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UNRAVELLING THE INTEGRATION MECHANISMS IN OPEN INNOVATION PROJECTS: THE CASE OF INTER-ORGANIZATIONAL NETWORKS

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ABSTRACT

In recent years, there has been a tendency to evolve the innovation process into a flexible model known as Open Innovation where innovation takes place with several external actors. Nevertheless, although organizations are applying Open Innovation within networks, there is still a poor understanding of the mechanisms that help integrate the innovation activities with other actors. This paper explores the integration mechanisms used in inter-organizational networks for Open Innovation Projects (OIPs) with six organizations representing two types of innovators, private firms and academic institutions, as well as a nexus agency that acts as an integrator between them. Our results show that besides the 21 categories of integration mechanisms obtained from an extensive literature review, six new categories of mechanisms apply particularly to OIPs i.e. strategic prioritization, government incentives, specific trading controls, environmental exchange, learning curve techniques, and compatible technology infrastructure. In addition, we propose a conceptual framework to study integration mechanisms in OIPs at the analysis level of inter-organizational networks within several types of Open Innovation actors. This study expands the literature in integration mechanisms that solely consider its application inside an organization. Likewise, it shows that in OIPs it is not sufficient to manage the integration of the innovation process like an individual function, but it needs to be done as an integrated chain of processes supported by specific mechanisms.

***Keywords**: open innovation, integration mechanisms, open innovation projects, universities, food industry*

INTRODUCTION

In an IBM CEO study (Chapman, 2006) a CEO stated, "Integration is as important as water is for sea traffic", referring to the significance of integration in Open Innovation (hereafter referred also as OI) activities. Practitioners are aware that to properly facilitate OI within an organization, it is necessary to set in place integration processes that vary depending of the context in question. Even though the significance of this integration is great it has so far received little academic attention (Elmquist, Fredberg, & Ollila, 2009; Neyer, Bullinger, & Moeslein, 2009). The question of how integration happens in Open Innovation Projects (OIPs) remains unexplained. Open Innovation is 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, Vanhaverbeke, & West, 2006; p. 1). Since Chesbrough (Chesbrough, 2003) introduced the concept of OI, more and more firms are trying to incorporate this model in their innovation strategy. This trend began primarily inside big firms but there is recent evidence that small and medium-sized firms (Brunswicker & Ehrenmann, 2013) are also managing OI with positive results. Even though this model has been criticized for being too prescriptive and for offering little new to innovation research or practice (Trott & Hartmann, 2009), undoubtedly OI has contributed to previous concepts such as employees cumulative innovation (Reuter, 1977) or user innovation (von Hippel, 1986). The idea of OI originated from current contexts where innovative processes demand combinations of distinct sets of actors, competences, and resources (Enkel, Gassmann, & Chesbrough, 2009). However, having this diversity in skills brings out the challenge of synergizing the various interdependent areas of the project they are working on. Firm absorptive capacity or traditional systems are not enough, but there is a need for new capabilities to retain and manage knowledge in partnerships and alliances (Brunswicker & Ehrenmann, 2013). In inter-firm cooperation teams, which are usually used in OIPs, there are important challenges in aligning disparate

performance incentives, work process, and project priorities (DeFillippi, 2002). Undeniably, it is of great relevance for firms to have effective communication, cooperation and integration between specialists and functions during the innovation process (Sicotte & Langley, 2000). This tension between the need for differentiation and for integration lies at the centre of the study of organizations and becomes quite a characteristic challenge for OIPs.

Moreover, the difficulty of understanding how inter-organizational integration takes place in the innovation process is inherent in OI (Elmquist et al., 2009). Even though this issue draws an increasing interest in practice, there are limited studies focusing on this issue. Hence, the purpose of our study is to investigate how is integration achieved in OIPs between inter-organizational networks of "outside innovators", specifically in projects between private companies and universities. To answer this question, a framework was developed using approaches to coordination and integration derived from literature, as well as anecdotal evidence. To investigate their applicability, we conducted semi-structured interviews with people working in two companies from the food industry, as well as researchers in three universities and one industry–university liaison. These organizations were selected because of their strong innovation and entrepreneurial culture, which indeed is reflected in some of their practices related to an OI approach in different levels and contexts. Even though researchers have identified five units of analysis in OI (i.e. individuals, firms, dyads, inter-organizational networks and national innovation systems (Vanhaverbeke & Cloodt, 2006)), this study is limited to the inter-organizational networks level, as its dynamics have not been studied extensively. In addition, the challenges of inter-organizational team-based cooperation in innovation projects can be managerial and thus the framework proposed as a result of this research can be of interest to practitioners when trying to successfully bring out novelty from different sources. The rest of this paper is organized in four sections. In section 2, we present a literature review briefly talking about OI but emphasizing more the integration mechanisms obtained from organizational theorists and others perspectives. In section 3, we provide a detailed description of the methodology employed as well as presenting information about the cases used. In section 4 we present the analysis and main results of the research together with their discussion. Finally in the last section, we present some conclusions, limitations, and recommendations for future research in the subject of integration in OIPs.

LITERATURE REVIEW

In the literature there are numerous recent reviews of past research, theoretical and empirical, focusing on OI (Elmquist et al., 2009; Huizingh, 2011; Lichtenthaler, 2011; Schroll & Mild, 2012). In these examinations, besides defining the peculiarities of OI, the literature mostly identifies differences with the traditional innovation process. It also provides models and theories concerning its applicability and adoption, and numerous authors have recommended how to foster, implement and promote this model to market. However, to the best of our knowledge and with few exceptions (see, e.g., Jaspers & van den Ende (2010); Lin & Chen (2012); and Wallin & Von Krogh (2010)), there are limited studies providing a clear understanding of the mechanisms (Enkel et al., 2009) and the integration process (Neyer et al., 2009) of how OI takes place when done in diverse levels of analysis. Even though OI is now a well-known concept due to continuous efforts from notorious scholars (see, e.g., Brunswicker & Ehrenmann (2013); Chesbrough et al. (2006); Enkel et al. (2009); Gassmann & Enkel (2004); van de Vrande, de Jong, Vanhaverbeke, & de Rochemont (2009); and Vanhaverbeke & Cloodt (2006)), we consider it important to explain its basic assumptions to clarify our research field and the relevance of our study.

