- knowledge codification capabilities: the ability of the subcontractor to codify tacit knowledge in norms, procedures, processes (Nonaka, Takeuchi, 1995).

Secondly, this framework highlights how the co-evolution between these capabilities impacts on two outputs:

- diversification of products/processes: the extent to which the subcontractors diversifies both its product portfolio (number of products) and processes (types of production processes adopted, types of process technologies implemented);
• diversification of customer portfolio: the extent to which the subcontractors diversifies its customer portfolio (number of customers, number of served industries).

Overall, the framework encompasses six research constructs. The first four constructs concern the subcontractors’ capabilities: a) knowledge codification capabilities; b) supply chain management capabilities; b) design capabilities and c) marketing capabilities. The last two constructs are outcomes of the evolutionary process of the subcontractors’ capabilities: a) diversification of products/processes portfolio; b) diversification of customers’ portfolio.

These research constructs are linked by the set of dynamic relationships sketched in figure 1.

The case studies show that the main driver of subcontractors’ evolution is the codification of at least part of their tacit technical and commercial knowledge. The knowledge codification capabilities refer to the ability of the subcontractor to evolve from a situation of traditional subcontracting, characterized prevalently by tacit knowledge, implicit routines and informal relationships, to a different situation characterized by a certain degree of knowledge codification, and of formalization of processes and inter-organizational relationships. Thus, the availability of knowledge codification capabilities represents a sort of necessary condition on the basis of which a subcontractor can structure the R&D function and introduce a quality system. These decisions, in turn, constitute the ground on which design capabilities are developed (relation 1a). Moreover, knowledge codification capabilities enable the setting up of marketing information systems which support and develop marketing capabilities (market monitoring and searching of new market opportunities (relation 1b)). Knowledge codification capabilities also facilitate the establishment of non passive relationships with main contractors (for example enabling such
cross-firm activities as root cause problem solving, just in time, target costing, total quality management), thus enhancing subcontractors’ relational capabilities (relation 1b).

Finally, knowledge codification capabilities positively impacts on supply management capabilities (relation 1c). As a matter of fact, knowledge codification fosters the establishment of supply partnerships based on technological knowledge transfer practices (Kotabe et al., 2003; Roper and Crone, 2003). It also enhances the subcontractors’ ability to assess and select their suppliers.

The evidence provided by our case studies is also consistent with supply chain management theory (Fine, 1998), which maintains that product architectures and supply chain architectures tend to align. On the one hand, subcontractors’ supply management and design capabilities are strictly interconnected in the analyzed cases (relation 2). Design capabilities allow the subcontractor to autonomously develop its component within a given product’s architecture. They improve the ability to efficiently allocate design tasks within and outside its boundaries. They also support the design process of its upstream partners. On the other hand, supply management capabilities improve the subcontractors’ ability to absorb new knowledge from its suppliers leveraging on good, long-standing and trustworthy relationships (Kotabe et al. 2003).

The case analysis highlights a bi-directional dynamic relationship also between design capabilities and marketing capabilities (relation 3). On the one hand, better design capabilities improve the subcontractor’s ability to approach the market proactively, with more valuable and complete products and services to offer to potential customers. Furthermore, design capabilities are the prerequisite for co-development practices. They improve the subcontractor’s ability to interact with sophisticated customers when these innovate. On the other hand, the development of relational capabilities grants access to (Dyer and Singh, 1998) and facilitate the absorption fo
(Cohen and Levinthal, 1990) technological knowledge from the customer, thus enhancing the subcontractor’s design capabilities.

The co-evolution of market and design capabilities has relevant impact on two outcomes: the diversification of customers’ portfolio and the diversification of products’/processes’ portfolio.

As for the first point, the enhancement of monitoring and searching capabilities leads the subcontractor to enlarge its market horizon, reaching an increasing number of potential customers and overcoming a local market situation that typically characterized a traditional subcontractor. Relational capabilities allow the subcontractor to transform potential customers in actual ones and to successfully manage and maintain the relations. Leveraging on these capabilities, the subcontractor diversifies its customers’ portfolio in terms of number, geographical markets and served industries (relation 4).

