THE OUTSOURCING OF INNOVATION ACTIVITIES IN SUPPLY CHAINS WITH HIGH-INTENSITY OF RESEARCH AND DEVELOPMENT

• Luigi Cantone
  FProfessor of Strategic Management and Marketing, Department of Management, Faculty of Economics
  University of Naples Federico II, Italy

• Pierpaolo Testa
  PhD, Department of Management, Faculty of Economics
  University of Naples Federico II, Italy

Summary: Introduction. 1. Outsourcing of innovation activities: the theoretical framework. 2. The supply chain of civilian aeronautic industry and outsourcing relationships. 3. The Boeing 787 Dreamliner project. 4. Conclusions, managerial implications and limits of the research.

ABSTRACT
The purpose of the paper has been to analyze how the outsourcing relationships are considered to be a source of innovation in industries which are characterized by an high-intensity of research and development activities and the innovation product process involves extended networked supply chains. The general aim of the paper is to explain, even through some conceptual models, “why” and “how” the interconnected system of outsourcing relationships take place in industries where the innovation product processes involve networked supply chains, characterized by an high intensity of innovation and knowledge. The main managerial implications which rise from the study are the following: the choices to outsource product innovation activities may have theoretical roots both in the transaction cost economics theory (cost-based) and in the stream of evolutionary theories resources-based, that is: Resource-based Theory (RbT), Competence-based Competitive Theory (CbCT), Knowledge-based Theory (KbT), Dynamic Capability Theory (DCT); the outsourcing has a strategic role to improve own innovation capabilities and knowledge base, integrate it with complementary capabilities of the external partners, absorb new competencies from the market, create new capabilities and knowledge when technological and markets needs changes occur on the market. This has a particular importance in the industries where the product innovation (R& D) activities are technologically complex, deployed into a global supply chain of suppliers, and require a continuous innovation. This paper recognizes the first findings of a ongoing research project focused on the outsourcing relationships into the aeronautical industry.

KEY WORDS  strategic outsourcing | outsourcing of innovation (R& D) activities | partnership outsourcing | collaboration for innovation activities | buyer-seller relationships | supply chain management.
Introduction

In recent years, the outsourcing has rapidly spread in the business world, affecting several activities of the firms’ value chain, not only operational ones, but strategic ones, too. This latter kind of outsourcing, in literature, has been defined strategic outsourcing (Quinn, 2000; Quinn, Hilmer, 1994, 1995; Alexander, 1996; Bryce, Useem, 1998; Baden-Fuller, Hunt, 2000; Baden-Fuller et alii, 2000; Arnold, 2000) because it involves activities or processes which are critical for the competitive advantage and the future growth of the firms.

In the past, the outsourcing decision making was identified with the term “make or buy”, and was based, prevalently, even if not exclusively, on economic convenience evaluations about the price-cost. Under this point of view, the importance of the cost economies for the outsourcing decisions may find its theoretical roots in the cost transaction economies theory, based on the seminal ideas of Coase (1937) and Commons (1931, 1934) and, later, developed by Williamson (1991).

Since early '90 years, several studies and researches have pointed out the role of strategic conditions and factors (not cost-based) which affect the outsourcing decisions. In fact, in a strategic perspective, the decision making process of an outsourcee firm puts in evidence non only the effects in terms of costs, but the impact that it has in terms of extending and integrating own resources, competencies and knowledge base, too. The outsourcing, therefore, has to be interpreted in accordance to the evolutionary theories, diffused since '80 years, such as Resource-based Theory (RbT), Competence-based Competition Theory (CbCT), Knowledge based Theory (KbT), Dynamic Capability Theory (DCT), of which we’ll argue more deeply later on. In accordance to the epistemological view of these theories, the assumption is the following: the outsourcing involves activities whose a firm haven’t got capabilities or haven’t relevance for the competitive advantage, innovation potentiality and future growth. Therefore, the boundaries of the firm’s value chain have to be defined into the set of the activities in which are embedded the distinctive competencies of the company, namely, the set of skills and knowledge that generate unique value for the customers, are exclusive source of competitive advantage, make up the base for the future innovation.

The increasing of the efficiency through the cost reduction and accessing to the new resources and capabilities to extend the competitive potential of the firm aren’t alternative objective in the outsourcing decision. There are situations for which the outsourcing decisions are aimed prevalently,
if not exclusively, to obtain scale economies that specialized external organizations (outsourcées) are able to realize with a huge reduction of the unitary product cost. For example, in aeronautic industry, the outsourcing of components and parts incorporating a simple or mature technology, and having technical features fundamentally quantitative, has this kind of purpose. At the same way, there are circumstances for which the cost reductions hasn’t any relevance because the aim of the outsourcing decisions is strategic, namely, to access to unique and specific competencies of external and specialized organizations. This is the case, for example, of the designing and manufacturing of a new family of advanced long-range mid-size “efficient” aircrafts, with a innovative fuselage completely in carbon fiber and some parts in titanium: the Boeing 787 Dreamliner. In fact, Boeing Company, the project owner of this innovative aircraft, has outsourced a substantial share of research and development activities of this innovative aircraft, such as the relative manufacturing activities, to a global network of suppliers (160 partners located in several countries: Japan, China, Sweden, Australia, USA, Italy, France, South Korea). About 70% of the activities – both of research and development and of manufacturing – has been outsourced to these global network of suppliers. It was the hugest outsourcing project in the history of Boeing Company and aeronautic industry. The motivations have been several: not only reducing the cost of project’s development and sharing the risks of the relative investments, but, fundamentally, accessing to technology and innovation capabilities of a specialized global network of suppliers, in particular for the new materials technologies (titanium, carbon fibers for the airframe structures), to shorten the time to market, increase the flexibility and the quality of the new product development process. The Boeing 787 Dreamliner case puts in evidence that the stimuli and argumentations of Cost Transaction Economics Theory can be synergistically integrated with resources theories ones to explain the outsourcing choices of product innovation activities (or R&D activities).