Open Innovation and Innovation Networks

Innovation has always been associated as a positive noun, especially in the business environment (van der Meer, 2007). There is evidence to a large extent that identifies innovation as the principal driver for companies to flourish, grow, be profitable, and sustain in the long term (Elmquist et al., 2009). But even if a company has a clear innovation strategy it may encounter barriers obstructing the innovation process. For instance, in a large-scale study, executives from 650 top-performing global companies mention that investing in innovation is seen as the key source to guiding growth; however it is also hard to implement a growth strategy through innovation due to the lack of appropriate tools (Koudal & Coleman, 2005). Thus, organizations have historically invested lots of resources and efforts in research and development areas to drive innovation and obtain a sustainable strategy. However, in recent years there is practice of a more open model where companies are aware that not all good ideas will come from the interior and not all innovations created within the company can be successfully marketed internally (Chesbrough et al., 2006). This

phenomenon was probably caused by the last decades' stronger global competition guided by a higher knowledge sharing and collaboration between firms' innovation processes (O Gassmann, 2006). Considering this, the Open Innovation model was shaped using ideas from innovation management – the process of bringing economic value to knowledge and creativity (van der Meer, 2007).

In addition, the innovation process itself should be innovated and not restricted to only one perpetual model. Proof of this statement is that evolution of the innovation process has been through five accepted generations known as technology-push (up to 1960s), market-pull (1960s), coupling processes (1970s), integrated innovation (1980s), and systems integration and networking (from 1990s) (Rothwell, 1992). More recently it has been argued that the evolution process should be synthesized to only four major innovation process progressions (Berkhout, Hartmann, Van der Duin, & Ortt, 2006). The 4th generation known as "Open R&D" emphasizes the managing networks with potential specialized innovation actors, for example as in OI. Others believe that OI is considered to be more the 3rd stage (van der Meer, 2007). Whichever authors' perspective is chosen, the signals are that OI is seen as the breakthrough that was needed in the way organizations innovate in recent years. Although the concept of OI originated only a few years ago, a lot has already been written about its advantages. Literature includes comparisons of the major advantages of an open model over a closed one (van der Meer, 2007), findings that the best innovative products and services come from innovation networks (Fowles & Clark, 2005), and even studies proposing that the model can help to overcome barriers between economy and sociology (Freund, 2010). More recently, studies have provided evidence on the direct positive effect between OI practices and firm performance across diverse environments (Lichtenthaler, 2009), between innovation revenues and firm financial performance (Fatur, Likar, & Ropret, 2010), and even between OI practices and energy efficiency (Ramirez-Portilla, Cagno, & Trianni, 2014) . In addition, practitioner's perspectives and real life cases prove the growing popularity of OI. On the Internet there are several websites promoting the model and its related networks (e.g., Innoget), as well as leading organizations exploring the model as a pillar of their innovation strategy (e.g., IBM, Intel, P&G and Cisco). Top management is already aware of the value of OI, as they know that the most significant sources of innovative ideas come from business partners and customers outside the firm (Chapman, 2006).

By definition, OI is related to open relationships with other firms. Organizations are becoming gradually more open to networks in order to create customer value (Vanhaverbeke, 2006). As an effect, firms trying to increase their innovation initiatives are using the services of other actors to find external sources of innovation. These actors called knowledge brokers are institutions bringing together firms, individual inventors, and people with problems to find solutions, and vice versa (Gwynne, 2007). However, networking can also include cooperation with other partners not necessarily in the same industry. Companies can develop relations with outside innovators (Neyer et al., 2009) or different types of external innovative actors such as external partners, clients, end customers, users, retailers, suppliers, and competitors (De Backer & Cervantes, 2008). Researchers mostly agree that to enlarge the scope and enhance the understanding of these OI actors, a breakdown should be made of different levels of analysis (Vanhaverbeke & Cloodt, 2006). In addition, to understand the position of the Open Innovation model from a bigger perspective, it is possible to use the concepts of value constellations. According to Vanhaverbeke and Cloodt (2006) these are defined as inter-organizational networks established to create value based on new business models, which can be situated on the right-hand of the OI model and innovation networks on the left-hand side (see figure 1).

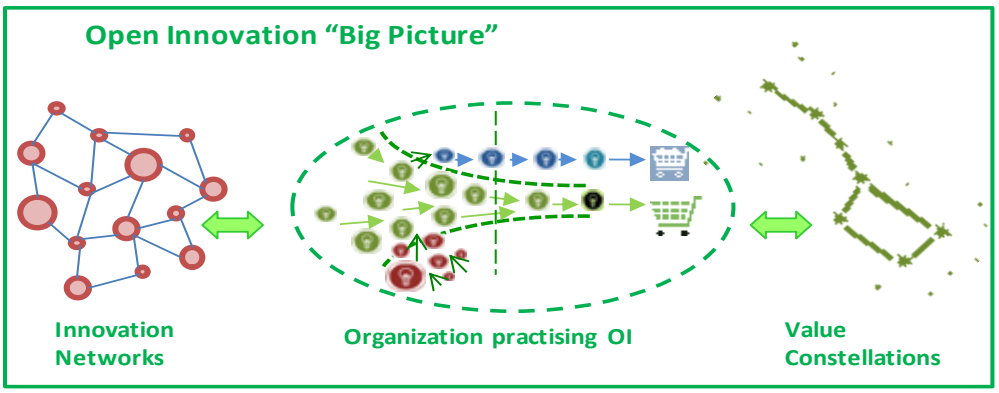

Fig. 1. Open Innovation Big Picture

The need for integration in OI Networks

Top management in many firms have in recent years considered adopting OI although pitfalls to this new innovation model may be present (Bughin, Chui, & Johnson, 2008). There are some general issues but it is also possible to find the following specific issues related to integration:

- Globalization increases the relationships amid innovators, which also increases the complexity to manage and integrate all kinds of competencies in the areas where additional expertise is required (Blau, 2007).
- There is a debate between OI theory and practice value (Trott & Hartmann, 2009), meaning that people could not be convinced that theoretical mechanisms work in practice.
- Organizations invest simultaneously in closed and OI thus mechanisms that can be suitable for one approach may not be proper for the other (Enkel et al., 2009).
- Even though OI uses mechanisms from its past contributors, there is no warranty of their appropriateness as early supplier involvement (Bidault, Despres, & Butler, 1998) may or may not help to integrate innovators.

