MultiCraft

International Journal of Engineering, Science and Technology
Vol. 2, No. 6, 2010, pp. 244-255

INTERNATIONAL JOURNAL OF ENGINEERING, SCIENCE AND TECHNOLOGY

www.ijest-ng.com

Open innovation and supply chain management in food machinery supply chain: a case study

Barbara Bigliardi[1], Eleonora Bottani[1*] & Francesco Galati[2]

[1] Department of Industrial Engineering, University of Parma, Viale G.P.Usberti 181/A – 43124 Parma, ITALY
[2] Department of Economy and Technology, University of San Marino, Strada della Bandirola 44 – 47898 Montegiardino, SAN MARINO
[*]Corresponding Author: phone +39 0521 905872; fax +39 0521 905705; eleonora.bottani@unipr.it

Abstract

Supply chains continue to growth in complexity, including numerous echelons and numerous players per echelon. Consequently, a company needs to integrate its activities with suppliers and customers, in order to survive. Innovation is a typical example of activity that a company should share with suppliers and customers. In particular, over the last few years, a specific concept of "*open innovation*" has been paving the way in the innovation management field. This paradigm describes a new approach to internal R&D management, which assumes that firms can and should use external ideas and internal ones, as well as internal and external paths to market, as they look to advance their technology. The aim of this paper is to provide insights toward open innovation practices in a specific supply chain, the food machinery one, moved by the consideration that there is little empirical evidence of open innovation strategies within this context. By means of case studies and semi-structured interviews, we examine a three-echelon supply chain, thus providing a picture of the adoption of open innovation in the food machinery industry. Results show that the actors that more adopt this new paradigm are manufacturer and customer, although all the three actors investigated agreed in defining the benefits derived from innovation and open innovation mechanisms. From this study, theoretical and practical implications can be derived and transferred to the whole food machinery industry.

Keywords: supply chain, integration, food machinery industry, open innovation, case study.

1. Introduction

Innovation has always been viewed as a process that takes place within the boundaries of a company. In the past years, the way firms innovate has changed: innovation is no longer limited to the realm of the firm, and it has, in many industries, moved from a closed to an open process (Chesbrough, 2003a). This notion of "open innovation" was first proposed by Chesbrough (2003a, b), and has quickly gained the interest of both researchers and practitioners (Elmquist *et al*., 2009), as a new way of thinking of innovation. Applying the concept of open innovation, firms explicitly cooperate with others actors, including customers, rivals, academics and firms in unrelated industries, to create innovations. The premise at the basis of the open innovation paradigm is that all the knowledge necessary for creating innovations is no longer present within the firms' boundaries; consequently, a company needs to acquire knowledge from other sources (West and Gallagher, 2006). Open innovation may be defined as "*the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively*" (Chesbrough *et al.*, 2006). This paradigm, considering Research and Development (R&D) as an open systems, assumes that valuable ideas can come from inside as well as outside the firm, and can be taken to market through external channels, from inside or outside the company. The literature on this matter identifies different antecedents to open innovation; Von Hippel (1988), in particular, identifies in his work four external sources of knowledge, namely: suppliers and customers, university, government and private laboratories, competitors, and other nations. In the today's fast-changing environment, many companies are thus building strong supply chain partnerships with business partners, such as manufacturers, distributors, suppliers, and customers.

Modern supply chains consist of numerous organizations. In the context of the food machinery industry, the supply chain starts with suppliers, who provide components and semi-finished goods to a manufacturer, which manufactures production plants and

equipments, and sells them to a customer. This latter, as an example, could be a food processing company or a beverage bottling company. In turn, it could deliver packaged foods to a retailer or distribution centre. Recently, the complexity of food supply chains has also been exacerbated by the need of including multiple external sources of knowledge when searching for successful new products and technologies. This process reflects the difficulties of a food industry in single-handedly meeting the heterogeneous (and sometimes contradicting) needs of customers, end-users and legislations (Sarkar and Costa, 2008). Managing the end-customer's demand in the food industry requires a kind of product development that involves developing, or adopting, innovative technological solutions and new business models (Costa *et al*., 2001; 2007). As products and services continue to grow in complexity, much potentially useful knowledge will necessarily reside outside of the firm (Bercovitz and Feldman, 2007). The establishment and management of relationships with customers, competitors, suppliers, and public/private research institutions, with the aim of acquiring additional knowledge and skills for innovation processes, are increasingly seen as an important way for the food industry to augment its innovation capability (Gatignon *et al.*, 2002; Hauser *et al.*, 2006). Consequently, open innovation mechanisms are increasingly being observed in the contexts of food and food machinery industry (e.g., Huston and Sakkab, 2006; Thomke and Von Hippel, 2002). Given the increasing number of players and relationships with customers and suppliers, an important challenge of supply chain management (SCM) is to manage the whole chain in an integrated way (Cooper *et al.*, 1997). It is commonly accepted that poorly integrated manufacturing processes, non-integrated manufacturing or distribution processes, poorly managed relationships with suppliers and customers are inadequate for the success of a supply chain (Chang and Makatsoris, 2001). Similar considerations hold for open innovation mechanisms: due to the wide number of players involved in the development of innovative products, innovation activities must be carefully coordinated. Hence, cross-boundary innovation management has become a widespread practice in supply chains and networks operating in several different contexts, and in the food industry in particular (Sarkar and Costa, 2008).

This paper provides insights toward open innovation practices in the food machinery supply chain, a context where there is still little empirical evidence of open innovation strategies (Knudsen, 2007). Specifically, by means of case studies and semi-structured interviews, we examine a three-echelon supply chain, including a food plant manufacturer, a supplier and a customer. We try to answer the following research questions:

i. how is open innovation perceived in the food machinery industry?
ii. what is the expected impact of open innovation on the performance of the food machinery supply chain?
iii. which is the role of suppliers and customers for developing new and innovative products?

The paper is organized as follows. Section 2 provides the necessary background as regards the topics highlighted by the research questions above. In the following section, we provide an overview of the food machinery field, so as to clarify the rationale behind the choice of this context. Section 4 details the research methodology adopted in this study. Results of the case studies are presented in section 5, together with a summary of findings. Section 6 concludes and provides an overview of possible future research activities.

2. Literature review

2.1 Role of suppliers and customers for innovation

Collaborative innovation has been receiving a growing attention in the technical literature, with global competition and technological change pointed out as the main drivers of this approach. There are several mechanisms for developing collaborations among supply chain partners, but the most frequent one is the progressive integration of key suppliers in partnerships; this involves a serious commitment among partners in terms of shared competitive attitude (Bertodo, 1991; Clark, 1989). According to Handfield *et al.*, (1999), the integration of suppliers in collaborative innovations (in particular, product innovation) can yield some significant benefits, which include achieving reduced cost at product development, decreased risk of failure and reduced time spent in product development. Liker *et al.* (1995) also demonstrated that the involvement of first-tier suppliers in co-design activities has positive impacts on the performance achieved in new product development, in terms of cost, quality and lead times. The partnership with suppliers may range from a simple search for new technologies and innovations, up to a collaboration where suppliers are fully responsible for the design of products required by the customer. More precisely, there are four main ways suppliers can be involved in collaborative product innovations (Lamming, 1993):

i. the supplier provides proprietary parts to a company. Often, proprietary parts are standard components and are designed and developed only by the supplier;
ii. the supplier provides components whose functional and performance requirements are specified by the customer, but whose engineering is handled by the supplier;
iii. the supplier provides parts whose characteristics are controlled and defined by the customer to a greater extent; or
iv. the supplier provides parts whose characteristics are controlled and defined entirely by the customer.