Many companies have redefined the business model working with an extensive use of outsourcing strategies. This phenomenon has, increasingly, involved activities of the value chain with high-intensity of technology innovation (R&D activities) and industries with global and high technology supply chains. In accordance with this trend, the outsourcing is considered to be an important potential source of innovation because it permits to access to specialized technological capabilities of external organizations and sustain more effectively and efficiently (i.e.: reducing development costs, shortening time to market, improving the flexibility, improving the
quality of the innovation) the research and development activities for the new product development (Carson, 2007; Engardio et alii 2005; Quinn, 2000; Howells 1999, Narula, 1999).

The increasing use of the outsourcing for the reconfiguration of the strategic business processes is related to some general trends: speed of technological changes; diffusion of the hyper competition in a wider set of industries (i.e.: automobiles, aerospace, computers, telecommunications, pharmaceutical, biotechnology, chemicals); increasing role of intangible assets, such as the cooperative inter-firms relationships, which play a strategic role for the innovation, creating and managing the competitive advantage of the firms in the actual and future markets (Capaldo, 1999; Doz, Hamel, 1998; Dyer, Singh, 1998; Hagedoorn, 1993, 1995); diffusion of the digital technologies (information and communication technologies) which permit the development of relationships in virtual environments, too (Prandelli, Verona, Raccagni, 2006; Sawney, Prandelli, 2000); the opportunity of the firms to focus its attention on the own core competencies, capabilities and knowledge base; the technology innovation, in many industries, is carried out by multiples technologies which can’t be governed by just a single firm, but by a variety of organizations operating inside of the value constellation of the industry (suppliers, intermediaries, competitors, customers, etc.) and outside of it (i.e: universities, other research organizations).


Therefore, in the perspective of the firm as an open system - characterized
by heterogeneous resources, protected by \textit{ex post} and \textit{ex ante} limits to competition, and imperfectly mobile (Peteraf, 1993) - the corporate strategy should be aimed to enhance and dynamically renew the internal capabilities of the firm, and, on the other side, use the outsourcing to increase the potential of value creation through the access to capabilities or other intellectual property of the external organizations which the company would not otherwise have access. These external capabilities, integrated with internal ones, may improve the reliability, productivity, quality, efficiency, and the costs in the long-term.

This managerial approach is particularly effective in industries living an high-intensity of product innovation carried out by several organizations of the business system competing downstream or upstream to the supply chain: automobiles, aeronautics (Amesse, Dragoste, Nollet, Ponce, 2001), pharmaceuticals (Piachaud, 2002), biotechnology (Powell, 1998; Powell, Koput, Smith-Doerr, 1996; Pisano, 1991), information and communication technology, chemical, aerospace. Generally, these firms' innovation networks are located in specific regional context, creating regional innovation systems, clusters and industrial districts which permit to exploit the advantages of the proximity (Marshall, 1920; Boshma, 2005; Brackzyk, Cooke, Heindenreich, 1998; Cohen, Levinthal, 1990, Etzkowitz, Leydendorff, 2000; Etzkowitz, 1997; Lundvall, 1992; Malmberg et alii, 1997; Maskell, Malberg, 1999; Porter, 1990; Becattini, 1979). For example, the aerospace industry has several most dynamic aerospace clusters in the world, located in Montreal, Seattle, Toulouse, Toronto, Sao Paulo, Hamburg, Munich (Niosi, Zhegu, 2005).

Therefore, the outsourcing strategy in the supply chain with high-intensity of technology innovation can improve the value creation process – for the customers and for the firms – because this strategic choice permits to integrate complementary competencies and knowledge and, consequently, to extend the innovation capabilities, decrease the risks, the costs and the time to market of product innovation process, increasing the quality of the performance.