Enkel et al. (Enkel et al., 2009) stress the necessity for a correct balance between classical innovation and the OI model, which in turn creates the need to find appropriate contributors and integration mechanisms. In their study of 107 firms, one of the most frequent implementation obstacles mentioned by firms was the high complexity integration. Similarly, in an IBM CEO study 80% of the interviewees rated integration as of huge importance (Chapman, 2006). Moreover, in innovation networks it is crucial to understand how to reduce the risk of losing Intellectual Property through coordination and integration (Fowles & Clark, 2005). Some researchers emphasize that in order to integrate innovators in OI processes, it should first be known what kind of innovators are being integrated (Neyer et al., 2009), and which are the proper practices to integrate knowledge (Jaspers & van den Ende, 2010; Wallin & Von Krogh, 2010). However, there is an intrinsic challenge within the OI model, as even though it increases the potential creativity in the innovation process, it also increases the complexity involved in managing it (Elmquist et al., 2009). Solving this challenge can be beneficial as companies which can orchestrate complex global value chains and integrate their innovation process, are 73% more profitable than others without proper integration abilities (Koudal & Coleman, 2005). Examples are Samsung and Porsche AG, part of whose growth factor in international markets relies on their capacity to coordinate and integrate innovation across their global operations and their partner networks.

Theoretical Framework

The existing Open Innovation paradigm does not consider to a great extent either the implementation or the integration elements. This means the model describes in a general way what the idea is but it does not specify the steps to implement it. We believe that the search for integration elements in Open Innovation needs to consider a broader range, from organizational theory views to a more specific innovation process context. First, in organization theory, integration is defined as any administrative tool whose implementation assists in achieving coordination among different units within an organization. Martinez and Jarillo (Martinez & Jarillo, 1989) have categorized these tools and mechanisms into two groups: structural and formal, and subtle and less formal. They mentioned that organizational theory moves towards the "less formal" group in response to the managerial challenge of coordinating an increasing number of dispersed and independent activities.

Second, the integration in innovation projects has been described as an attempt to elevate the linkages within each project component, enable more effective interaction among them, and create visibility that allows identification of bottlenecks (Putzger, 1998). Some researchers have described the principal elements of integration as being information systems, inventory management, and supply chain relationships (Handfield & Nichols, 1999). Others believe that the fundamentals of integration of an innovation process are considered to be collaboration, cooperation, trust, partnerships, information and technology sharing, and the management of integrated chains of processes (Akkermans, Bogerd, & Vos, 1999). While still others claim the selection of the most appropriate integration mechanisms will vary depending on the levels of the innovation project's uncertainty and ambiguousness (Daft & Lengel, 1986). Integration mechanisms related to R&D projects should also be considered because of the direct relation to this area in the context of OI. Based on the literature, the mechanisms could be grouped as:

- *Horizontal structures* entwine with established functional structures. They are achieved through information systems, direct contact, task forces, full-time integrator, and teams (Daft, 1998).
- *Formal project leadership* in innovation projects has a crucial integrative role within the project team. Formal leaders support the communication with top management as well as the internal dynamics of the team (Ancona & Caldwell, 1992).
- *Planning and process specification* can be a powerful integration mechanism (Cooper, 1996). Planning can be appropriate for R&D projects with moderate level of novelty and less for extremely novel projects (Adler, 1995).
- *Information technology* facilitates coordination of innovation projects by increasing communication speed and reducing its cost, widening the information network and allowing access to communal information (Dean & Snell, 1991).
- *Informal leadership* portrayed by project champions can act as "informal integrators" by reducing ambiguousness in personal contacts (Cooper, 1996).

Third, even though there is not a clear understanding of the integration mechanims to fully profit from OI (Enkel et al., 2009), there are some recent studies providing some insights. First, as technology can facilitate innovation enablers (Chapman, 2006), it can be classified in the categories of coordinating, liberating, and including (Elmquist et al., 2009). A more focalized study argues that organizing OI is related to the selection of the right mechanisms for integrating domain knowledge outside and within the firm (Wallin & Von Krogh, 2010); however the mechanisms proposed are sequential steps rather than parallel and simultaneous means to achieve integration. In a similar way, the role of integration mechanisms in OI teams has been explored within student team contests (Lin & Chen, 2012); nevertheless the sample used does not represent any type of firm and the three mechanisms studied (team vision, commitment, and self-efficacy) seem more from a behavioural rather than organisational nature. Other than these basic guidelines, there are no concrete and accepted mechanisms that support the implementation and integration of OI. Nevertheless, it can be useful to examine OI case studies in order to identify and synthesize special elements (O Gassmann, 2006).

For instance, Philips has been the subject of study by authors because of its advanced OI business model (Broer & Zeper, 2004; Chapman, 2006; Viskari et al., 2007). A big project in the firm was the creation of the High Tech Camp to foster OI and to integrate people, technology, and knowledge between the firm and innovators (Vaughan, 2009). Therefore the integration mechanism identified in this case is the creation of an innovation ecosystem, either physical or virtual. P&G is another example of a firm using a distinct integration mechanism. It uses information and communication technologies to enable the exchange of distributed sources of information in the OI process (Viskari, Salmi, & Torkkeli, 2007). This technological interface reinforced by an open culture to adapt external ideas enables the firm to integrate with different groups of innovators (Vaughan, 2009). In a similar way, Nokia has created a worldwide innovation network which gives the firm the ability to multiply efforts on projects, improve innovation efficiency, create new innovation ecosystems, and create more shared value (Dittrich & Duysters, 2007) ,which in turns creates a sociable system to share relevant knowledge. Other ideas from practitioners' anecdotal evidence show that a common technique is the involvement of a third party to guide through the closed-open process. These parties are companies specialized in encouraging OI implementation and in the integration aspect. The literature on innovative networks and innovation systems defines them variously as central agencies (Teubal, Yinnon, & Zuscovitch, 1991), central firms (Sawhney & Prandelli, 2000), innovation intermediaries (Oliver Gassmann, Daiber, & Enkel, 2011; Katzy, Turgut, & Holzmann, 2013), or systems integrators (Brusoni & Prencipe, 2001; Jaspers & van den Ende, 2010). More difficult but not impossible is the process of defining a new organizational identity and culture to foster and integrate OI throughout the entire company (Viskari et al., 2007).