Clearly, scenarios (i) and (iv) do not properly describe collaborative innovations, as the role of suppliers is either completely passive (scenario (iv)) or the supplier is the sole responsible for the product manufactured (scenario (i)); conversely, scenarios (ii) and (iii) are good examples of open innovation and co-design mechanisms. Moreira, (2005), addresses the main key factors that make the supplier-producer relationship well succeeded in the supply chain, in the context of Portuguese companies. Through an exploratory study involving 4 companies, he found that the most critical aspect in the development of any technological innovation is the suppliers' capacity in developing R&D competencies.

Focusing on studies referring to food and food machinery fields, Sarkar and Costa (2008) reviews three examples of open innovation in that context, two of which refer to the case of launch of new product and the remaining one to the design of new food flavor. Two out of three examples mentioned fall in the category of supplier-producer collaboration, while the third one required developing a more complex network of inter-relationships, including seed companies, farmers, packers, consumers and legislators (Vanhaverbeke and Cloodt, 2006). From the works described it emerges that there is a relevant body of literature describing the role of supplier-producer collaboration in innovation; however, as the analysis if often limited to two echelons, the role of other supply chain players is rarely investigated. Specifically, the role of customers for innovation is often neglected. In this study, we examine a whole supply chain with the purpose of investigating the role of all players in open innovation practices.

2.2 Impact of innovation on supply chain performance

Nowadays, innovation is at the top of managers agendas, and is considered a key element of business success (Bigliardi and Dormio, 2008). Innovation is unavoidable for companies in order to develop a competitive advantage and maintain it (Khazanchi *et al.*, 2007; Stock *et al.*, 2002). Recent studies have suggested that a company in order to develop successful innovation, regardless the industry it belongs to, rely on the interaction with external actors (Chesbrough, 2003a; Laursen and Salter, 2006), such as the customers (Gruner and Homburg, 2000; Thomke and Von Hippel, 2002) as well as the suppliers (Song and Di Benedetto, 2008; Wagner, 2003). At the same way, a large amount of studies in the innovation and supply chain management domains recently underscores the way in which customers' and supplier's innovations allow them to achieve high performance (Kim *et al.*,2006; Ulrich and Ellison, 2005). Central to this theme is the need for firms to look outside of their organizations for opportunities to collaborate and coordinate with partners to ensure that their supply chains both efficient and responsive to dynamic market needs.

The expected benefits of collaborative innovation on supply chain players are well described in literature. Egger and Egger, (2006) argue that delegating more responsibilities to suppliers leads to benefits for the manufacturer, which can better focus on their core competencies, thus improving their internal performance. Moreover, collaborative innovation allows leveraging the expertise and know-how of partners (Lemke *et al.*, 2003). Azadegan and Dooley, (2010), also provide empirical evidence that the innovativeness of supplier has positive impacts on several performance of the manufacturer, in terms of cost, quality, product development, flexibility and delivery. Conversely, there are few studies which provide useful indicators for assessing the performance resulting from collaborative innovation. Moreira (2005) evaluates the supplier-customer collaborations on the basis of 14 indicators, ranging from the presence of collaborative experiences to the type of relationships. Shokri et al., (2010) emphasize the impact of the supplier development on reducing the defects in supplier quality for a food distribution SME. The authors conducted an empirical study to measure the performance of the suppliers against three key performance indicators of the outsourcing and supplier's performance. As a result, they found that supplier development through data and information exchange and better communication by any food distribution SME raises the problems more promptly. Angerhofer and Angelides (2006) and Gaiardelli *et al.* (2007) propose metrics for assessing the impact of supply chain collaboration on the overall performance of the supply chain; the latter authors particularly focus on performance metrics for after sale service. More recently, comprehensive performance measurement frameworks for collaboration mechanisms were proposed by Kim *et al.*, (2010), and Papakiriakopoulos and Pramatari (2010). Other studies (e.g., Gunasekaran et al., 2004; Thakkar et al., 2009; Bigliardi and Bottani, 2010) propose general performance measurements that can be used in the context of supply chain management and for SMEs in particular. In this study, the indicators available in literature will be exploited (or adapted) to assess the key aspects of innovation mechanisms described in section 5.

3. The food machinery framework

The Italian food machinery industry stands among the most important sectors of the whole metalworking industry (11% of the total) and employs about 18,000 workers, with a turnover of about 3,500 million Euros and an export of about 60 to 80% of the overall production. According to data, 60% of the 700 businesses operating in this sector are exporters, with an approximate 65% share of export on turnover. The industry can claim a high degree of excellence in terms of technological innovation and quality of products and services, but it can also play the role of solution provider for its customers. Thanks to these features of excellence, the Italian industry of machinery for the food sector has become a world leader, thanks most of all to the progress made in planning, building and implementing techniques, not to mention the continuing process of technological innovation.

The choice for selecting such a sector is, first of all, motivated by the fact that research and development for new technological solutions for the processing of food products is extremely active and dynamic. Food machinery manufacturers place a great attention to innovation, as they are always focused on improving customers' return on investment through innovative designs of machinery and equipments. Moreover, the supply chain of food products and food manufacturing has received a great deal of attention in the last decade, due to issues related to public health; this motivated a further shift toward innovation. As mentioned earlier in this paper, the food machinery industry is also a field where open innovation mechanisms are increasingly being embraced by companies, since the supply, development and commercialization of new technologies often involves collaboration between other entities (e.g., public research institutions, end-users or suppliers). At the same time, however, empirical studies on this topic are still limited, and would benefit from additional insights.

Finally, the local industry of Parma (Italy) region mainly encompasses companies directly operating in the food and food machinery industry, or related to this field, and offering a wide variety of products both in the areas of first- and second-stage

processing and all featuring a noteworthy specialization in production techniques and high-quality finished products. Complete food processing systems, designed and produced in Parma, are installed throughout the world, particularly for mass production of canned tomatoes and sauces, vegetables in general, regular and exotic fruit, juices, preserves, beverages, canned meats and fish, and pasta. Not by accident the province of Parma is known as Italy's "Food Valley". As an indication of the importance, it should be pointed out that the food industry represents the 35% of the total of industrial sectors, reaching a turnover of 6,500 million € out of a total of 19,200 million € (Unione Parmense degli Industriali, 2007).