The synergic combination of internal and external resources, competencies and knowledge is one of the motives that explains the increasing diffusion of the collaborative outsourcing relationships aimed to product innovation. The innovation-based outsourcing sets off the importance of the relational capabilities of the outsourcee firm - the “strategic center” of an innovative value constellation (Lorenzoni, Baden-Fuller, 1995) - to create, manage and develop the relationships with the network of the firms inside the supply chain, and to learn, absorb (Cohen, Levinthal, 1990) and integrate
(Grant, 1996) complementary resources, competencies and knowledge, im-
perfectly imitable, mobile, reproducible and substitutable.
The outsourcing of product innovation activities (namely, R&D activities),
based on a dense network of collaborative relationships, generates several
benefits both for outsourcee and for outsourcer. More specifically:
1. the shared investments are focused on the resources and capabilities
   of each firm, optimizing the relative returns;
2. the access to the base of complementary resources of independent and
   specialized outsourcers of the business system, such as suppliers, cus-
   tomers, competitors, complementors and substitutes;
3. the opportunity that among more organizations of the business system
   can develop distinctive relational advantages, originating by inter-firms
   collaborative relationships for the product technology innovation
   (Hagedoorn, 1993, 1995, 2002; Hagedoorn, Schakenraad, 1994; Doz,
   Hamel, 1999; Dyer, Singh, 1998; Freeman, 1991; Howells, 1999; How-
   ells, James, 2001; Lipparini, 1995, 1998; Lorenzoni, 1992; Lorenzoni,
   Baden-Fuller, 1995; Lorenzoni, Lipparini, 1999; Capaldo 1999; Das,
   Teng, 2000) in different forms, such as partnership, alliances, joint ven-
   tures, accords (Roberts, Berry, 1985);
4. the opportunity to absorb and transfer capabilities and tacit knowledge,
   imperfectly transferable (Capaldo 2004; Cohen, Levinthal, 1989, 1990);
5. the creation of new knowledge and competencies useful to carry out
   product innovation, not realizable just leveraging the internal capabil-
   ities of any single firm of supply chain (Capaldo, 2004);
6. the risk sharing of idiosyncratic investments;
7. the improvement of the flexibility inside of the supply chain;
8. the increasing of the efficiency with a decreasing of the costs.
That said, the aim of this paper is to analyze the role of the outsourcing
decisions in supply chain characterized by: a. an high-intensity of product
innovation; b. the product is technological complex, namely, it is the result
of the convergence of several and specific technologies that are developed
and supplied by more organizations operating along the supply chain; c.
a relative dispersion of the activities across nations that made up over the
time regional agglomerations such as regional innovation systems, clusters
and industrial districts which permit to exploit Mashallian externalities
(Marshall, 1920)as either economies of specialization, labor market
economies (based on the local human capital pool) and/or knowledge
spillovers.
As we said above, many industries have this structural and competitive
profile. In this paper the focus is on the aeronautic industry. The supply
value chain of the industry, as it will be better deepen in the following, is configured, to give just a simplified picture, in four main blocks, articulated in a typical pyramidal configuration (Niosi, Zhengu, 2005; Amesse, Dragoste, Nollet, Ponce, 2001).

First of all, at the top of the pyramid operate the so called System Integrators/Original Equipment Manufacturers (OEMs) - such as Boeing and Airbus in the market of large civilian aircrafts, Bombardier, Embraer, Alenia Aeronautica for regional jets - who carry out the design and the final assembly of the aircrafts. These firms manage the relationships with the customers (relationships capabilities), exploit the new market’s opportunities (sense making capabilities), define the product concept of new aircraft (innovation capabilities), define the design of the whole aircraft (design capabilities), coordinate the activities of prime contractors positioned at the second tier of the aeronautic pyramid (project management and leadership capabilities), assemble the whole aircraft with the parts designed and/or manufactured by the prime contractors (engineering capabilities of assembling).

At the second tier of the pyramid operate the so called prime contractors (or small primes), companies which design and/or manufacture complex parts and subassemblies of an aircraft. These firms of the supply chain have the technological and organizational capabilities to design and manufacture parts and subassemblies (wings, parts of fuselage, avionics, etc.).

At third tier of the pyramid works a concentrated number at global level of the subcontractors, generally small and medium firms, that supply single components or parts. Just a few number of these subcontractors have technological capabilities that permit them to collaborate with the prime contractors to designing activities for the development of parts and components to assemble in new aircrafts.

The role of the four general tiers, such as the relationships among them, will be explained in details later on. Now is useful say that among the several firms of the aeronautic supply chain there are hierarchical-collaborative relationships, top-down like.

That said, this paper focus the attention on outsourcing relationships supply chain-level of the aeronautical industry. The industry case has been arranged through a review of the literature and specialized publications (Polese, Proietti, 2007; Fontana, Caroli, 2004; Pepe, 2007; Pritchard, Pherson, 2005; Gates, 2006; Carson, 2009; Vittachi, 2003; 2007; Webber, 2009), and collecting information on the web-site of primary companies (Boeing, Airbus, Embraer, Bombardier). The considerations about the outsourcing relationships industry-level have been developed relatively to the
Boeing 787 Dreamliner project, namely, the first aircraft whose airframe structures are completely manufactured in carbon fiber composite to improve the efficiency of the aircraft’s performance and the relative manufacturing process. We believe that this aeronautical program has innovated the outsourcing relationship into the supply chain of the aeronautic industry.

The paper recognizes the first findings of an ongoing research project; in the next future the aim will be to extend the case study approach at firm-level, and to analyze the outsourcing relationships of a sample of the firms operating at the first three tiers of worldwide supply chain, always relatively to B787 Dreamliner program. At the moment, we have completed the interviews with managers of Alenia Aeronautica SpA e Dema SpA involved on B787 Dreamliner program; also, we have gathered information about Boeing Co. and the outsourcing strategy carried out for the B787 program.