As for the second point, design capabilities are the bases of the suppliers’ innovative capabilities (Petroni and Panciroli, 2002) that produce the development of new products and/or processes by the subcontractor (relation 5).

Finally, the case studies suggest a feedback relationship between the diversification of products/processes portfolio and the marketing capabilities (relation 6). Indeed, the development of new products and processes gives more chances to the subcontractors to search for new market niches even in businesses very different from the original ones. Furthermore, more diversified products and processes make the subcontractor more attractive to existing customers thus supporting the development of interfirm collaboration.
DISCUSSION AND CONCLUSIONS

Our analysis has two main empirical results. Firstly, it provides a segmentation of Italian subcontractors on the base of their design and marketing capabilities. Secondly, it proposes a model to understand and predict subcontractors’ evolution. From these results we can derive some important theoretical and managerial implications.

As for the first point, results of the cluster analysis on a sample of 417 subcontractors located in the north east of Italy identify four segments of subcontractors characterized by an increasing endowment of marketing and design capabilities: traditional subcontractors (24.2% of the sample), question mark subcontractors (20.1% of the sample), developing subcontractors (32% of the sample) and developed subcontractors (23.7% of the sample). We qualify each cluster using a set of variables of our database and show that developed and developing subcontractors have more valuable commercial and technological resource endowments than question mark and traditional subcontractors. This supports theory predictions and confirms our understanding of the Italian context: the evolution of the subcontractors is largely determined by the co-evolution of design and marketing capabilities. Moreover, somewhat surprisingly, the fact of being part of an industrial cluster/district seems to be irrelevant for the evolution pattern of the subcontractors.

As for the second point, from a cross-case analysis of ten case studies, and after a series of iterative cycles of data gathering, we develop a general model for subcontractors’ evolution in terms of products/processes diversification and customer portfolio diversification. The model highlights several important aspects of subcontractors’ evolution.

Firstly, the model shows that for the subcontractors’ evolution process to be successful, a wide range of capabilities have to interact dynamically overtime. In particular, from the model it merges that knowledge codification, supply management, design and marketing capabilities are
mutually reinforced and tend to be aligned overtime. For example, a subcontractor cannot achieve excellence in marketing activities and, at the same time, lag behind in terms of design capabilities. On the whole, this result suggests that, in order to understand firm’s competitive advantage, scholars, particularly those that draw on RBV (resource-based view) of the firm, should carry out longitudinal studies to capture how firm’s capabilities interact overtime (Teece et al. 1997; Lorenzoni and Lipparini, 1999), thus creating new knowledge and capabilities, rather than consider them as independent entities (Combs and Ketchen, 1999; Kotabe et al., 2004).

Secondly, supply management capabilities emerge as distinctive capabilities for the subcontractors’ evolution. This is somewhat surprisingly, given the fact that most of the literature on supply networks focuses on the ability of focal or lead firms to deliberately manage their supply networks to create architecture of capabilities located both internally and externally (Lorenzoni and Balden-Fuller, 1995; Lorenzoni and Lipparini, 1999; Dyer and Nobeoka, 2000). We claim that this ability is important also for the subcontractors. Indeed, some developed subcontractors (that we call leading subcontractors) outsource relevant activities to second tier Suppliers and manage a supply network of numerous suppliers at different levels. These subcontractors leverage on the complementary knowledge (Robert and Crone, 2003) of upper tier suppliers and coordinate supply chains where knowledge is fragmented over a variety of actors. In these cases supplier relationships are intense, highly integrated and stable overtime and together realize integral supply chains (Fine, 1998) characterized by a high geographical, organizational, cultural and technological proximity. Other developed subcontractors (that we call modular subcontractors) leverage on the modular architecture of their products and design flexible and modular supply chains that can adapt to different and variable needs of each customer. As argued by Fine (1998), modular supply chains exhibit low proximity among the
chains thus realizing a low but effective integration among customers and suppliers. This low integration allows modular subcontractors to manage a portfolio of supply chains each of which satisfies a particular customer’s need and to design new supply chain architectures if new customers’ needs emerge.

