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A framework for Open Innovation practices:
Typology and characterisation

María Isabel Rodríguez-Ferradas
University of Navarra

Jose A. Alfaro-Tanco
University of Navarra

Francesco Sandulli
University Complutense of Madrid

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ABSTRACT

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The main objective of this research is to conduct a comprehensive literature review of OI practices, which is necessary to clarify the concept and propose more precise terminology. In this study, we develop a theoretical framework that identifies and defines 19 different OI practices typologies, according to three dimensions: direction of resources flow, innovation process stage, and type of relationship.

This paper makes a relevant contribution from two perspectives: academic and managerial. From the academic perspective, our work opens the door to future research directions in the OI field that if based in the proposed theoretical framework, could help strengthen the theoretical foundations of this innovation management paradigm. In terms of the managerial view, this new typology of OI practices could help managers select more appropriate practices according to their needs and resources.

María Isabel Rodríguez-Ferradas
University of Navarra

Jose A. Alfaro-Tanco
University of Navarra

Francesco Sandulli
University Complutense of Madrid

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María Isabel Rodríguez-Ferradas¹

José A. Alfaro-Tanco²

Francesco Sandulli³

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Keywords: Open innovation, Openness, Practices, Literature review

¹ Area of Industrial Design, Department of Mechanical Engineering, TECNUN - University of Navarra, Spain. P^o Manuel de Lardizabal, 13. 20018 San Sebastián, Spain. mirodriguez@tecnun.es

² Department of Business Administration, School of Economics - University of Navarra, Spain. Campus Universitario s/n. 31009 Pamplona, Spain. jalfaro@unav.es (*Corresponding author*).

³ Department of Management, School of Economics and Business - University Complutense of Madrid. Campus de Somosaguas. 28223 Pozuelo de Alarcón (Madrid), Spain. sandulli@ccee.ucm.es

Highlights

- We discuss the need for a conclusive list of open innovation practices.
- We discuss results from our review of the literature on open innovation practices.
- We identify 19 different typologies of open innovation practices.
- We analyse dimensions used to characterise open innovation practices.
- We propose a theoretical framework to classify open innovation practices.
- This framework can underpin a practical approach to the selection of open innovation practices.

1. Introduction

The research field of Open Innovation (OI) has grown exponentially since Chesbrough coined the term in 2003, which he later defined as “the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation” (Chesbrough et al., 2006).

OI has been widely reported in the literature on innovation management research, but in spite of the growing body of the literature on openness, there is a lack of clarity and a degree of dissatisfaction in the research community with the evolution of the concept. After more than ten years of the emergence of the OI paradigm, there remain some under-researched areas that could help managers better understand how to implement OI, as has been noted in published reviews of the OI literature in recent years (Dahlander and Gann, 2010; Huizingh, 2011; Remneland-Wikhamn and Wikhamn, 2013).

Critical voices from the research community around the OI paradigm are increasingly louder, claiming the need for further research on issues that may contribute to the reinforcement of the theoretical foundations of the OI paradigm, such as developing more precise terminology (Elmqvist et al. 2009), providing further insights into practices and tools for managing OI processes (Lichtenthaler 2011), and developing a coherent typology of OI modalities according to their level of openness and interactivity (Penin et al. 2011).

One of the most common complaints of researchers is the lack of a comprehensive and unified list of typologies of OI practices in the literature (Van de Vrande et al. 2009; Lee et al. 2010; Lichtenthaler 2011; Bellantuono et al. 2013; Rass et al. 2013), which has negative consequences to advancing the understanding of the OI model in two key areas. On the one hand, from the theoretical point of view, it hinders the comparison of findings by different researchers in the field (Dahlander and Gann, 2010). On the other hand, from the managerial point of view, it makes it very difficult for managers select the most appropriate practices according with their needs and resources. Many references from the literature emphasise the importance of research on how firms can implement OI (Chesbrough and Crowther, 2006; Dahlander and Gann, 2010; Pisano and Verganti, 2008; Raasch et al., 2008; Bilgram et al., 2008).