1. Outsourcing of innovation activities: the theoretical framework

Innovation has always been one of the main forces driving the long-term competitive advantage and growth of the firms. The effect that it can generate in terms of “creative destruction” (Shum peter, 1994, pp. 81-85), its ability to profoundly redefine the rules of competition are undoubted importance to renew, even radically, the ways to create value, for customers and companies.

The meaning of innovation recognized in this paper is relative to research and development activities for the new products development.

Over time, the outsourcing of innovation (or R&D) activities have been analyzed in literature under different points of view, such as: organization and control mechanisms employed by the outsource to increase the productivity of R&D activities outsourced at outsourcer firm and protect the intellectual property (Carson, 2007); strategic and economic logics underlying the choice (Quinn, 2000; Narula, 1999); contractual actual models (Grossman, Helpman, 2005, 2003, 2002; Hagedoorn, Hesen, 2007); affects on the innovation performance (Ren, Wang, Wu, Zhang, 2007); problematic of technology transferring between outsourcee and outsourcer (Amesse, Dragoste, Nollet, Ponce, 2001); networks of learning (Powell, Koput, Smith-Doerr, 1996; Powell, 1998; Pisano, 1991; Hagedoorn, 1993, 1995; Hagedoorn, Schakenraad, 1994)

The product innovation activities, until recently, were carried out internally by the same companies. This internal choice had several reasons: 1. the strategic importance of product innovation for the long-term competitive
advantage and the growth of the firm; 2. the need to control the core technologies and intellectual property, and reduce as much as the risks of knowledge and competencies spillovers; 3. the difficulties and the high costs of coordinating external business partners (suppliers, competitors, customers) involved in the product innovation activities; 4. the difficulties to share tacit knowledge, critical factor in the collaborative relationships for the technology innovation; 5. difficulties of arrange formal contracts and monitoring the subcontractors.

In recent years, however, the managerial orientation of innovation activities is changed. This kind of outsourcing is increased because it permits to reduce the costs and the risks (risk sharing) of R&D projects, access to new and complementary resources, competencies and knowledge (tacit and explicit) of external organizations, shorten the time to market of new product development.

In other words, the collaborative outsourcing relationships along the supply chains are an effective strategic option in high-intensive innovation industries. One of interesting cases of outsourcing of R&D, with an increasing diffusion, is that of the Contract (or Clinical) Research Organizations (CROs) for the drug development in the pharmaceutical industry. The outsourcing of R&D activities at CROs has changed profoundly the traditional process of drug development in the pharmaceutical companies. “CROs provide product development services to the pharmaceutical and biotechnological industries, allowing to the clients (pharmaceutical and biotechnological firms) to manage more efficiently and cost-effectively the R&D efforts. The CROs market size, in the year 2007, is estimated at $17.5 billion and growing. Revenue is increasing at an annual rate of 14-16 percent ..... clinical trials conducted by CROs are completed in average of 30 percent more quickly than those conducted in-house. This results in an average time savings of some four to five months, translating to $120 million to $150 million in increased revenue potential”(ACRO-Association of Clinical Research Organization web-site)

As we said before, the theoretical approach of this paper is founded on the perspective that the outsourcing of innovation (R&D) activities for new product development has to be analyzed in accordance to two firm’s theories: Transaction-Cost Economies Theory (TCE); Resource-based Theory (RbT) and all the other theories which have the epistemological roots in it, such as Competence-based Competitive Theory (CbCT), Knowledge-based Theory (KbT), Dynamic Capability Theory (DCT).

In accordance with TCE, the fundamental competitive aim of the firm, in the hypothesis of an existing low differentiation among market’s competi-
tors, is minimizing of the transaction costs, namely, the sum of the internal production costs and governance of transactions ones. According to this theoretical approach, the decisions to outsource product innovation (R&D) activities aim to carry out this cost-based objective. Therefore, the choices to outsource these activities have to consider the structure and the interaction of the production and transaction costs. This decision isn’t always an effective and efficient choice when the market prices (buying on the market of innovation activities by external operators through price mechanisms) are lower than internal development costs of innovation, because the economies originating from the differences between internal costs and market prices could be less than the increasing of the transactions’ governance costs.

That said, in accordance with the principles of TCE, we argue that the outsourcing of product innovation activities is preferable to insourcing when this strategic choice determines a reduction of cumulated cost of production and transaction, such as the risks related to that decision (quality, time, knowledge spillovers, information leakage, etc.) are low. In the perspective of the outsourcee firm, then, the risks of the outsourcing decisions for technology innovation activities are low, and consequently are low the transaction costs, when: a. the uncertainty around the innovation relationship is low; b. the frequency of transaction is low; c. the investments in specific assets are low; d. don’t exist, or are not much relevant, the information asymmetries.