In sum, we have reviewed extant literature regarding innovation process integration and the integration in OIPs. This literature shows that integration efforts come in a variety of forms and, as such, are also associated with a variety of mechanisms not yet standardized. Throughout the literature we identified a trend towards specifying the types of collaboration, a common category of innovators and the analysis levels (Vanhaverbeke & Cloodt, 2006). Following the nature of OI, we expect to find that beside structural and formal mechanisms the integration in OIPs will also include subtle and informal mechanisms. All these mechanisms to be investigated are summarized in table 1. Through a comparison of the classic inter-

organizational innovation projects where all collaborative actors are known and are integrated in the process by established mechanisms, in OIPs the external sources can be unexpected or are rarely known in advance. Therefore, our assumption is that the integration mechanisms used in OI have to be able to support interchangeability of the networks involved, and also enable a flexible integration infrastructure to accommodate for various potential participants.

Table 1. Integration mechanism in non-conventional innovation processes.

	Structural and formal mechanisms	**Subtle and less formal mechanisms**
Integrations mechanisms from organizational theory	Departmentalization or *grouping of organizational units*, shaping the formal structure Centralization or decentralization of decision making through the hierarchy of *formal authority* Formalization and standardization: *written policies*, rules, job descriptions, and *standard procedures* such as manuals. Planning: strategic planning, *budgeting*, functional plans, *scheduling*, etc. Output and behavior control: *financial performance*, technical reports, sales and marketing data, as well as *direct supervision*	Lateral or cross-departmental relations: direct managerial contact, *temporary or permanent teams*, task forces, committees, *integrators*, and *integrative departments*. Informal communication: personal contacts among managers, management trips, *meetings*, conferences, *transfer of managers*, etc. Socialization: building an *organizational culture* of known and shared strategic objectives and values by training, managers exchange, career path management, *measurement and reward systems*.
Integration mechanisms in R&D projects	Formal Leadership– Delegation of power. Motivation of team members. Use of personal credibility, expertise and authority. Formal project leaders seen as external integrators. Planning and process specification– Project breakdown into components. Tasks and responsibilities effectively delegated. Information Technologies– Allow communal information (electronic mail, voice mail, and electronic data management)	Horizontal Structures – Information systems, direct contact, task forces (temporary assignments), full-time integrator and teams. Informal leadership – Project and technical champions showing transformational leadership, such as persistence, influence, risk-taking and persuasiveness.
Integration mechanisms in OIPs	State of the art Innovation Technology and infrastructure. Involvement of a third party mediator or 'nexus agents'. Redefining a new organizational identity (a more drastic mechanism)	Creation of an innovation ecosystem or a sociable system for knowledge sharing between actors Tools and methods promoting better visibility and flexibility within the innovation processes. Activities to involve stakeholders e.g. empowerment

METHODOLOGY

This study was treated as exploratory considering that few researchers have focused on this topic. It used an interpretivist and an inductive approach, as innovation projects are social constructions made by social actors' actions, which were used to move from specific observations to broader generalizations. Therefore the use of qualitative data can be justified in this study (Bryman & Bell, 2007) as it contributes to grasping meanings in complex data by developing categories or themes (Saunders, Lewis, & Thornhill, 2003). It used a mixed research strategy where different approaches were considered in order to have the best-suited strategy for the study. For instance, grounded theory was weighed as it is useful to expand upon the explanation of a phenomenon by identifying its key elements, and then categorizing the relationships of those

elements to the context and process of the phenomena (Strauss & Corbin, 1998). However, as using grounded theory has some disadvantages of being a formalized research strategy, a research strategy using both grounded theory and ethnography was used (Seidel, 1998). This mixed strategy allowed increasing the 'density' and 'saturation' of recurring categories, as well assisting in providing follow-up procedures in regards to unanticipated results. Besides, interlacing data collection and analysis in this manner is also designed to increase insights and clarify the parameters of the emerging theory (Seidel, 1998). At the same time, this method supports the actions of initial data collection and preliminary analyses while attempting to incorporate previous research literature. This strategy guarantees that the analysis is based on the data obtained but at the same time on pre-existing constructs.

Data sources and participants

Maximum variation sampling was used to collect data and explain the key elements from different scenarios. These scenarios include six organizations in Mexico: three universities, two companies from the food industry, and one university-based nexus agency. This accounts for seven in-depth interviews with relevant actors directly involved with OIPs. The three academic institutions are renowned in terms of quality education, as well as being continuously involved with entrepreneurship and innovation activities. In order to avoid organizational generalizations of any type based on the limited interviews the names of the organizations are not disclosed. In addition, this study attempts to emphasize the type of context rather than the name of an organization for its best practices. The first university has 33 campuses throughout the country with another 42 technical schools. Its learning strategy is oriented towards the development of entrepreneurial practices and thus it is involved in several innovation projects. The second university has five main campuses in Mexico City with a strong focus in technological innovation in the local industry. The third university is located in Northern Mexico and despite having only one campus it is renowned due to its strong research by collaborating with multinational corporations in electronics, high-tech firms, and universities in the south of the USA. It should be noted that even if the universities differ in their profiles, i.e., public or privately funded, all have in common that innovation is embedded in their culture.

The two multinational companies have a good reputation for innovation in the food industry. This is visible as both companies based their growing strategies on market expansion by offering innovative and quality products to customers. The first company is dedicated to the production and commercialization of different types of cereals. It has a close involvement with education centres in the central region of Mexico and thus, it has an extensive number of innovation projects involving different types of actors. The second company is dedicated to the production and commercialization of dairy products. This company focuses more on customizing the products for regions but it also develops projects with innovators ranging from customers to communities of scientists in universities in the central region of Mexico. A nexus agency, i.e. a mediator between these two types of innovators, was also selected. However, the nexus agency as such is not a type of innovator; its main function is to integrate and coordinate the efforts between different types of actors in the innovation process. This nexus agency is located geographically in a research institute; therefore the entrepreneurial and innovation culture of the institution influences it indirectly. The selection criterion for the participants was based on the contribution derived from their professional activities in the context of OI as seen in table 2.

Table 2. Information about the interviews with participants.