Thirdly, knowledge codification capabilities constitute a sort of logical antecedent and organizational prerequisite for the subcontractor’s evolutionary process to be successful. This finding makes an original contribution to the literature on the strategy for knowledge creation in firms, especially medium and small ones. Indeed, in the knowledge-based view of the firm (Grant, 1996; Kogut and Zander, 1992; Nonaka and Takeuchi, 1995), the relationship between the knowledge-codification capabilities and the creation of new tacit or explicit knowledge has not been sufficiently explored. As our results show, knowledge codification capabilities contribute to the creation on new knowledge in the form of new design, marketing and supply management capabilities. We claim that knowledge codification capabilities foster the creation of new knowledge by enhancing both willingness to share knowledge and understanding among individuals (Un and Cuervo-Cazurra, 2004). Knowledge codification capabilities develop new organizational–level communication routines between individuals at all levels of the organizations thus promoting the transfer of knowledge within and across organizational boundaries. Furthermore they contribute to create a common and available base of knowledge for all the organization thus creating a common code (Arrow, 1974) or a common knowledge (Grant, 1996) that make possible for individuals to understand each other. Following Eisenhardt and Martin (2000), knowledge codification capabilities can be classified as dynamic capabilities in that they are organizational processes by which organizations alter their resource and knowledge base.
The cluster analysis shows that there are a lot of subcontractors (55%) that have underdeveloped design and marketing capabilities. Our evolutionary model tells us that this scarce evolution is due, at the end, to the low level of knowledge codification capabilities of these subcontractors. Thus, we can infer that there exists a sort of inertia of the subcontractors to codify knowledge that continues to be, for a relevant part, individual rather than organizational and tacit rather than explicit. One possible explanation of this could be that the owners of the small firms normally tend to obstruct the processes of formalization of routines, creation of specialized functions and delegation of authority that are associated with knowledge codification processes.

Beyond its managerial and theoretical implications, this study can also be useful in generating further conceptual and empirical research.

First, future research, may propose further segmentations of subcontractors within the same cluster (for example different typologies for developed subcontractors). Second, given the explorative nature of the study, our subcontractors’ evolutionary model emerges from a 10 longitudinal cross-case analysis. Thus, further quantitative research is needed to tested the relationships among the research constructs hypothesised in the model. Third, scholars should develop new indicators to empirically measure the capabilities involved in the model (i.e. marketing, design, supply management and knowledge codification capabilities). Finally, given the importance of knowledge codification capabilities as a particular type of dynamic capabilities, scholars should study the reasons, both internally and externally originated, the lead to the development of the knowledge codification capabilities.
References


Arrow K., 1974, The Limits of Organization, Norton, New York, NY


Lorenzoni G., Balden-Fuller C., Creating a Strategic Center to Manage a Web of Partners, California Management Review, 1995, 37, 3