TCE is an useful theoretical framework to explain the outsourcing decisions of technology innovation (R&D) activities; therefore, it has several limits to explain theoretically and extensively this strategic choice. These limits rise by some assumptions of the same theory: 1. first of all, the firm is considered as a contracts’ portfolio rather than a portfolio of resources, competencies and knowledge, continuously improved, renewed and integrated, through the work of company’s external organizations, too. Under this point of view, the TCE isn’t able to recognize the connections between outsourcing of product innovation activities and the dynamic growth of firm’s capabilities portfolio; 2. the focus is based on transactions as isolated episodes. There aren’t commitments or constraints for the decisions of transactions governance originating from the path dependency; 3. the hypothesis of absolute rationality of economic agents isn’t completely rejected. In fact, it’s recognized when the theory asserts that for any transaction the firm choices the governance structure minimizing the sum of production and transaction costs; 4. it’s asserted that the switching costs related to the choices of transactions’ governance – insourcing (hi-
erarchy), length’s arm outsourcing relationships (market), intermediate structures (collaborative outsourcing relationships) – can completely be determined ex ante, during the phase of negotiation and decision making (confirming the acceptance of the absolute rationality hypothesis). However, just a part of these costs can be foreseen and defined before relationship takes place. A substantial part of them could emerge just during the outsourcing relationship; 5. the horizontal relationships among interconnected firm’s activities aren’t recognized. The existence of synergies among activities increase the difficulties to separate interconnected activities, except with costs very high. In the outsourcing of technology innovation a great role have the intangible interrelations among the value chain’s activities. The horizontal interrelations put in evidence the connections in the firm’s value chain that originate by the sharing of intangible resources (know how, technological and managerial capabilities); these connections carry out learning processes by interaction, co-specialized and generally tacit, among the members of the organization. The existence of horizontal interrelations limits the opportunities to outsource technology innovation activities; 6. even if are considered hybrid structure for the transactions’ governance (positioned between hierarchy and market structures), aren’t sufficiently explored alternative strategies to reduce the risk of outsourcing when the transactions require high specific and idiosyncratic investments, as are the R&D investments for the new products development.

TCE, even though puts in evidence the limits above described for the comprehension of the outsourcing of product innovation activities, can be an useful approach if integrated with the theoretical suggestions of the Resource-based Theory (RBT) and by the other evolutionary theories that in it have the epistemological roots and are an its evolution: Competence-based Competitive Theory (CbCT); Knowledge-based Theory (KBT); Dynamic Capability Theory (DCT).

In the RBT perspective the outsourcing of product innovation activities originates from the need of the firm, under the pressure of competitive end environmental changes, to access to new resources, complementary, heterogeneous, imperfectly imitable, mobile, reproducible and substitutable. This situation could induce the firm to create relationships with external organizations of the supply chain and the business system (suppliers, customers, competitors, substitute, complementors) that have these kind of resources.

The CbCT, instead, puts in evidence the role of distinctive competencies to create and develop the firm’s competitive advantage. “Core competen-
cies are the collective learning in organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies.” In accordance with this definition of Prahalad and Hamel (1990) and with the principles of CbCT, the outsourcing of innovation activities permit to access to the stream of complementary technological competencies for the new product development which a single firm couldn’t have interest to have or be able to develop internally.

The KbT, instead, sees the firm as a portfolio of individual and organizational knowledge. In the KbT’s perspective, the outsourcing relationships – but more in general, the inter-firms relationships – are a way to extend and integrate the base of technological knowledge indispensable for product technology innovation. In other words, to nurture and renew the product innovation potentiality, the firm accesses to complementary knowledge of external organizations through the creation of knowledge links or knowledge networks.

The DCT, finally, recognizes that the firm, to survive in hypercompetitive context, must dynamically modify and renew the own organizational set of capabilities. In some circumstances – for example, when the time to explore new strategic technological capabilities is too long and/or the investments are highly risky – the innovation or integration or extension of the firm’s capabilities portfolio may require necessarily the collaboration of capability-holders external to the organizational boundaries.

To understand the outsourcing of product innovation activities, the evolutionary theories of the firm and TCE have to be integrate. The TCE argumentations focus on a cost-based and short-time perspective; the theories of resources (RBT, CbCT, KbT, DCT), instead, have a strategic and long-time perspective. The integration of these two approaches, in our idea, permits to define a conceptual model to better interpret the outsourcing decisions of product innovation (R&D) activities.

In conclusion, the integrative perspective of the theoretical approaches above described (TCE, RbT, CbCT, KbT, DCT), the decision making process about the outsourcing relationships of product innovation activities aimed to obtain the following objectives: 1. reducing the costs of innovation development and the transactions costs relatively to an insourcing decision; 2. reducing the fixed costs of the investments in R&D activities; 3. improvement of the strategic and operational flexibility; 4. focus on investments in innovation activities which make up the core competencies and knowledge for the competitive advantage and the future growth of the firm; 5. creating relationships for the innovation with external organization on activities for which the firm hasn’t, actually, distinctive or superior tech-
nological capabilities, and hasn’t ability or interest to reproduce internally them in the future; 6. accessing to the innovation resources, competencies and knowledge of the external outsourcer to strengthen or renew the innovation capabilities base of the outsourcee (competence leveraging strategy); 7. learning new competencies around technology innovation by interacting with external organizations (competencies learning strategy); 8. absorbing new capabilities around innovation developing collaborative relationships with best in class outsourcers; 9. co-creating new knowledge for the development of new products-markets through alliances with outsourcers (competence building strategy).