In this paper, we focus on the concept of OI practices that Huizingh (2011) defines as “the processes that managers start when deciding ‘when, how, with whom, with what purpose, and in what way should they cooperate with external partners’”. Our work addresses the research gap of the identification, definition and characterisation of the several OI practices typologies in a systematic way through an extensive review of OI literature.

The research questions guiding our literature review are the following: Which OI practices have been identified by the literature on OI? Which dimensions have been used by the research community to characterise OI practices?

From the literature review, we obtain different and relevant findings. First, we propose a comprehensive list of 19 different OI practices typologies, which have been reported by researchers in both qualitative and quantitative studies, enriched with clear definitions and references from the literature, that are a path to deepen existing knowledge around each practice. Second, we extend our literature review to the dimensions that authors of the OI literature have used to compare or classify OI practices. Our approach allows us to identify seven dimensions and to define from each of them the range of values they can take. Third, we develop an in-depth analysis of the most relevant literature references from each of the 19 OI practices to find the values of those three specific dimensions: direction of resources flow, type of partners, and innovation process stage. Moreover, we propose a new dimension, named type of relationship, which is related to the number of partners needed to implement an OI practice and, consequently, the complexity of implementing it.

Finally, we synthesise our results in a novel theoretical framework that classifies the 19 OI practices typologies in relation to three dimensions: direction of resources flow, innovation process stage, and type of relationship. This research helps to enrich the OI literature because the proposed theoretical framework permits us to show graphically the OI practices from three different points of view. Moreover, from a managerial viewpoint, this new classification of typologies of OI practices could help managers to select the most appropriate practices according to their needs and resources.

This paper is structured as follows: First, in section two, we present our review method. Second, in section three, we summarise the results of our literature review

on OI practices and present the different typologies of OI practices identified. Next, in section four, we analyse which dimensions are used in the literature to characterise OI practices. In section five, we propose the theoretical framework that relates OI practices and dimensions. Finally, in section six, we discuss the implications for theory and practice and propose future research lines derived from our work.

2. Review method

We performed a systematic literature search of publications through April 2014 in the ISI database in addition to two additional innovation journals, the European Journal of Innovation Management and the International Journal of Innovation Management, which are not covered by this database but are relevant to the OI literature. The search criteria used were the selection of items that contain the terms "open innovation" or "openness" in the topic or title fields. Naturally, there are publications closely related to OI that do not use these terms, but this lies outside the scope of this research. Further, to refine the search on the ISI database, the following areas of knowledge were selected: Business economics; Engineering; and Operations research and management science. This search returned a total of 331 papers.

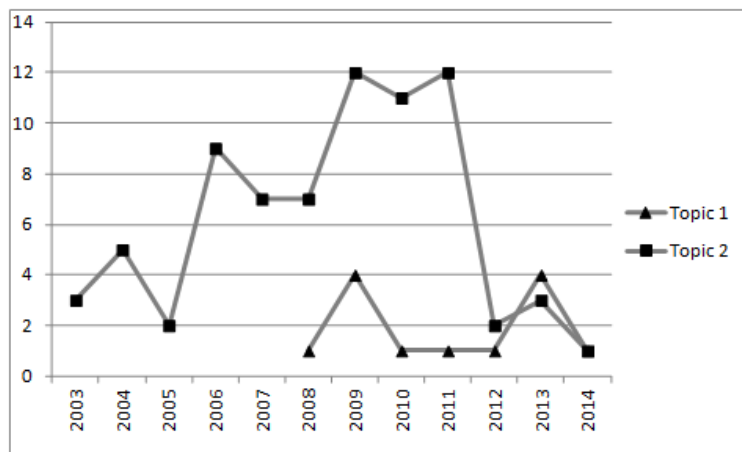
As a first screening, we reviewed abstracts for each of these 331 publications to determine whether each was related to our research. When an abstract was inconclusive, the full paper was examined before making a decision. This filtering resulted in a shorter list of 80 selected papers, which were classified based on two main topics: Topic 1, which encompassed 10 papers that included proposals of classification of OI practices typologies, and Topic 2, which referred to other 70 papers focusing on research on specific OI practices.

At this stage, we built a database to store all relevant information for each selected article. More specifically, the fields that this database contains are the following: authors, year of publication, journal, topic, typologies of OI practices, research methodology, and a field of remarks to highlight some of the relevant contents of each paper. Then, the full papers were examined to complete the database.