Table 1: The sample composition: Breakdown by industry and firm size

<table>
<thead>
<tr>
<th>Industry</th>
<th>Subcontractor size (# of employees)</th>
<th>1-9</th>
<th>10-19</th>
<th>20-49</th>
<th>50-99</th>
<th>&lt;100</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronics</td>
<td>#</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>35,3</td>
<td>23,5</td>
<td>23,5</td>
<td>5,9</td>
<td>11,8</td>
<td>100,0</td>
</tr>
<tr>
<td>Mechanics</td>
<td>#</td>
<td>68</td>
<td>56</td>
<td>49</td>
<td>16</td>
<td>10</td>
<td>199</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>34,2</td>
<td>28,1</td>
<td>24,6</td>
<td>8,0</td>
<td>5,0</td>
<td>100,0</td>
</tr>
<tr>
<td>Rubber &amp; Plastics</td>
<td>#</td>
<td>13</td>
<td>9</td>
<td>10</td>
<td>1</td>
<td>4</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>35,1</td>
<td>24,3</td>
<td>27,1</td>
<td>2,7</td>
<td>10,8</td>
<td>100,0</td>
</tr>
<tr>
<td>Furniture</td>
<td>#</td>
<td>33</td>
<td>42</td>
<td>25</td>
<td>5</td>
<td>3</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>30,6</td>
<td>38,9</td>
<td>23,1</td>
<td>4,6</td>
<td>2,8</td>
<td>100,0</td>
</tr>
<tr>
<td>Apparel</td>
<td>#</td>
<td>15</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>75,0</td>
<td>20,0</td>
<td>0,0</td>
<td>5,0</td>
<td>0,0</td>
<td>100,0</td>
</tr>
<tr>
<td>Textiles</td>
<td>#</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>38,4</td>
<td>23,1</td>
<td>23,1</td>
<td>7,7</td>
<td>100,0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>#</td>
<td>140</td>
<td>118</td>
<td>91</td>
<td>25</td>
<td>20</td>
<td>394</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>35,5</td>
<td>29,9</td>
<td>23,1</td>
<td>6,4</td>
<td>5,1</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Table 2: Cluster Analysis Summary: clusters’ size and descriptive statistics for the discriminating variables (SI, CPD, DC)

<table>
<thead>
<tr>
<th>Clusters</th>
<th>% Export on total sales (SI)</th>
<th>Number of customers (CPD) (mode and %)</th>
<th>CAD system (DC) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (n=93)</td>
<td>23,7</td>
<td>50 or more (100,0)</td>
<td>Yes (94,9)</td>
</tr>
<tr>
<td>B (n=77)</td>
<td>12,2</td>
<td>20-49 (54,7)</td>
<td>Yes (100,0)</td>
</tr>
<tr>
<td>C (n=123)</td>
<td>6,7</td>
<td>20-49 (38,9)</td>
<td>No (100,0)</td>
</tr>
<tr>
<td>D (n=91)</td>
<td>6,0</td>
<td>1 - 9 (40,7)</td>
<td>No (100,0)</td>
</tr>
</tbody>
</table>

Table 3: clusters’ profiles

<table>
<thead>
<tr>
<th>Clusters</th>
<th>Modal size (%)</th>
<th>% sales from shop floor activities</th>
<th>APT (%)</th>
<th>Patents</th>
<th>Proprietary technology</th>
<th>Certified Quality</th>
<th>Industrial District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed subcontractors</td>
<td>20-49 (36%)</td>
<td>26%</td>
<td>30 (32%)</td>
<td>14 (15%)</td>
<td>36 (39%)</td>
<td>31 (33%)</td>
<td>20 (22%)</td>
</tr>
<tr>
<td>Developing subcontractors</td>
<td>20-49 (26%)</td>
<td>36%</td>
<td>23 (30%)</td>
<td>10 (13%)</td>
<td>22 (29%)</td>
<td>24 (31%)</td>
<td>9 (10%)</td>
</tr>
<tr>
<td>Question mark subcontractors</td>
<td>10-19 (41%)</td>
<td>47%</td>
<td>20 (16%)</td>
<td>5 (4%)</td>
<td>16 (13%)</td>
<td>17 (13%)</td>
<td>35 (38%)</td>
</tr>
<tr>
<td>Traditional subcontractors</td>
<td>1-9 (39%)</td>
<td>51%</td>
<td>10 (11%)</td>
<td>5 (5%)</td>
<td>15 (16%)</td>
<td>7 (8%)</td>
<td>28 (30%)</td>
</tr>
</tbody>
</table>
Table 4: The case studies