2. The supply chain of civilian aeronautic industry and outsourcing relationships

The civilian aeronautic industry is hierarchically organized in four main tiers, in the form of a pyramid (Niosi, Zhedu, 2005; Amesse, Dragoste, Nollet, Ponce, 2001; Cantone et alii, 2007). At the top of the pyramid are positioned the so called OEMs-Original Equipment Manufacturers, such as Airbus, Boeing for large commercial jets, Embraer, Bombadier, Alenia Aeronautica, for regional jet.

First of all, at the top of the pyramid operate the so called Original Equipment Manufacturers (OEMs) - such as Boeing and Airbus in the market of large commercial jets, and Bombadier, Embraer, Alenia Aeronautica for regional jets - who carry out the design and the final assembly of the aircrafts. These firms perform the role of system integrators; more specifically, they manage the relationships with the customers (relationships capabilities) and the marketing activities, exploit the new market’s opportunities (sense making capabilities), define the product concept of new aircrafts (innovation capabilities), define the design of the whole aircraft and prototype it (design capabilities), coordinate the activities of the prime contractors positioned at the second tier of the aeronautic pyramid (project management and leadership capabilities), assemble the whole aircrafts with the parts designed and/or manufactured by the prime contractors (engineering capabilities for assembling). Relatively to the airframe structures and subassemblies, in years past, the OEMs defined standards and technical specifications of production for the prime contractors suppliers, who make the subassemblies in their care (operational outsourcing). In recent years, however, the prime contractors are directly involved in the design of airframe structure (for example, part of fuselage, wings) and/or subassemblies (for example, landing gears), too; in addition, they assume
the market risk (of any new aircraft through a mechanism of risk sharing (risk sharing partnership). In other words, each prime contractor acquires a share of the aircraft’s value, reflecting the cost of airframe structure/sub-assembly that itself will design and manufacture. The possible returns on investment, therefore, will proportionally take place with the sales of the aircraft to the customers (airlines). The collaborative relationships among integrators/OEMs and prime contractors is based on the following guidelines: sharing of innovation activities; risk, cost and profit sharing of innovative projects for the new product development; co-design of the products with engagement of inter-firm teams; common commitment of the partners to lower costs and enhance profitability. The collaboration on innovation activities between system integrators/OEMs and prime contractors is particularly intense and strong in the case of development of new aircrafts (B787 Dreamliner of Boeing, Airbus 380 of EADS Airbus, for example).

The system integrators/OEMs outsource part of innovation activities for two fundamental motives: 1. the innovation activities aren’t strategic and have a low strategic risks (for example, risk of knowledge and capabilities spillovers). In this case the OEMs have as aim to reduce the costs, enhance profits and flexibility of the innovation projects; 2. lack of technology capabilities and knowledge for innovation development. In this case the aim of OEMs is to integrate and/or absorb complementary and indispensable technology capabilities of suppliers to carry out innovation development programs. Not infrequently, the choice of prime contractors is affected by so called off-set strategies. In other words, have signed agreements with countries that require the provision of aircrafts against the involvement of national suppliers into the designing and/or manufacturing activities of parts, subassemblies or components. For example, the Chinese Government has required to Boeing to carry out part of the activities of the new 787 in China against substantial orders of 787 by Chinese airlines.

At the second tier of the pyramid operate the so called prime contractors (or small primes), companies which design and manufacture airframe structures, subassemblies, propulsion systems, on-board avionics of an aircraft. These firms of the supply chain have the technological and organizational capabilities to design and manufacture these complex parts of an aircraft. The prime contractors are medium-large global players but smaller than OEMs. They are the primary interlocutors of OEMs and, as we have already told, they assume the risk of the innovation project by sharing a portion of the costs of new aircrafts’ development. Actually, some of the principal prime contractors who have relationships with Boeing, for example, are
Alenia Aeronautica, Mitsubishi Heavy Industries, Dasa, Latecore, Kawasaki Heavy Industries, Rolls-Royce, General Electric, Pratt & Whitney.

The prime contractors, in recent years, participate directly to the development of innovation activities, the design and manufacturing of new aircrafts. They have assumed the role of strategic partner of OEMs because have developed internally over the time specific technology innovation capabilities. Therefore, the outsourcing relationships are of long-time and based on a collaborative approach. The prime contractors, moreover, coordinate, as “small primes”, the relationships and the activities of all other subcontractors operating downward of the supply chain (tier 3). This subcontractors are called supplier of “second level”, too, because they haven’t direct relationships with OEMs, but just with the prime contractors. In fact, the prime contractors can’t carry out alone all the manufacturing activities of new orders by OEMs, neither can assume all the risks of the new innovative projects. The subcontractors are specialized in the manufacturing of parts, components or subassemblies. Generally, the prime contractors define standards and technical specifications of production to suppliers of the “second level” subcontractors, who make the subassemblies in their care (operational outsourcing). Some subcontractors, with specific technological and organizational capabilities, can collaborate to the development and design of parts and subassemblies of new aircrafts, under the coordination of prime contractor (outsourcing of innovation activities). These suppliers, in some cases, have direct relationships with OEMs both on innovation-based activities and operational ones. Of course the number of subcontractors with these innovation capabilities is very narrow.