Interview	Context	Position	Length
Interviewee 1 (Int1)	Company	Innovation Manager	68 min
Interviewee 2 (Int2)	Nexus agency	Liaison Coordinator	75 min
Interviewee 3 (Int3)	Company	Innovation Manager	60 min
Interviewee 4 (Int4)	Company	Brand Manager	84 min
Interviewee 5 (Int5)	Researcher	Professor and Consultant	78 min
Interviewee 6 (Int6)	Researcher	Full Professor and Researcher	73 min
Interviewee 7 (Int7)	Researcher	Full Professor and Researcher	81 min

Data collection and method of analysis

The data was collected through semi-structured interviews and all of them were made with computer-assisted telephonic tools – VoIP software. The interviews were transcribed and then coded based on the research. Two of the authors read, examined, and coded all transcripts in parallel to lower the level of bias and give more reliability to the coding process. After this task all authors agreed that there were no great inconsistencies in identifying and coding the mechanisms and jointly perform a categorization of the mechanisms. The coding and categorization process consisted of six steps that were combined with other methods (Bryman & Bell, 2007) . In this case, as there were integration mechanisms obtained from the literature review, it was possible to interpret the segments and the labels to fit their main concepts in one of the pre-established categories and subsequently assign them one or more of the chosen nomenclature. In particular, during steps 1 to 4 of the coding process, a loop was constantly revised as follows: it was done individually, then proving it with the other author´s work, and finally it was done jointly between the three authors. This method also helped to explore the relationships between categories and to reconcile different points of view.

RESULTS AND DISCUSSION

During the data coding we identified 6 categories that did not fit in any of the categories of our theoretical framework. However, these new categories were not present in all of the interviews, in comparison to most of the other 21 categories. After the identification of all the potential categories we summarized them through a data display and analysis approach (Saunders et al., 2003). After several iterations to develop a visual form that represented the data in the simplest and most complete way possible, the result is the matrix in figure 2. It summarizes the integration mechanisms, their corresponding codes, the number of mentions in the interviews, and the organizational context (company, nexus agency or university) for each interviewee. Another visible arrangement is the division between "soft" and "hard" mechanisms. We agreed to use this classification as all the categories found fitted into one of these labels. Based on this classification, one of our earliest findings is that 65% of the mechanisms can be labelled as "soft" in comparison to only 35% labelled as "hard". This finding confirms our assumption that that due to the flexible and non-restrictive nature of OI it is more probable that the subtle and less formal mechanisms are more common in OI practices and projects.

				Interviewees context							
				Com	Nex	Com	Com	Uni	Uni	Uni	
Source	Type	Integration Mechanisms category	Code	Int1	Int2	Int3	Int4	Int5	Int6	Int7	SUM
Theoretical Framework	Hard	Departamentalization	OT-DEP	3	1	0	0	2	1	1	8
		Centralization or decentralization	OT-CENDEC	1	1	1	0	1	0	0	4
		Formalization and standardization	OT-FORSTA	1	5	2	1	2	6	3	20
		Planning	OT-PLAN	2	3	2	0	1	2	2	12
		Output and behaviour control	OT-CON	1	3	0	1	6	2	2	15
		Formal Leadership	RD-FORLEAD	9	4	3	2	4	6	5	33
		Planning and process specification	RD-PLANSPEC	1	4	2	2	4	2	3	18
		Information Technologies	RD-INFOTECH	2	2	2	1	3	1	2	13
		Innovation technology infrastructure	OI-INNOTECH	1	2	2	2	1	3	0	11
		Nexus agency	OI-NEX	2	3	4	0	1	2	2	14
		New organizational identity	OI-ORGID	2	0	0	0	0	0	1	3
									Subtotal		151
	Soft	Lateral or cross-departmental relations	OT-CROSS	11	5	9	3	5	4	6	43
		Informal communication	OT-INFOCOM	8	3	5	7	6	7	2	38
		Socialization	OT-SOC	13	4	7	3	8	3	7	45
		Horizontal Structures	RD-HOR	3	5	1	1	5	0	3	18
		Informal leadership	RD-INFLEAD	0	3	0	3	4	7	3	20
		Innovation Ecosystem	OI-INNOECO	1	2	1	2	2	2	1	11
		Sociable system for knowledge sharing	OI-SOCSYS	4	6	4	6	0	2	4	26
		Visibility tools	OI-VIS	13	2	7	1	2	0	4	29
		Flexibility tools	OI-FLEX	8	6	7	2	4	4	5	36
		Stakeholder involvement	OI-STAKE	6	3	12	6	5	7	7	46
									Subtotal		312
Interviews	Hard	Government incentives	NW-GOV	0	2	0	0	0	3	1	6
	Hard	Strategic prioritization	NW-SPRI	1	0	3	0	0	0	1	5
	Hard	Specific trading controls	NW-TRACON	1	0	0	1	0	0	0	2
	Hard	Compatible Technology Infrastructure	NW -TECINFR	0	0	0	1	0	3	2	6
	Soft	Environmental exchange	NW-ENVEX	1	0	0	0	1	0	1	3
	Soft	Learning curve techniques	NW-LECU	0	1	0	0	1	2	0	4
									Subtotal		26
			Total	95	70	74	45	68	69	68.2	489

Fig. 2. Matrix of results including new categories found during the interviews.

Considering that most of the integration mechanisms seem to overlap or have very similarly related concepts and examples, it was possible to group them within a concept with a higher order of abstraction, similar to categorizations in other studies (e.g., see the six dimensions in (Brunswicker & Ehrenmann, 2013)). Therefore the result was the creation of five core categories: *social*, *operational*, *technological*, *organizational*, and *environmental*. This is aligned to the idea that good coding in a qualitative data analysis (QDA) process should yield between three and eight final categories (Seidel, 1998). The distribution of the 27 integration mechanisms in the five categories is shown in figure 3. In addition we have also suggested the existence of new mechanisms. These were characterized and labelled as *strategic prioritization*, *government incentives*, *specific trading controls*, *environmental exchange*, and the use of *compatible technology infrastructure*.

Source	Type	Integration Mechanisms categories	Code	Core Category
TF	S	Informal communication	OT-INFOCOM	Social
TF	S	Socialization	OT-SOC	
TF	S	Horizontal Structures	RD-HOR	
TF	S	Informal leadership	RD-INFLEAD	
TF	S	Stakeholder involvement	OI-STAKE	
TF	H	Information Technologies	RD-INFOTECH	Technological
TF	H	Innovation technology infrastructure	OI-INNOTECH	
Int	H	Compatible Technology Infrastructure	NW -TECINFR	
TF	S	Flexibility tools	OI-FLEX	Organizational
TF	H	Departamentalization	OT-DEP	
TF	H	Centralization or decentralization	OT-CENDEC	
TF	H	New organizational identity	OI-ORGID	
TF	S	Lateral or cross-departmental relations	OT-CROSS	
TF	S	Visibility tools	OI-VIS	
Int	H	Strategic prioritization	NW-SPRI	
TF	H	Formal Leadership	RD-FORLEAD	Operational
TF	H	Formalization and standardization	OT-FORSTA	
TF	H	Planning	OT-PLAN	
TF	H	Output and behaviour control	OT-CON	
TF	H	Planning and process specification	RD-PLANSPEC	
Int	S	Learning curve techniques	NW-LECU	
TF	H	Nexus agency	OI-NEX	Environmental
TF	S	Innovation Ecosystem	OI-INNOECO	
TF	S	Sociable system for knowledge sharing	OI-SOCSYS	
Int	H	Government incentives	NW-GOV	
Int	H	Specific trading controls	NW-TRACON	
Int	S	Environmental exchange	NW-ENVEX	

Fig. 3. Cluster of integration mechanisms in five categories.