Moreover, from the analysis of these articles, we found 8 additional references from new sources. Six of these articles are from journals not covered by our initial research, and the other two are from conferences, but we find that all of them are

relevant to our research objectives. Therefore, we included these additional publications in our database. Finally, our database included 88 publications, 13 were classified in Topic 1, the proposals of classification of OI practices, and 75 were classified in Topic 2, which included papers focused on research on specific OI practices.

From the analysis of all the items included in our database, we also obtained information that helps to understand the evolution of research on OI practices over the last decade. At first sight, it is interesting to note the number of articles published per year on both topics included in our database. As Figure 1 shows, the majority of the articles we considered were published between 2009 and 2011.



Source: Own database

Fig. 1. Articles published per year by topic. For 2014, the graphs show only the number of publications from January to April.

Regarding the journals in which these articles were published, in Table 1 we show the eight journals that contain more than a sixty per cent of these publications, while the rest are widely distributed among other 38 publications. This result indicates that the topics included in our literature review arouse the interest of a wide community of researchers.

Journals	No. of papers	Indexed	Impact Factor (2012)
Technovation	12	Yes	3.177
R&D Management	11	Yes	1.58
Research Technology Management	9	Yes	0.712
Creativity and innovation management	5	Yes	0.855
Research Policy	5	Yes	2.850
California Management Review	4	Yes	1.667
European Journal of Innovation Management	3	No	-
International Journal of Innovation Management	3	No	-
Journal of Product Innovation Management	3	Yes	1.379
Other publications (with less than 3 papers in the database)	33	-	-
Total	88		

Table 1. Most relevant journals in relation to research on OI practices

Source: Own database

Other interesting information that can be drawn from our database analysis relates to the research methodologies applied in these publications. As we can see in Table 2, a summary of the results from this analysis shows that qualitative research methods are predominant, receiving more than twice as many references as quantitative methods.

These results can be explained by the difficulties encountered by researchers in collecting quantitative data in a field of research where the basis on which to build their studies continues to be confused.

Methodology	Number of papers
Qualitative	49
Quantitative	23
Combination of both	7
Review of literature	9
Total	88

Table 2. Distribution of analysed publications by research methodology

Source: Own database

The next step in our research methodology was to construct a first list of 16 OI practices typologies obtained through a detailed review of the 13 publications classified in Topic 1 of our database. The work performed to achieve this first list also provided us some interesting conclusions regarding the state of the art that reinforced the existence of the research gap addressed with our research, which are detailed in section 3 of this paper.

From this initial list of typologies of OI practices, we proceeded to a thorough analysis of the publications included in Topic 2 of our database. The objectives of this analysis were the following:

- Check if all the OI practices exposed in these articles were already included in our list or not, to identify new typologies.
- Find relevant information in relation to each typology of OI practice, which will be useful for describing each of them, such as proposed definitions by researchers, most relevant references from the literature, and examples of applications by companies.

These objectives were achieved, and three new typologies of OI practices that were not included in the first list were added. We also obtained enough information to provide a rich description of each of the 19 OI practice typologies.

Subsequently, we again reviewed all publications included in our database to identify different dimensions that researchers have used to compare or classify OI practices,

and for each dimension we looked for information about the range of values that it could take, a brief description of what each value meant, and the most relevant references where this information was found. The result of this review was the identification and characterisation of 7 different dimensions.

The next task in our research was to identify which dimensions we could assign values based on the information about each typology of OI practice included in the publications ranked in Topic 2 of our database. As a result of this analysis, we found that with the information contained in these publications, we could assign values for three of the identified dimensions: direction of resources flow, types of partners, and innovation process stage. Then, we characterised the 19 typologies of OI practices by specifying the values for these 3 dimensions and obtained some interesting conclusions in relation to this mapping, which are included in following sections. At this stage, we also proposed a new dimension, named type of relationship, which can help to understand the level of complexity for implementing each OI practice.

Finally, we discuss what dimensions can provide the most valuable information to managers for selecting the most appropriate practices for opening their innovation according to their needs and resources, and according to our conclusions, we propose a novel theoretical framework that classifies the 19 OI practices typologies in relation to three dimensions: direction of resources flow, innovation process stage, and type of relationship.