At the fourth tier operate a wide number of small suppliers (“third level” suppliers) that manufacture in outsourcing components or parts technologically not complex, generally, assembled by firms of tier 2 and 3 (operational outsourcing).

In several countries, the aeronautic supply chain make up spatial agglomerations such us regional innovation systems, clusters, industrial districts which permit to exploit the advantages of the proximity (Marshall, 1920; Boshma, 2005; Brackzyk, Cooke, Heidenreich, 1998; Cohen, Levinthal, 1990, Etzkowitz, Leydesdorff, 2000; Etzkowitz, 1997; Lundvall, 1992; Malmberg, 1997; Maskell, Malberg, 1999; Porter, 1990; Becattini, 1979).

The aerospace industry has several most dynamic aerospace clusters over the world, located, to give just some example, in Montreal, Seattle, Toulouse, Toronto, Sao Paulo, Hamburg, Munich (Niosi, Zhegu, 2005). In Italy there are some important regional poles such as in Piemonte, Campania, Puglia, Lazio. Alenia Aeronautica takes place the role of “central”
firm with own specialized plants in Piemonte (Turin, Caselle), Campania (Pomigliano d’Arco, Nola, Casoria), Puglia (Foggia, Grottaglie-Taranto). Each plant is a competence centre on a specific set of aeronautic activities. The headquarter of Alenia Aeronautica is in Rome. It has the full control (100%) of some subsidiaries: Officine Aeronavali (plants in Tessera-Venice, Brindisi and Naples-Capodichino, for overhaul & maintenance activities), Alenia SIA (plant in Turin), Aermacchi (plant in Venegono-Varese for training production, integration and testing naselling activities), Galileo Avionica (plant in Nerviano-Milan), Alenia Inc.

As we have put in evidence above, the outsourcing relationships in the aeronautic supply chain – both innovation-based ones and operational ones – are hierarchically collaborative, top-down like. The role of prime contractors is very important because they are business partners of innovative projects toward the OEMs (System Integrator), upward of the pyramid. The role of co-partner is increased during the last 10-15 years. They, also, take place a strategic role because involve, coordinate and manage the innovative and operational activities of a numerous small and medium supplier operating downward of supply chain (the suppliers of “second” and “third” level). These prime contractors have the innovation capabilities to develop and manufacture internally own civilian aircraft. This is the case of Alenia Aeronautica who is OEM, in collaboration with EADS France, for the regional aircraft ATR.

3. The Boeing 787 Dreamliner Project

The Boeing 787 Dreamliner is a wide-body, two-engines, highly fuel efficient commercial aircraft designed and assembled by Boeing Company. It is made out of lightweight and highly durable composite incorporating advanced aluminium alloys and the conventional design sports sweptback wings with two pylon-mounted engines. This aircraft is the first over the world to have the fuselage made entirely in carbon fibre and some part in titanium too reinforce the aero structure.

The development of the program began in the 2003 with the name “7E7”. The first roll-out of the aircraft was scheduled in July 8th 2007 (“787”), but probably it will take place in December 2009, with two years of delay. Another peculiar characteristic of the project is that the design and/or manufacturing of the aircraft are outsourced for the 70 percent of the aircraft’s cost to a numerous global network of suppliers. In the past, Boeing has always outsourced the production of parts, components, subassemblies of aero structures, transferring to the involved suppliers all the technical standards
and specifications. With the new B787 project Boeing has modified own outsourcing approach assuming the role of supervisor of activities realized by the global network of prime contractors. Boeing, however, continues to manage the final assembling, in the Everett (USA) plant, of the several sub-assemblies, parts and components manufactured by the suppliers. The principal prime contactors involved on B787 program are: Saab (Sweden), Mitsubishi Heavy Industries (Japan), Fuji Heavy Industries (Japan), Kawasaki Heavy Industries (Japan), Alenia Aeronautica (Italy), Rolls-Royce (United Kingdom), Messier-Dowty (United Kingdom), Goodrich (USA), Spirit (USA), Dasa, Latecore France, General Electric (USA), Pratt & Whitney (USA), Kal-ASD (South Korea).