4. Research methodology

To answer the aforementioned research questions, a three-step research strategy has been adopted (see Figure 1), as described below.

Step 1 consists in a review of scientific bibliography, aimed at analyzing the main dimensions of open innovation, as well as to investigate deeply the industry selected, with the purpose of highlighting its main characteristics. This phase was performed by academics of the University of Parma.

Step 2 of the research was the development of a questionnaire for the analysis of open innovation practices. The questionnaire translated the main dimensions of open innovation in the context of the food machinery field and operationalized the concept in the industry selected, taking into account the peculiarities of innovation activities undertaken by food machinery companies. A panel study involving 10 people (R&D managers of food machinery companies as well as academics and consultants with a significant experience in the field of open innovation) was organized following the recommendations by Yin (2003). We perform two rounds of interviews with such managers, to accomplish the following main tasks: first, to distinguish the phases of the innovation process within the specific supply chain, as well as to discuss the reasons for the choice of open innovation models by the actors of the same supply chain, on the basis of the characteristics of the industry previously identified; second, to understand how open innovation is expected to impact on the supply chain as a whole.

As a result of this phase, we derived a theoretical framework for the analysis of open innovation for the context investigated. Specifically, the panel members agreed on the content of a four-page questionnaire, to be used for the following case studies, structured into four basic sections as follows:

- Section1 (*general information*): the aim of this section was to collect general information on the company, such as location, size (in term both of number of employees and turnover), industry, product developed, and so on. Moreover, the budget for R&D activities and a general definition of innovation for the company was required in Section 1;
- Section 2 (*relationships with the customer*): the purpose of this section was to collect information about the type, intensity and peculiarities of the relationships with the customer. In particular, questions within this section aimed at identifying the importance the company assigns to its customer, its specific features, the customization or investments required to meet the customer's requirements, as well as its involvement in the innovation process;
- Section3 (*relationships with the supplier*): this section aimed at collecting information similar to those required in the previous section, but referred to the relationships with the supplier. Moreover, questions about the performance level of the suppliers and its innovativeness were included in Section 3;
- Section 4 (*open innovation issues*): this section aimed at identifying a definition of open innovation, generally accepted by all the actors that belong to the supply chain under examination, as well as the way each company implements open innovation practices, and the impact that the adoption of an open innovation model has on the performance of each company and of the supply chain as a whole. Moreover, respondents were asked to provide the description of an innovation project developed together with the customer or supplier, in order to collect the personal judgments and opinions about this experience.

During *step 3*, a multiple case study was conducted, in order to test the framework resulting from the previous step into a supply chain. In this step, we exploited the framework developed through an in-field investigation, which involved a food machinery supply chain. Specifically, data was collected using semi-structured interviews, that were recorded and transcribed, and that involved the R&D managers of an industrial plant manufacturer for the food industry, located in Parma, together with one supplier and one customer of the company. One or two R&D managers for each company investigated were involved in this phase.

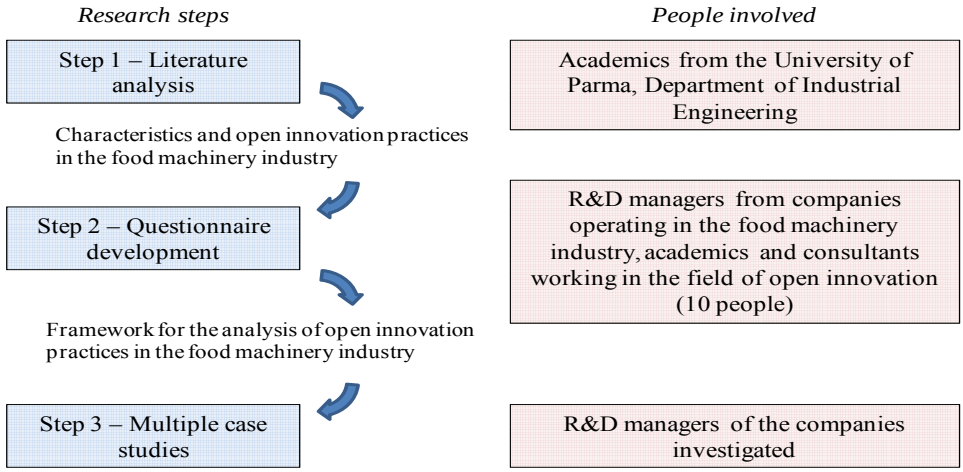

Figure 1: Steps followed in the research

5. Open innovation trends in the food machinery supply chain

5.1 The supply chain investigated

The three echelon supply chain analyzed, composed of a food plant manufacturer, together with its main customer and supplier, is schematically represented in Figure 2. As required by the companies interviewed, we cannot disclose company names; from now on, they will be referred to as *Manufacturer*, *Supplier*, and *Customer*. The companies selected are all considered top innovators in their industries, and are thus appropriate for this study.

As regards the scheme of the interview described in section 4, the food plant manufacturer was asked to answer to all the four sections of the questionnaire, while *Customer* and *Supplier* were asked to answer only Section 3 and 2 respectively, besides sections 1 and 4 (cf. Figure 2). As for the latter, the food plants manufacturer answered whether he/she was collaborating with his/her supplier and with his/her customer, while the supplier and customer answered related to their collaboration with their food plants manufacturer.

As previously mentioned, the focus of the interviews was on the identification of the innovation processes undertaken by the firms involved in the study. This was complemented by other issues, such as the way the supplier and customer companies are involved by the plant manufacturer, the phase of the innovation process where their involvement is crucial, as well as the phases where the plant manufacturer involves other actors, and so on. Moreover, the final part of the interviews was experience-oriented, that is it focused on the experiences and perceptions of the interviewees (e.g., on success or failure factors, strengths and weaknesses of the open innovation practices).

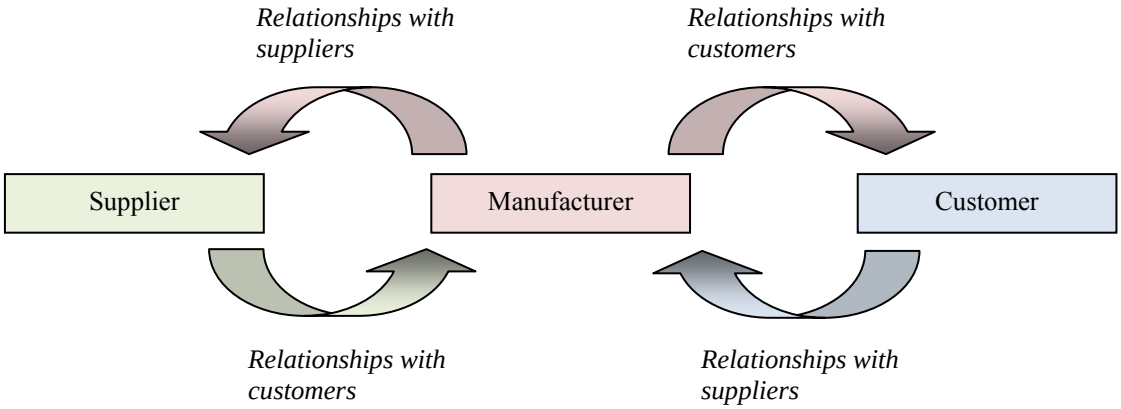

Figure 2: The supply chain investigated (Note: *italics* = relationships investigated in the case study).