Considering that 21 categories of integration mechanisms obtained from the literature review were confirmed in our analysis, we consider it more relevant to discuss primarily the six new mechanisms that seem to be distinctive of OIPs:

- Government Incentives. Several authors have studied the influence of government incentives and tax policies on innovation (see, e.g., Bernstein (1986) or Cantwell & Mudambi (2000)). However, we have not found any evidence that studies relate these incentives as integration mechanisms. We believe they should be considered as such because if provided with government incentives, firms may reduce the risks usually associated with R&D activities, and thus, fostering innovation projects.
- Strategic Prioritization. This mechanism is often found in project portfolio management as big firms usually have a trade-off decision between the amount of projects and budget, being forced to give priority to certain projects based on their strategic direction. By pursuing a certain strategic direction, the companies are in a position to concentrate their efforts on the adequate allocation of available resources (Mikkola, 2001). If directed by the company's project prioritization, innovation actions taken could prove to be highly beneficial in terms of gathering resources and competences from various sources, resulting in cooperation on inter-organizational level.

- Specific trading controls. Exclusively the industry interviewees mentioned this integration mechanism. The rationale is that it may affect mainly firms that have to abide by the rules of the market, industry, or region (Scotchmer, 2004). By respecting the same rules and working in similar environments, the OI actors are aware of all the conditions and circumstances surrounding them and their partners. This could positively affect the harmony they want to achieve in order to innovate.
- Compatible Technology Infrastructure. Nowadays all firms need a basic level of IT infrastructure in order have an ability to integrate their processes. The capability of a common technology infrastructure includes both the technical support and managerial expertise required to sustain and bring out the innovation from the net of combined efforts of all OI actors.
- Environmental exchange. Although there are significant similarities with the 'exchange of managers' practice that fits into the Socialization mechanism (OT-SOC), three interviewees provided us with sufficient arguments to identify this as a new mechanism. The logic behind this is that prolonged exchange of managers should be a type of environmental exchange as the more time managers spend on an exchange period the more they could influence the organizations. Therefore, prolonged stay and environmental exchange may affect the quality and extent of integration.
- Learning curve techniques. Mainly the scholars and the nexus agency mentioned this mechanism, possibly because of their organizations' nature related to knowledge accumulation and distribution. Better knowledge can give more fluidity to the process of integration because less time is needed for coordination of activities and as implied in the interviews, some mid-steps can even be disregarded.

A framework proposal for integration mechanisms in OIPs

We followed the suggestion on focusing on an analysis level of OI often disregarded in studies (Vanhaverbeke & Cloodt, 2006), thus we chose the inter-organizational networks level. However, we believe it is important to draw some connections between the other levels of analysis and the new created categories of integration mechanisms. Therefore we propose a multi-organizational framework with wider applicability in the context of inter-organizational networks. By doing this we attempt to provide a structure that supports the application of the new mechanisms classification we identified in the university–industry projects into a more advanced range of innovation actors. Since only one integration mechanism (government incentives) showed a slight tendency to be more prominent in the university setting, we believe that all of them have a generic quality when it comes to their application in other contexts within OI networks. The framework shown in figure 4 illustrates how integration mechanisms could harmonize the different activities and projects of OI actors.

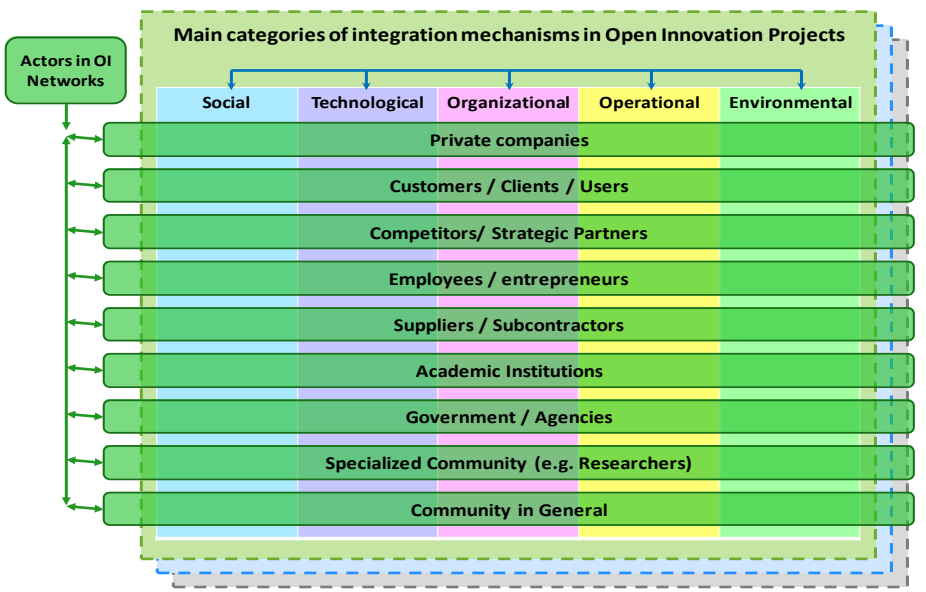

Fig. 4. Proposed conceptual framework with new categories of integration mechanisms and their relation with inter-organizational networks in OIPs.

The actors were considered based on the different types of collaborations and actors in literature and practice (De Backer & Cervantes, 2008; Neyer et al., 2009; Viskari et al., 2007). The arrows on the left side of the diagram represent the organizations and individuals' association capability as well as the interchangeability of networks involved. The five inner boxes represent the new categories of mechanisms, each one representing that each mechanism does not overlap with the others. However, all the core categories are linked through the upper arrows to clarify their relationships and possible self-applicability; in this way, the mechanisms can be used all at the same time or independently. The dotted boxes behind the central diagram represent other types of mechanism classifications that could overlap in organizations. This means we acknowledge that the integration mechanisms proposed, in our case for OIPs, will probably overlap with other type of organizational mechanisms (Ouchi, 1978). This framework does not represent the process of how the mechanisms are used in a systematic way but rather it is a conceptualization of the idea of integration as a common grid for OIPs between different innovators. It also supports the notion that integration mechanisms used in OI have to enable interchangeability of networks involved and flexible integration infrastructure that can accommodate various potential participants (Fowles & Clark, 2005).