<table>
<thead>
<tr>
<th>Firm</th>
<th>Stage of evolution</th>
<th>Funded</th>
<th>Industry</th>
<th>Sales (mil €)</th>
<th>Emp</th>
<th>Product lines</th>
<th>CAD</th>
<th>N° cust.</th>
<th>% of export</th>
<th>Cert. of quality</th>
<th>APT</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Developed</td>
<td>1979</td>
<td>Furniture</td>
<td>4,994</td>
<td>150</td>
<td>Components Subcontracted and branded final products</td>
<td>Yes</td>
<td>&gt;100</td>
<td>20%</td>
<td>ISO 9001 FSC</td>
<td>Automated handling (AH); FMS; CNC; CAM</td>
</tr>
<tr>
<td>12</td>
<td>Question mark</td>
<td>1956</td>
<td>Furniture</td>
<td>7,105</td>
<td>88</td>
<td>Components Subassemblies</td>
<td>No</td>
<td>&gt;150</td>
<td>5%</td>
<td>No</td>
<td>FMS; Automated handling; CNC</td>
</tr>
<tr>
<td>13</td>
<td>Developed</td>
<td>1972</td>
<td>Mec.</td>
<td>40,762</td>
<td>351</td>
<td>Components Sub-assemblies Production Equipment</td>
<td>Yes</td>
<td>20</td>
<td>70%</td>
<td>-</td>
<td>FMS; EDI; ERP</td>
</tr>
<tr>
<td>14</td>
<td>Developed</td>
<td>1990</td>
<td>Mec.</td>
<td>4,573</td>
<td>50</td>
<td>Components Production Equipment</td>
<td>Yes</td>
<td>&gt;200</td>
<td>10%</td>
<td>No</td>
<td>FMS; CNC; CAM</td>
</tr>
<tr>
<td>15</td>
<td>Developed</td>
<td>1978</td>
<td>Mec.</td>
<td>2,861</td>
<td>80</td>
<td>Mechanical components Sub-assemblies</td>
<td>Yes</td>
<td>300</td>
<td>75%</td>
<td>-</td>
<td>EDI; AH; FMS; DNC; CAM</td>
</tr>
<tr>
<td>16</td>
<td>Developed</td>
<td>1985</td>
<td>Mec.</td>
<td>4,132</td>
<td>37</td>
<td>Mech. shop activities Subcontracted final products</td>
<td>Yes</td>
<td>&gt;100</td>
<td>15%</td>
<td>-</td>
<td>EDI; AH; FMS; CNC; CAM</td>
</tr>
<tr>
<td>17</td>
<td>Developed</td>
<td>1952</td>
<td>Mec.</td>
<td>4</td>
<td>35</td>
<td>Industrial taps and fittings</td>
<td>Yes</td>
<td>&gt;500</td>
<td>50%</td>
<td>-</td>
<td>EDI; CNC</td>
</tr>
<tr>
<td>18</td>
<td>Developing</td>
<td>1980</td>
<td>Plastics</td>
<td>1,70</td>
<td>40</td>
<td>Engineering services Dies Components Branded final products</td>
<td>Yes</td>
<td>100</td>
<td>5%</td>
<td>ISO 9001</td>
<td>EDI; CAM; Robots; Moldflow</td>
</tr>
<tr>
<td>19</td>
<td>Developed</td>
<td>1950</td>
<td>Rubber</td>
<td>19,192</td>
<td>440</td>
<td>Rubbery components of different types</td>
<td>Yes</td>
<td>&gt;100</td>
<td>55%</td>
<td>ISO 9001</td>
<td>FMS; CNC; CAM</td>
</tr>
<tr>
<td>110</td>
<td>Developed</td>
<td>1969</td>
<td>Plastic</td>
<td>44,802</td>
<td>130</td>
<td>Components Branded final products</td>
<td>Yes</td>
<td>&gt;50</td>
<td>25%</td>
<td>ISO 9001</td>
<td>FMS; CNC; CAM</td>
</tr>
</tbody>
</table>
Figure 1: A model of subcontractors’ evolution