5.1 The Manufacturer

The *Manufacturer* was investigated through a site visit on January 2010. During the visit, we also answered the questionnaire by means of semi-structured interviews with two representatives of the R&D area. *Manufacturer* was established in the area of Parma in 1979, and started its activity manufacturing conveyors and packaging equipments for the food industry. According to the specification of the European Commission (2003), it is currently a big company (more than 80 million Euros aggregate turnover in 2007), operating in the field of beverage bottling plants; since 1990, it offers complete bottling lines to numerous customers about

all over the world. As the company expanded its activity and the range of products offered over the years, R&D activities and innovation have always played a crucial role for Manufacturer. According to the head of R&D area, *Manufacturer* perceives "innovation" as any activities not directly related to the company core business, which allows the company to increase its sales volume, reduce its costs or increase competitiveness. Consequently, the company invests about 1.5% of the annual turnover in R&D activities, which are particularly focused on product and process innovations, with a clear orientation on industrial processes.

Given the kind of product, the manufacturing activity of the company are managed on an engineering-to-order basis; hence, once the order is received from a customer, *Manufacturer* starts the design and development of the bottling plant, and contacts the suppliers for purchasing the required equipments, components and semi-finished goods. In this regard, it should be mentioned that *Manufacturer* interacts with two different kinds of suppliers. Numerous suppliers provide standard components (e.g., electrical parts) to *Manufacturer*; hence, according to the scheme proposed in section 2.1, they fall into the collaboration mechanism described by the category (i), which does not properly indicate a collaborative innovation. Such suppliers were thus neglected in the analysis, which was focused on the second group of suppliers; this latter encompasses medium- or big-sized companies which collaborate with suppliers in the design and development of specific components for the beverage bottling lines (i.e., category (iii) of the collaboration mechanism). This is also the case of the *Supplier* described in section 5.2. As supplier selection criteria, *Manufacturer* primarily evaluates the reliability and technical performance of the supplier, which are critical to ensure high performance of the bottling lines manufactured; compared to such criteria, the relevance of cost and other economical aspects is significantly lower. Suppliers of critical components are always involved in the product development, starting from the design stage. The supplier is informed about the technical characteristics of the component, the performance required by the customer and some other aspects, relevant for designing and manufacturing the component (e.g., size or capacity of the bottling plant). The same collaboration mechanism is followed when the supplier is involved by the *Manufacturer* in the development of new technical solutions, which are often protected by means of patents.

As far as the relationships with the customer are concerned, most of the customers of *Manufacturer* are multinational big-sized companies, with significant bargaining power; such customers require high performance bottling plants, and this is why they actively participate in the last phases of the product development, i.e. assembling and testing activities of the plant. Conversely, the customer is rarely involved in the design and development of the product, and in innovation as well. According to the *Manufacturer*, this choice is motivated by the fact that directly involving the customer in the design of the bottling plant could lead to excessive customization of the product; rather, the strategy of *Manufacturer* is to "adapt" the products manufactured to meet the requests of customers, avoiding customizations. Nonetheless, *Manufacturer* has developed specific research activities collaboration with both *Supplier* and *Customer*; some examples will be described in sections 5.2-5.3 respectively.

Finally, as regards the open innovation issues, we have already mentioned that suppliers are usually involved in the development of innovations. In addition to the collaborations with suppliers, *Manufacturer* also makes use of a network of partners as possible external sources of knowledge for developing new technical solutions; such network includes research laboratories, universities, consultants and suppliers. Overall, the network of collaborations encompasses more than 20 partners. Moreover, most of the new technical solutions developed by the *Manufacturer* originate from different market fields, and in particular from the pharmaceutical one, indicating that the company is also active in looking for innovative solutions externally.

5.2 The Supplier

The *Supplier* was investigated through a direct interview with a R&D manager, in May 2010. The *Supplier* is a big enterprise (320 employees and more than 50 million Euros), founded in Northern Italy, and has recently entered the stock of a multinational company specialized in the design and development of high technology inspection and control systems for bottling lines. *Supplier* started its activity operating as a manufacturer of machines and capping turrets for the bottling industry, and rapidly reached the Italian market leadership, where it gained the confidence of several International companies, thus becoming in the years one of the most important and qualified producers in its industry. Its machineries are highly customized: *Supplier* manufactures no more than 5 equal machines per year (out of a total of 700 machines/year), thus satisfying the needs of different customers operating in different industries. Besides the bottling industry, products manufactured are commercialized in the food, oil and lubricant, chemical, cosmetic and, more recently, pharmaceutical markets, both in Italy and abroad. Moreover, the company is continuously searching for new industries and new markets to propose and commercialize its products.

The company is highly verticalized, developing internally almost 95% of its products, thus allowing quality control, short time to market and rapid changes. This decision is mainly due to the need of guaranteeing the high precision level of its products and meeting the quality level required by its customers. Moreover, due to the severe quality standard required, the company does not exploit the Far East market and its low cost workforce.

As for innovation, the main innovative projects of the company refer to the development of electronically-based machineries, which will replace the more traditional mechanically-based, feature that distinguishes *Supplier* from its competitors. Innovation is a fundamental feature of the company, in order to maintain its competitive advantage on the market: the innovations introduced range from designing new details and technical features for an existent machinery (that is, an incremental innovation) to developing completely new machinery (that is, a radical innovation). *Supplier* develops innovation explicitly required by its customers, as the *Manufacturer*; nonetheless, it also develops independently innovations to be proposed to its customers. Hence, the innovation process is both "pulled" by the customer and "pushed" to the company itself. *Supplier* R&D unit is composed by 12 employees, mainly involved in applied research. In order to correctly meet the customer's needs, *Supplier* often develops an innovation together with the customer that required it (i.e., the *Manufacturer*, in this case): this process is a kind of co-design. In

recent years, mainly due to the ever increasing competitiveness and threatens of the environment where *Supplier* works, it started protecting its innovations by means of patents. R&D manager underlined the strong inclination of the company toward the research and development of innovative and technologically advanced solutions, able to solve the specific customer needs, over the willingness to generate a continuous and lasting contact with the customer, the attention toward the market evolution and the continuative co-operation with international leading companies. These factors enabled *Supplier* to demonstrate during years its reliability, solidity, as well as creativity. Specifically, the strong attitude to product innovation following and forecasting the evolution of customers' needs, the precise willingness to reach top quality levels and the natural inclination to the business growth and internationalization have always featured the *Supplier*.