CONCLUSIONS AND FUTURE RESEARCH

We will continue seeing an increasing number of companies trying to implement the concept of open innovation during the next years. Integration mechanisms, in our opinion, have a crucial role in these efforts. Unfortunately there are still not enough studies providing specific integration tools and mechanisms for this field. We believe that our findings helped responding the question of how integration is achieved in OIPs between inter-organizational networks of innovators, specifically in projects between private companies and universities. This study contribute by: a) confirming an extensive list of integration mechanisms applied in OIPs, including six new mechanisms not found before in common integration theories; b) defining a set of five core categories of integration mechanisms; and c) proposing a skeleton where these categories are connected to form a conceptual framework that contributes in giving more information about integration in OI. We contribute to theory, as this research is one of the first attempts to study and map the integration mechanisms in OI with the support of empirical data. In practice, the idea of "one-size-fits-all" is not probable in OI, thus we provide practitioners with a guide to integration mechanisms, which they can cherry-pick from in order to integrate their OI activities.

Due to the scope of our research question, some relevant topics on the integration dynamics in OI were not studied. Therefore we believe opportunities for future research include: the effect of integration mechanisms on the success of OIPs, study cases of companies and networks struggling with OI to evaluate the mechanisms efficacy, confirming the mechanisms within other actors, industries, and countries, and the relation of the mechanisms with the stages of the OIP life cycle. We also acknowledge that our inventory of mechanisms could be incomplete, as we did not consider some elements such as the influence of the innovation culture of a country or organization, which may be subject to variability in different contexts. In general, although our proposed categories and framework need to be confirmed with more empirical studies, we think it is valid and useful as a map for understanding the means that make integration possible in OIPs and networks. We hope this will encourage other researchers to continue studying the integration dynamics to a greater extent and depth. Based on this study we conclude that in OI it is not sufficient to manage the integration of the innovation process like an individual function but it needs to be done as an integrated chain of processes supported by specific mechanisms.

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REFERENCES

Adler, P. S. (1995). Interdepartmental interdependence and coordination: the case of the design/manufacturing interface. *Organization Science*, *6*(2), 147–167.

Akkermans, H., Bogerd, P., & Vos, B. (1999). Virtuous and vicious cycles on the road towards international supply chain management. *International Journal of Operations and Production Management*, *19*(5/6), 565–581.

Ancona, D. G., & Caldwell, D. (1992). Bridging the boundary: external activity and performance in organizational teams. *Administrative Science Quarterly*, *37*(4), 634–695.

Berkhout, A. J., Hartmann, D., Van der Duin, P., & Ortt, R. (2006). Innovating the innovation process. *International Journal of Technology Management*, *34*(3/4), 390–404.

Bernstein, J. I. (1986). The Effect of Direct and Indirect Tax Incentives on Canadian Industrial R&D Expenditures. *Canadian Public Policy*, *12*(3), 438–448.

Bidault, F., Despres, C., & Butler, C. (1998). The drivers of cooperation between buyers and suppliers for product innovation. *Research Policy*, *26*(7/8), 719–732.

Blau, J. (2007). Philips Tears Down Eindhoven R&D Fence. *Research Technology Management*, *50*(6), 9–10.

Brunswicker, S., & Ehrenmann, F. (2013). Managing Open Innovation in SMEs : A Good Practice Example of a German Software Firm. *International Journal of Industrial Engineering and Management*, *4*(1), 33–41.

Brusoni, S., & Prencipe, A. (2001). Unpacking the Black Box of Modularity: Technologies, Product and Organizations. *Industrial and Corporate Change*, *10*(1), 179–205.

Bryman, A., & Bell, E. (2007). *Business Research Methods* (2nd ed., p. 786). Oxford: Oxford University Press.

Bughin, J., Chui, M., & Johnson, B. (2008). The next step in open innovation. *Mckinsey Quarterly*. Retrieved from http://www.mckinseyquarterly.com/information_technology/networking/next_step_in_open_innovation_2155#registerNow

Cantwell, J., & Mudambi, R. (2000). The Location of MNE R&D Activity: The Role of Investment Incentive. *Management International Review*, *40*(5).

Chapman, M. (2006). Building an innovative organization: consistent business and technology integration. *Strategy and Leadership*, *34*(4), 32–38.

Chesbrough, H. (2003). Open innovation: The new imperative for creating and profiting from technology. Boston: Harvard Business Press.

Chesbrough, H., Vanhaverbeke, W., & West, J. (2006). *Open Innovation: Researching a New Paradigm* (p. 372). Oxford: Oxford University Press.

Cooper, R. G. (1996). Overhauling the new product process. *Industrial Marketing Management*, *25*(6), 465–482.

Daft, R. L. (1998). Organization Theory and Design. South Western College Publishing.

Daft, R. L., & Lengel, R. H. (1986). Organizational Information Requirements, Media Richness and Structural Design. *Management Science*, *32*(5), 554–571.

De Backer, K., & Cervantes, M. (2008). *Open innovation in global networks* (p. 127). Paris: OECD Publishing.

Dean, J. W. J., & Snell, S. A. (1991). Integrated manufacturing and job design: moderating effects of organizational inertia. *Academy of Management Journal*, *34*(4), 776–804.

DeFillippi, R. J. (2002). Organizational Models for Collaboration in the New Economy. . *Human Resource Planning*, *25*(4), 7–18.

Dittrich, K., & Duysters, G. (2007). Networking as a Means to Strategy Change: The Case of Open Innovation in Mobile Telephony. *Journal of Product Innovation Management*, *24*(6), 510 – 521.

Elmquist, M., Fredberg, T., & Ollila, S. (2009). Exploring the field of open innovation. *European Journal of Innovation Management*, *12*(3), 326–345.

Enkel, E., Gassmann, O., & Chesbrough, H. (2009). Open R&D and open innovation: exploring the phenomenon. *R&D Management*, *39*(4), 311–316.