Boeing has maintained internally the core competence of aerodynamic and engineering of assembling. Mitsubishi Heavy Industries Ltd designs and manufactures the more innovative part of the aircraft: the wings. It has developed a new composite material and incurred in huge investment in R&D. The Japanese suppliers are emergent players into the aeronautic industry; the entry of these firms in the market could break the dominance of western firms on airframe structures as exclusive prime contractors of OEMs as Boeing. The development of supplying market in Japan has been sustained by the same Boeing. In fact, Boeing Company has been committed, in the recent years, to transfer technology knowledge and other critical competencies to the Japanese firms, through global sourcing and system integrator policies. The Japanese firm have been financed with specific funds by the Japanese Government for the growth of competencies of the Japanese firms in the field of the aeronautic design and production. Alenia Aeronautica designs and produces in outsourcing the central fuselage and the horizontal stabilizer of the 787. It has role of prime contractor and share with Boeing the risk of the project (risk sharing partner). Alenia Aeronautica, in its turn, outsources part of the production of components to subcontractors (tier 3 of the supply chain) and suppliers of “third level” (tier 4), assuming the role of main contractor toward Boeing. Generally the outsourcing concerns operational activities; just a few number of subcontractors– with strong and specialized technological capabilities – are involved by Alenia Aeronautica into the co-design of components and parts to subassembly. The relationships between Alenia Aeronautica and aeronautical subcontractors are based on hierarchical-cooperative governance mechanisms, too.

Both Japanese firms and Alenia Aeronautica design and supply critical aero structures of the 787 for which they have an excellent base of capabilities and knowledge. The outsourcing of the manufacturing and/or design of
innovative components to specialized subcontractors permit to Alenia Aeronautica to reduce the costs and improve the quality of product. What are the advantages and disadvantages of these outsourcing strategy of Boeing? The advantages are the following: access to the market; access to complementary competencies and knowledge; improvement of the time to market; decreasing of the costs; risk sharing partnership; decreasing of the investments and relative risks. The disadvantages might be: spillovers of competencies and knowledge; strategic vulnerability by the suppliers; strategic risk of inefficient and ineffective performance of suppliers. However, the outsourcing relationships with prime contractors for the activities of 787 are based on contractual accords which provide the sharing of the risks and benefits related to the project. Another way to manage the outsourcing relationship with prime contractors is the creation of joint ventures. Boeing adopts outsourcing strategies (off-set strategies) based on the stipulation of “compensation” contracts, too. These contracts provide the transferring of technologies, competencies and knowledge to the prime contractors of a foreign country by Boeing against the buying of aircrafts by the airlines of the same foreign country.

4. Conclusions, managerial implications and limits of the research

The purpose of the paper has been to analyze how the outsourcing relationships are considered to be a source of innovation in industries which are characterized by an high-intensity of research and development activities and the innovation product process involves extended networked supply chains. The general aim of the paper is to explain, even through some conceptual models, “why” and “how” the interconnected system of outsourcing relationships take place in industries where the innovation product processes involve networked supply chains, characterized by an high intensity of innovation and knowledge. The main managerial implications which rise from the study are the following: 1. the choices to outsource product innovation activities may have theoretical roots both in the transaction cost economics theory (cost-based) and in the stream of evolutionary theories resources-based, that is: Resource-based Theory (RbT), Competence-based Competitive Theory (CbCT), Knowledge-based Theory (KbT), Dynamic Capability Theory (DCT); 2. the outsourcing has a strategic role to improve own innovation capabilities and knowledge base, integrate it with complementary capabilities of the external partners, absorb new competencies from the market, create new capabilities and knowledge when technological and markets needs
changes occur on the market. This has a particular importance in the industries where the product innovation (R&D) activities are technologically complex, deployed into a global supply chain of suppliers, and require a continuous innovation; 3. relatively to aeronautic supply chain, the inter-firm outsourcing relationships are based on the following guidelines: sharing of innovation activities; risk, cost and profit sharing of innovative projects for the new product development; co-design of the products with engagement of inter-firm teams; common commitment of the partners to lower costs and enhance profitability. The inter-firm collaboration on innovation activities is particularly intense and strong in the case of development of new aircrafts. The system integrators/OEMs outsource part of innovation activities for two fundamental motives: the innovation activities aren’t strategic and have a low strategic risks (for example, risk of knowledge and capabilities spillovers). In this case the OEMs have as aim to reduce the costs, enhance profits and flexibility of the innovation projects; lack of technology capabilities and knowledge for innovation development. In this case the aim of OEMs is to integrate and/or absorb complementary and indispensable technology capabilities of suppliers to carry out innovation development programs.

This paper recognizes the first findings of a ongoing research project. The empirical analysis are based on the aeronautic industry case; also, the considerations have been developed relatively to a product innovation project, namely, Boeing 787 Dreamliner aircraft, that has changed the outsourcing relationships in the worldwide aeronautical supply chain. These are even the limits of argumentations argued in the paper. Therefore, in the next future the aim will be to extend the case study approach at firm-level, and to analyze the outsourcing relationships of a sample of the firms operating at the first three tiers of worldwide supply chain, always relatively to B787 Dreamliner program. At the moment, we have completed the interviews with managers of Alenia Aeronautica SpA e Dema SpA involved on B787 Dreamliner program; also, we have gathered information about Boeing Co. and the outsourcing strategy carried out for the B787 program.

REFERENCES


Commons J.R. (1934), Institutional Economics, University of Wisconsin Press, Madison.


Directorate General, Science, Research and Development.


Fontana P., Caroli M. (2004), Aviation Business. Strategie competitive e modello di sviluppo, Roma, RIREA.


Lundvall B. (1992) (edited by), National systems of innovation: toward a theory of Innovation and Interactive Learning, Pinter Publisher, London.