Supplier cooperates with Universities, but its main cooperation refers to important customers characterized by high negotiation power. *Manufacturer* is an example: the relationship with this company has lasted for more than 25 years, and started when, on the one hand, *Supplier* decided to enter the market of plastic caps, and, on the other side, *Manufacturer* was looking, in the same years, for a reliable supplier of the same product. The reciprocal and continuous exchange of information and knowledge, coupled with the collaboration of both the companies within each phase of the new product development process, from the idea generation to the commercialization, with a particular emphasis on the design phase, are the main aspects that guarantee this long lasting relationship, making the distance (more than 200 kilometres) non influential for collaborations. As the *Manufacturer* R&D manager stated: "Choosing *Supplier* as partner to implement the innovation project described was mainly motivated by the potential of *Supplier*, which was on the reference market for decades and featuring direct branches in various continents".

The main strengths of the collaboration between *Manufacturer* and *Supplier* may be listed as follows: a strong innovative boost of the products, the possibility of integrating both commercial and service facilities, and the opportunity of using the positioning complementarities, benefiting of the various featuring skills and relevant market shares. Recently, the two companies have started the development of a new research project that refers to the cost reduction and substitution of existent machinery with a new one to be sold to those customers that are more sensitive to cost and performance compared to quality. The project is still at the initial steps of the innovation process, that is the two companies have co-defined the product concept.

5.3 The Customer

The *Customer*, that was investigated through a direct interview with a R&D manager in July 2010, is one of the few large multinational Italian food companies and one of the major players worldwide (about 4 billion Euros and about 14.000 employees) in the production and distribution of food and beverages essential for daily well-being: milk, dairy products (yoghurts, cream-based sauces, desserts and cheeses) and fruit-based beverages. The company is part of a large group, born near Parma in 2005, which operated in 16 core countries with offices and manufacturing facilities and in 10 countries through licenses.

Customer has a strong innovative tradition, developing high added-value food products to improve nutrition of its consumers all over the world in the sector. It develops internally new technologies, which are then adapted to create new products as well as new bottling plants, jointly with its main suppliers of food plants (of which *Manufacturer* is an example). The innovations developed by the company are mainly process innovation and product innovation. The former are mainly realized using internal resources, while the latter refer to the development of new recipes or ingredient for the final product.

As for the collaboration aspects, *Customer* pays attention to the relationships with its suppliers, thus obtaining a value-added supply. In the choice of its suppliers (international in 90% of the cases), particular attention is paid to two factors: the capacity of the supplier to manufacture customized products (that is, the bottling plants), and the possibility to establish long lasting relationships. Moreover, when evaluating a new plant to be acquired, the company does not consider only the acquisition cost, but also the operational and maintenance cost. The company also collaborates with Universities and research centres, even if seldom due to relatively high costs and commitment required by the company itself.

The R&D manager described a project recently developed with the company *Manufacturer*; due to confidentiality, he provided us only a general description of this project. The project refers to a process innovation, specifically the development of a new and competitive (especially from the economic standpoint) packaging, able to maintain the microbiologic characteristics of the milk, but in the meantime with industrial characteristics of capacity, speed and efficiency. The project involves different actors: the companies *Manufacturer* and *Customer*, a supplier of material and a third party, with the task of monitoring the cost of the new packaging. At first, it has been undertaken a supplier selection, based on the evaluation of their knowledge and their interest in the project to be developed. These actors, conjointly, have established the successful and unsuccessful thresholds, i.e., the way to measure the results obtained, both technical and operative, and the ways of validation.

The reason at the basis of the long lasting relationship between *Manufacturer* and *Customer* has been confirmed by the R&D managers of both companies: "Both the companies are committed to the highest standards of corporate governance and full compliance with all laws affecting the businesses. Moreover, they are characterized by the same values: added values to shareholders, consumer focus, quality and innovation". As the *Customer* R&D manager stated: "Our passion to succeed and to excel brings us to choose *Manufacturer* as the main Italian supplier of bottling plants that allows us to consistently achieve our mission".

5.4 Lessons from the case studies

To derive insights from the case studies, we have summarised the key points of each supply chain player as per Table 1. Moreover, the collaboration mechanisms have been resumed in Table 2, and evaluated on the basis of several performance parameters, taken or adapted from the literature (Gunasekaran *et al.*, 2004; Moreira, 2005).

Table 1: Findings from the case studies – innovation in the food machinery supply chain.

	Supplier	*Manufacturer*	*Customer*
Perception of innovation	Very relevant, since the company manufactures numerous new products per year	Strategic for achieving competitive advantage and new market fields	Strategic for the development of new products
Type of innovation developed	Product innovations, both incremental and radical	Product and process innovations, with a clear orientation on industrial processes	Product and process innovations
Drivers of innovation	Requests by the manufacturer or the final customer; internal R&D activities	Requests by the final customer; analysis of competitors; internal R&D activities	Requests by the customers; health and safety requirements
Open innovation strategy	Cooperation with customers and, consequentially, with universities	Network of multiple partners, including research labs, universities, consultants and suppliers. Analysis of technical solutions available in different market fields (e.g., pharmaceutical)	Collaboration suppliers, Universities and research centres.
Benefits of innovation on supply chain player	Increased customer satisfaction; better service level delivered to customers; increased quality of the product manufactured	Increased sales volume; reduced costs; increased competitiveness; increased customer satisfaction	Increased competitiveness; possibility of increasing the yearly number of new products developed

Table 2: Findings from the case studies – collaboration mechanisms in the food machinery supply chain.

	Supplier-Manufacturer relationship	*Manufacturer-Customer* relationship
Type of relationship	Mature (partnership)	Under development
Role of the partnership for open innovations	Strategic: both partners play are critical for the development of new technical solutions.	Still limited
Stage of major involvement in innovation	Early stage of new product development (design stage). No direct involvement in the commercialization.	Last stages of product development (i.e., assembling and testing). No direct involvement in innovation
Benefits of the mutual relation	Possibility to focus on its core business; improved performance of the new product or technical solution developed.	Possibility to establish long lasting relationships and decrease the cost for acquiring new bottling plants.

From the Table 1, it can be appreciated that all the companies investigated are active in innovation, and in open innovation in particular, thus confirming their suitability for the case study. Innovation seems to be manly driven by the customers, although the companies develop internal R&D activities, which lead to new technological solutions to be proposed to the market. As expected, open innovation strategies may vary depending on the supply chain player considered: specifically, all players make use of collaborations with suppliers/customers, while research centers and universities are seldom used by *Supplier* and *Customer*. Conversely, *Manufacturer* developed a wide network of collaborations which are exploited when new technological solutions should be investigated. Moreover, in line with other studies available in literature, innovation provides significant benefits for all players investigated; such benefits range from improved service level delivered to customers, up to increased turnover of the company.