Fatur, P., Likar, B., & Ropret, M. (2010). Going More Open in Innovation: Does it Pay? *International Journal of Industrial Engineering and Management*, *1*(3), 77–83.

Fowles, S., & Clark, W. (2005). Innovation networks: good ideas from everywhere in the world. *Strategy and Leadership*, *33*(4), 46–50.

Freund, R. (2010). How to Overcome the Barriers Between Economy and Sociology With Open Innovation, Open Evaluation and Crowdfunding? *International Journal of Industrial Engineering and Management*, *1*(3), 105–109.

Gassmann, O. (2006). Opening up the innovation process: towards an agenda. *R&D Management*, *36*(3), 223–228.

Gassmann, O., Daiber, M., & Enkel, E. (2011). The role of intermediaries in cross-industry innovation processes. *R&D Management*, *41*(5), 457–469.

Gassmann, O., & Enkel, E. (2004). Towards a Theory of Open Innovation : Three Core Process Archetypes. In *R&D Management Conference (RADMA)* (pp. 1–18). Lisbon, Portugal.

Gwynne, P. (2007). Open Innovation's Promise and Perils. *Research Technology Management*.

Handfield, R. B., & Nichols, E. L. (1999). *Introduction to Supply Chain Management*. Englewood Cliffs: Prentice-Hall.

Huizingh, E. (2011). Open innovation: State of the art and future perspectives. *Technovation*, *31*(1), 2–9.

Jaspers, F., & van den Ende, J. (2010). Open innovation and systems integration: how and why firms know more than they make. *International Journal of Technology Management*, *52*(3/4), 275.

Katzy, B., Turgut, E., & Holzmann, T. (2013). Innovation intermediaries : a process view on open innovation coordination. *Technology Analysis & Strategic Management*, *25*(3), 295–309.

Koudal, P., & Coleman, G. C. (2005). Coordinating operations to enhance innovation in the global corporation. *Strategy and Leadership*, *33*(4), 20 – 32.

Lichtenthaler, U. (2009). Outbound open innovation and its effect on firm performance: examining environmental influences. *R&D Management*, *39*(4), 317–330.

Lichtenthaler, U. (2011). Open innovation: Past Research, Current Debates, and Future Directions. *Academy of Management Perspectives*, *25*(1), 75–93.

Lin, C. P., & Chen, S. (2012). The Role of Integration Mechanism in Open Innovation Team: An Exploratory Study on Cross-Field Student Team Contests. In *2012 Proceedings of PICMET '12: Technology Management for Emerging Technologies* (pp. 1953–1960). Vancouver.

Martinez, J. I., & Jarillo, C. J. (1989). The Evolution of Research on Coordination Mechanisms in Multinational Corporations. *Journal of International Business Studies*, *20*(3), 489–514.

Mikkola, J. H. (2001). Portfolio management of R&D projects: implications for innovation management. *Technovation*, *21*(7), 423–435.

Neyer, A. K., Bullinger, A. C., & Moeslein, K. M. (2009). Integrating inside and outside innovators: a sociotechnical systems perspective. *R&D Management*, *39*(4), 410–419.

Ouchi, W. G. (1978). The transmission of control through organizational hierarchy. *Academy of Management Journal*, *21* (2), 173–192.

Putzger, I. (1998). All the ducks in a row. *World Trade*, *11*(9), 54.

Ramirez-Portilla, A., Cagno, E., & Trianni, A. (2014). Is Innovation an enabler of Energy Efficiency? An exploratory study of the foundry sector. *Energy Procedia*, *61*, 1191–1195.

Reuter, V. G. (1977). Suggestion systems: utilization, evaluation, and implementation. *California Management Review*, 78–79.

Rothwell, R. (1992). Successful industrial innovation: critical factors for the 1990s. *R&D Management*, *22*(3), 221–240.

Saunders, M., Lewis, P., & Thornhill, A. (2003). *Research Methods for Business students* (3rd Ed., p. 614). Essex: Pearson Education Limited.

Sawhney, M., & Prandelli, E. (2000). Communities of Creation: Managing Distributed Innovation in Turbulent Markets. *California Management Review*, *42*(4), 24–54.

Schroll, A., & Mild, A. (2012). A critical review of empirical research on open innovation adoption. *Journal Für Betriebswirtschaft*, *62*(2), 85–118.

Scotchmer, S. (2004). *Innovation and Incentives*. Cambridge: The MIT Press.

Seidel, J. V. (1998). *Qualitative Data Analysis*. *Qualis Research* (pp. 1–15). Retrieved from http://www.scribd.com/doc/7129360/Seidel-1998-Qualitative-Data-Analysis

Sicotte, H., & Langley, A. (2000). Integration mechanisms and R&D project performance. *Journal of Engineering and Technology Management*, *17*(1), 1–37.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Grounded theory, procedures and techniques*. (Sage, Ed.). Newbury Park, CA.

Teubal, M., Yinnon, T., & Zuscovitch, E. (1991). Networks and Market Creation. *Research Policy*, *20*(5), 381–392.

Trott, P., & Hartmann, D. (2009). Why "Open Innovation" is old wine in new bottles. *International Journal of Innovation Management*, *13*(4), 715–736.

Van de Vrande, V., de Jong, J. P. J., Vanhaverbeke, W., & de Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, *29*(6-7), 423–437.

Van der Meer, H. (2007). Open Innovation; The Dutch Treat: Challenges in Thinking in Business Models. *Creativity and Innovation Management*, *16*(2), 192–202.

Vanhaverbeke, W. (2006). The Interorganizational Context of Open Innovation. In H. W. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), *Open innovation : researching a new paradigm*. Oxford: Oxford University Press.

Vanhaverbeke, W., & Cloodt, M. (2006). *Open Innovation in Value Networks*. (H. W.Chesbrough, W. Vanhaverbeke, & J. West, Eds.). Oxford: Oxford University Press.

Vaughan, B. (2009). A collaborative approach. *Password - Philips Research Technology Magazine*, 31.

Viskari, S., Salmi, P., & Torkkeli, M. (2007). *Implementation of Open Innovation Paradigm. Cases: Cisco Systems, DuPont, IBM, Intel, Lucent, P&G, Philips and Sun Microsystems*. Finland.

Von Hippel, E. (1986). Lead users: a source of novel product concepts. *Management Science*, *32*(7), 791–805.

Wallin, M. W., & Von Krogh, G. (2010). Organizing for Open Innovation: Focus on the Integration of Knowledge. *Organizational Dynamics*, *39*(2), 145–154.