As regards to the collaboration mechanisms (Table 2), the *Supplier-Manufacturer* collaboration is well-established, and strategic to the development of innovations. This is a consequence of the fact that, due to the kind of product manufactured, there is the need of involving the Supplier in the product development, from the initial stage of the process (i.e., the design phase). Conversely, the *Manufacturer-Customer* collaboration is quite different. First, it is relatively new, and thus its role for open innovation is still limited. At the same time, the *Customer* mainly develops product/process innovations, which refer to the development of new food products or new processes for food treatment. Such innovations significantly differ from those developed by the *Manufacturer*, which is more oriented toward the development of new production lines; hence, the partnership has a more limited role for open innovations. Nonetheless, the mutual relations always provide benefits to the companies, both from the economic perspective and from the strategic one.

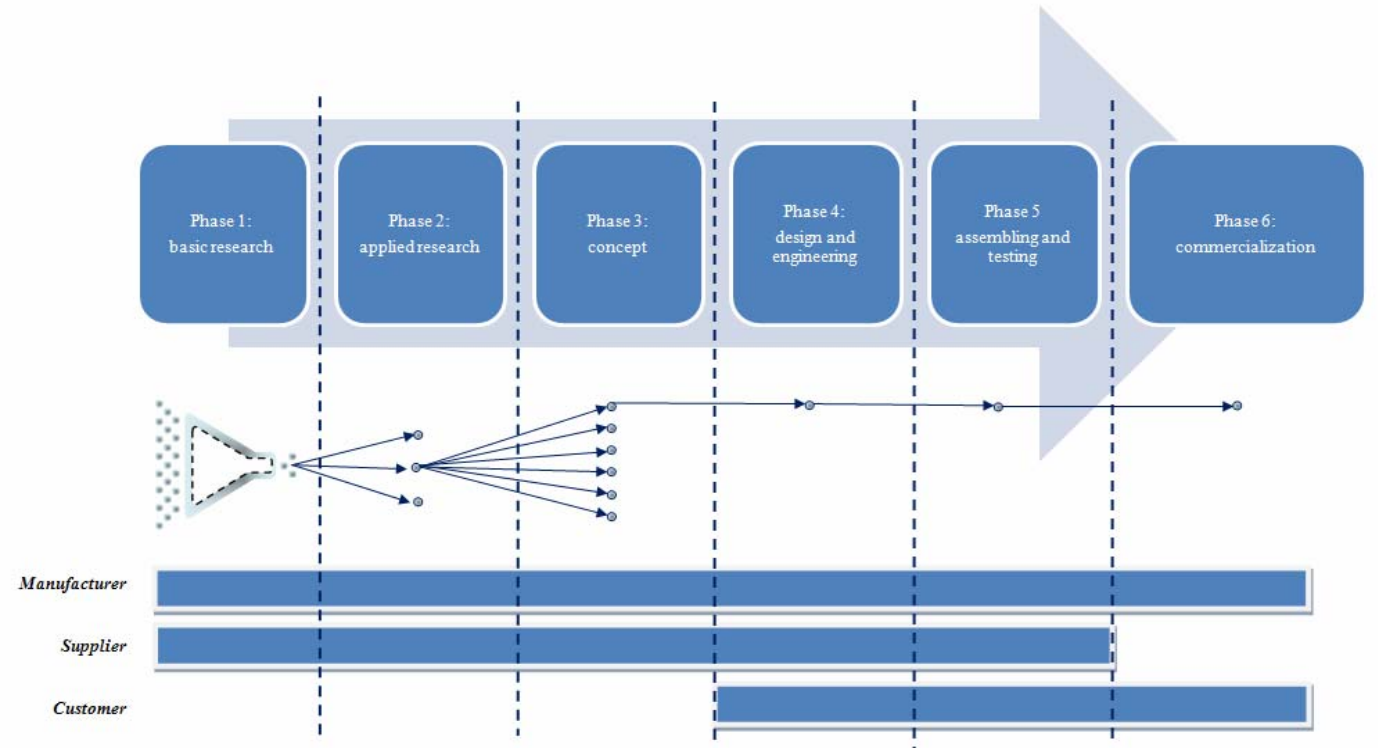

Figure 3: The innovation process of *Manufacturer* and the development of each actor of the supply chain in the same.

As regards the commitment of each actor within the innovation process developed by the central company of the supply chain investigated (that is the *Manufacturer*), the analysis show that *Supplier* and *Manufacturer* are the most active among the chain members as shown schematically in Figure 3. As for the supplier, the company resulted to be involved in all the phases of the innovation process, from the basic research (the generation of the idea) to the assembling and testing phase. Commercialization is an exception in this regard, as the *Supplier* has only a support role in this activity. The *Manufacturer*, obviously, is involved in all the phases of the innovation process: when it receives an order by customers, it starts the design and development involving the plants supplier. On the contrary, the *Customer* is more involved in the last phases of the process, specifically in the assembling and testing phase, while its involvement during the first phases is quite limited.

Summarizing, within the food machinery supply chain investigated the actors that more adopt the open innovation are, in order, *Manufacturer* and *Customer*. Conversely, *Supplier* rarely adopts outsourcing or looks for cooperation with actors different from its customers, mainly due to the severe quality standards required. All the three actors agreed in defining the benefits derived from innovation and mutual relationships, such as, in particular, the increased customer satisfaction as well as the increased competitiveness.

6. Conclusions and recommendations

For firms, one way of dealing within highly competitive markets is to collaborate with other firms for the development and manufacturing of new products. In particular, innovation is increasingly achieved in networks because firms may acquire all the knowledge necessary for creating innovations, by cooperating with other sources, such as customers, suppliers, Universities and so on (West and Gallagher, 2006). Scholars refer to this new way to innovate with the term “open innovation”. The establishment and management of relationships among the actors of the supply chain with the aim of acquiring additional knowledge and skills for innovation process, are acquiring increasing importance in particular within the food and food machinery industries (Hauser *et al.*, 2006; Huston and Sakkab, 2006; Thomke and Von Hippel, 2002; Vanhaverbeke and Cloodt, 2006).

The paper represents one of the first attempts to assess the extent and the determinants of the adoption of the open innovation paradigm in a specific industry. In particular, it investigates the case of the food machinery industry which represents one of the most important Italian sectors of the whole metalworking industry for number of employees, turnover and export. Based on an in depth review of the relevant literature on the matter of open innovation and on the characteristics of the sector under investigation, a framework of analysis has been developed through a panel study, involving R&D managers of companies operating in the food machinery supply chain and academics whose research interests mainly concern innovation, identifying the main issues of open innovation within the industry, the role of different actors of the supply chain within the phases of innovation process, as well as the extent the adoption of an open innovation model impact on the performance of the supply chain as a whole. Afterwards, the

framework, operationalized into a questionnaire, has been used to investigate a food machinery supply chain operating in northern Italy, including a food plant manufacturer, together with a supplier and a customer of the same.

As a result from the case studies, we can first conclude that all the supply chain players perceive innovation as a key factor to survive in today's competitive markets, and are all active in innovation and in open innovation in particular. Innovation mechanisms are frequently driven by the customers, although all companies investigated also develop internal R&D activities, which lead to new technological solutions. It also emerged that open innovation is particularly relevant to the *Manufacturer*, which exploits a wide network of collaborations when investigating new technological solutions. All the players investigated agree that innovation and collaboration mechanisms provide significant benefits, including better service level delivered to customers, increased turnover, increased number of new products developed per year, and better efficiency of R&D activities. Such findings indicate that companies cannot reach competitive advantage only by means of internal research; instead, the ability to link the internally developed research to the knowledge available outside a company is an important leverage for competitive advantage.

As expected, the *Customer* is more contributing to entering new markets for the traditional food product' than the food plants manufacturers, thus confirming results from other studies that found that the customers are usually more internationally oriented (Theuvsen, 2004) and that an international market orientation of any member of the chain enhance the innovation capacity of the supply chain as a whole (Aylward and Glynn, 2006; Gellynck *et al.*, 2007). Furthermore, the *Customer* in the food machinery supply chain is larger sized, result that is perfectly in line with other studies, which stressed that the company size is positively related to the innovation capacity (Avermaete *et al.*, 2003, 2004; Coppola and Pascucci, 2008).

The results of the multiple case studies allow us to assess the framework and to further discuss the impact of the adoption of an open innovation model. In particular, it is possible to derive both theoretical and practical implications from this study. As far as the theoretical implications are concerned, the paper suggests that the characteristics of the industry under investigation (for example, primarily, the phases of the typical innovation process) are key aspects to consider when investigating the implementation of open innovation, thus highlighting the lack of similar studies in the literature. From a practical standpoint, the case studies described provide innovation managers with a picture of the adoption of the open innovation paradigm, as well as the phases where open innovation prevails, together with the relative impact of each actor on the innovative process.

Nevertheless, we recognize some limitations of the study, mainly due to the case study methodology adopted: the supply chain analyzed, in fact, is a three-echelon one, which is quite limited as for number of actors involved and cannot be representative of all food supply chains. As a consequence, the impact of open innovation adoption may vary if extending the analysis to other actors of the same supply chain. Moreover, the study is focused on a specific industry, while it might be possible to argue that different sectors might have a different approach to open innovation. It would be interesting to extend the analysis to other supply chains, and to carry out comparative studies to identify open innovation patterns that are either supply chain-specific or generalisable. These points will be the basis for future studies. This research could also be extended and supported by a quantitative study, based on statistical survey and thus involving a wider sample of companies investigated. We believe, however, that this paper represents a valuable basis for future research and managerial discussions in the field.

References

Angerhofer B.J., and Angelides M.C., 2006. A model and a performance measurement system for collaborative supply chains. *Decision Support Systems*, Vol. 42, No. 1, pp. 283-301.

Avermaete T., Viaene J., Morgan E.J., and Crawford N., 2003. Determinants of innovation in small food firms. *European Journal of Innovation Management*, Vol. 6, No. 1, pp. 8–17.

Aylward D. and Glynn J., 2006. SME innovation within the Australian wine industry: A cluster analysis. *Small Enterprise Research: The Journal of SEAANZ*, Vol. 14, No. 1, pp. 42–54.

Azadegan A. and Dooley K.J., 2010. Supplier innovativeness, organizational learning styles and manufacturer performance: An empirical assessment. *Journal of Operations Management*, in press.

Bercovitz J.E.L., and Feldman M.P., 2007. Fishing upstream: firm innovation strategy and university research alliances. *Research Policy*, Vol.36, No.7, pp. 930–948.

Bertodo R. 1991. The role of suppliers in implementing a strategic vision. *Long Range Planning*, Vol. 22, pp. 40-48.

Bigliardi B., and Bottani E., 2010. Performance measurement in the food supply chain: a balanced scorecard approach. *Facilities*, Vol. 28, No. 5/6, pp. 249-260

Bigliardi B., and Dormio A.I., 2008. An empirical investigation of innovation determinants in food machinery enterprises. *European Journal of Innovation Management*, Vol. 12, No. 9, pp. 223-242.

Chang Y., and Makatsoris H., 2001. Supply chain modelling using simulation. *International Journal of Simulation: Systems, Science & Technology*, Vol. 2, No. 1, pp. 24-30.

Chesbrough H., 2003a. *Open Innovation – The new imperative for creating and profiting from technology*. Boston (MA): Harvard Business School Press.

Chesbrough H., 2003b. The logic of open innovation: managing intellectual property. *California Management Review*, Vol. 45, No. 3, pp. 33-58.

Chesbrough H., Vanhaverbeke W., and West J., 2006. *Open Innovation: Researching a New Paradigm*. Oxford (UK): Oxford University Press.

Clark K.B., 1989. Project scope and project performance: The effects of parts strategy and supplier involvement on project development. *Management Science*, Vol. 35 No. 10, pp. 1247-1263.

Cooper M.C., Lambert D.M., and Pagh J.D., 1997. Supply chain management: more than a new name for logistics. *The International Journal of Logistics Management*, Vol. 8, No. 1, pp.1-13.

Coppola A., and Pascucci S., 2008. Governance "archetypes" and innovative behaviours in the Italian agri-food sector. In *8th International conference on management in agrifood chains and networks*. Ede (The Netherlands): Wageningen Academic Publishers.

Costa A.I.A., Dekker M., Beumer R.R., Rombouts F.M., and Jongen W.M.F., 2001. A consumer-oriented classification system for home meal replacements. *Food Quality and Preference*, Vol. 12, pp. 229-242.

Costa A.I.A., Schoolmeester D., Dekker M., and JongenW.M.F., 2007. To cook or not to cook: a means-end study of the motivations behind meal choice. *Food Quality and Preference*, Vol. 18, pp. 77-88.

Egger H., and Egger P., 2006. International outsourcing and the productivity of low-skilled labor in the EU. *Economic Inquiry*, Vol. 44, No. 1, pp. 98–107.

Elmquist M., Fredberg T., and Ollila S., 2009. Exploring the field of open innovation. *European Journal of Innovation Management*, Vol. 12, No. 3, pp. 326-345.

European Commission, 2003. Commission Recommendation 2003/361/EC of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises. *Official Journal* L124 of 20.05.2003

Gaiardelli P., Saccani N., and Songini L., 2007. Performance measurement of the after-sales service network - Evidence from the automotive industry. *Computers in Industry*, Vol. 58, pp. 698–708

Gatignon E.H., Tushman M.L., Sith W., and Anderson P., 2002. A structural approach to assessing innovation: construct development of innovation locus, type and characteristics. *Management Science*, Vol. 48, pp. 1103-1122.

Gellynck X., Vermeire B., and Viaene J., 2007. Innovation in food firms: Contribution of regional networks within the international business context. *Entrepreneurship & Regional Development*, Vol. 19, No. 3, pp. 209–226.

Gruner K.E., and Homburg C., 2000. Does customer interaction enhance new product success? *Journal of Business Research*, Vol. 49, No. 1, pp. 1−14.

Gunasekaran A., Patel C., and McGaughey R.E., 2004. A framework for supply chain performance measurement. *International Journal of Production Economics*, Vol. 87, pp. 333–347.

Handfield R., Ragatz G., Petersen K., and Monczka R., 1999. Involving suppliers in new product development. *California Management Review*, Vol. 42, No.1, pp. 59-82.

Hauser J., Tellis G.J. and Griffin A., 2006. Research on innovation: a review and agenda for Marketing Science. *Marketing Science*, Vol. 25, pp. 687-717.

Huston L., and Sakkab N., 2006. Connect and develop: inside Procter and Gamble's new model for innovation. *Harvard Business Review*, Vol. 84, pp. 58-66.

Khazanchi S., Lewis M.W., and Boyer K.K., 2007. Innovation-supportive culture: the impact of organizational values on process innovation. *Journal of Operations Management*, Vol. 25, No. 4, pp. 871–884.

Kim D.Y., Kumar V., and Kumar U., 2010. Performance assessment framework for supply chain partnership. *Supply Chain Management: An International Journal*, Vol. 15, No. 3, pp. 187–195.

Kim J., and Frees E., 2006. Omitted variables in multilevel models. *Psychometrika*, Vol. 71, No. 4, pp. 659–690.

Knudsen M.P., 2007. The relative importance of interfirm relationships and knowledge transfer for new product development success. *Journal of Product Innovation Management*, Vol. 24, pp. 117-138.

Lamming R., 1993. *Beyond Partnership: Strategies for Innovation and Lean Supply*. London (UK): Prentice Hall.

Laursen K., and Salter A., 2006. Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal*, Vol. 27, No. 2, pp. 131-150.

Moreira A.C., 2005. Supplier-buyer collaboration in New Product Development: four case studies involving SMEs. *Brazilian Journal of Operations & Production Management*, Vol. 2, No. 1, pp. 5-24.

Papakiriakopoulos D., and Pramatari K., 2010. Collaborative performance measurement in supply chain. *Industrial Management & Data Systems*, Vol. 110, No. 9, pp. 1297-1318

Sarkar S., and Costa A.I.A., 2008. Dynamics of open innovation in the food industry. *Trends in Food Science & Technology*, Vol. 19, pp. 574-580.

Shokri A., Nabhani F., and Hodgson S., 2010. Supplier development practice: Arising the problems of upstream delivery for a food distribution SME in the UK. *Robotics and Computer-Integrated Manufacturing*, Vol. 26, No. 6, pp. 639-646

Song M., and Di Benedetto C. A., 2008. Supplier's involvement and success of radical new product development in new ventures. *Journal of Operations Management*, Vol. 26, No. 1, pp. 1−22.

Stock G.N., Greis N.P., and Fisher W.A., 2002. Firm size and dynamic technological innovation. *Technovation*, Vol. 22, pp. 537-549.

Thakkar J., Kanda A., and Deshmukh S.G., 2009. Supply chain performance measurement framework for small and medium scale enterprises. *Benchmarking: An International Journal*, Vol. 16, No. 5, pp. 702-723

Theuvsen L., 2004. Transparency in netchains as an organizational phenomenon: exploring the role of interdependencies. *Journal on Chain and Network Science*, Vol. 4, No. 2, pp. 125–138.

Thomke S., and Von Hippel E., 2002. Customers as innovators: A new way to create value. *Harvard Business Review*, Vol. 80, No. 2, pp. 5−11.

Ulrich K.T., and Ellison D.J., 2005. Beyond make-buy: Internalization and integration of design and production. *Production and Operations Management*, Vol. 14, No. 3, pp. 315−330.

Unione Parmense degli Industriali, 2007. *Settori industriali e servizi*. Available at www.upi.pr.it (accessed July 2010).

Vanhaverbeke W., and Cloodt M., 2006. Open innovation in value networks. In H.W. Chesbrough et al., (Eds.), *Open innovation: Researching a new paradigm* (pp. 258-281). Oxford (UK): Oxford University Press.

Von Hippel E., 1988. *The Sources of innovation*. Oxford (UK): Oxford University Press.

Wagner S.M., 2003. Intensity and managerial scope of supplier integration. *Journal of Supply Chain Management*, Vol. 39, No. 4, pp. 4−15.

West J. and Gallagher S., 2006. Challenges of open innovation: the paradox of firm investment in open-source software. *R&D Management*, Vol. 36, No. 3, pp. 319-331.

Yin R.K., 2003. *Case Study Research: Design and Methods*. Thousand Oaks (CA): Sage Publications.

Biographical notes

Dr. Barbara Bigliardi graduated (with distinction) in 2004 in Industrial Engineering and Management at the University of Parma and holds a Ph.D. in Industrial Engineering from the same University in 2008, with a thesis on the technological innovation management in the food machinery industry. Since 2005 she has been researcher at the Department of Industrial Engineering of the same University. She is currently teaching "Business administration" at the degree courses in Industrial Engineering and Management and Mechanical Engineering, and "Economics and Corporate Organizations A" at the degree courses in Information Engineering (Computer Engineering, Electronic Engineering, and Communication Engineering) at University of Parma. She is also strongly involved in Executive Education running seminars for public and private organizations. Her primary research interests focus around innovation, human resources management, performance management systems, knowledge asset & intellectual capital management and entrepreneurship. She has authored or co-authored many publications, including articles and research reports on the range of research topics listed above. Her research has been published on international journal, as well as on national and international conferences. She is also member of the editorial board of an international journal and referee for numerous international scientific journals.

Dr. Eleonora Bottani graduated (with distinction) in 2002 in Industrial Engineering and Management at the University of Parma (Italy). In March 2006, she got her Ph.D. in Industrial Engineering at the same University. She is lecturer (with tenure) in Mechanical Industrial Plants at the University of Parma since 2005. She taught "Supply Chain Management" to the Industrial Engineering and Management class, and, at present, she teaches "Logistics for the Food Industry" to the Mechanical Engineering for the Food Industry class. Her research activities concern logistics and supply chain management issues, and encompass intermodal transportation, development of methodologies for supplier selection, analysis and optimization of supply chains, supply chain agility, supply chain modeling and performance analysis. As secondary research topics, she studies industrial plants, with a particular attention to process optimization and plant safety. Results of her studies related to the above topics have been published in about 60 scientific papers, most of which appear in national and international journals, as well as in national and international conferences. She acts as a referee for about 40 international scientific journals and for several international conferences. She is editorial board member of two international scientific journals.

Dr. Francesco Galati graduated (with distinction) in 2009 in Industrial Engineering and Management at the University of Parma. He is attending a Ph.D. course in Management Engineering at the University of San Marino. His research activities mainly concern innovation management, project management and technology transfer.

Received July 2010
Accepted November 2010
Final acceptance in revised form November 2010