3. Literature review on OI practices

As was mentioned in section 2, from the review of the literature we found 13 articles that proposed OI practices classifications. In Appendix A, we present a summary of the contents of these 13 publications in relation to our research objectives as well as the list of OI practices proposed in each of them. When analysing these publications, we reached some preliminary conclusions that were still amazing despite, in some cases, being expected. The first is that different authors use different terms to refer to OI practices: modes (Pisano and Verganti, 2008; Poot et al. 2009; Lee et al. 2010); activities (Van de Vrande et al. 2009; Parida et al. 2012; Mina et al. 2013; Remneland-Wikhamn and Wikhamn 2013); practices (Leimester et al. 2009; Theyel 2013; De Araújo et al. 2014); instruments (Rohrbeck et al. 2009; Hilgers 2011; Rass

et al. 2013). We may observe as there is not a predominant concept, which is a fact that clearly adds confusion to this research stream.

The second is that several of these publications indicate that the list of OI practices is based on a review of the literature, but the authors have not included details on the methodology and sources used to produce them (Van de Vrande et al. 2009; Leimester et al. (2009); De Araújo et al. 2014).

Finally, we realised that each author proposes a different list of OI practices typologies and the dimensions used to describe or classify these OI practices are also diverse.

From the qualitative analysis of these publications, we construct a list of 16 OI practices typologies, which is included in a table in Appendix B, where we present the references each OI practices typology comes from. This qualitative review was performed with a critical discussion among the three authors of this paper of each of the OI practices proposed by the different authors. As a result of this critical review, the following practices proposed by these 13 publications were initially excluded from our list:

- Involvement of non-R&D workers (Van de Vrande et al. 2009) and collaboration with other enterprises within the enterprises group (Poot et al. 2009): Where to place the boundaries of the firm is an open issue in the OI literature. On this point, we decided to restrict our research to OI practices in which the firm collaborators are totally external agents, meaning from outside the firms or even the enterprises group that the firm belongs to.
- Internet toolkits (Leimester et al. 2009) or on-line toolkits (Hilgers 2011): In the literature, the use of IT toolkits appears as a tool used to facilitate the interaction with external agents in more than one OI practice, such as crowdsourcing (OIP2) (Leimester et al. 2009) or idea competition (OIP4) (Piller and Walcher 2006; Adamczyk et al. 2012). Therefore, we consider these to be tools used to implement different typologies of OI practices, but are not OI practices in themselves.
- Spin-outs (Rohrbeck et al. 2009): We consider this to be one of the forms that corporate venture capitalism can take, and therefore, we do not separate it as a different OI practice.

- Test market (Rohrbeck et al. 2009): This is a stage of the innovation process, but not an OI practice as far as whether it can be developed in a closed or open way, and therefore, it cannot be considered an OI practice.
- Using the internet to search for new trends or technology, reading technical magazines, using information from trade organisations, and participating in innovation-related fairs or shows (De Araújo et al. 2014): We consider these to be practices for market and technology intelligence that can be developed in a closed or open way and therefore cannot be considered OI practices.

From this initial list of 16 typologies of OI practices, we proceeded to a thorough analysis of the publications ranked in Topic 2 of our database. The objectives of this analysis were the following: First, we completed our preliminary list with new typologies of OI practices that were not included in that list. Second, we identified articles of reference in relation to each typology of OI practice to look for detailed definitions of each OI practices and examples of their use in firms. Finally, we completed the rest of the fields in our database for each of these 75 publications, such as all the typologies of OI practices mentioned in each of them, research methodology, and comments to highlight some of the relevant contents of each paper in relation to our research objectives.

As a main result from this analysis, we added three new typologies of OI practices to our list: regional innovation clusters, staff exchanges, and scientific committees. In addition, we upheld the exclusion decisions to construct the preliminary list of 16 OI practices typologies. Finally, we found enough information in these publications to complete Table 3, where we present our final proposal of these 19 OI practices typologies, with a detailed definition of each of them, recommended references from the literature to explore each typology, and the identification of examples of application by different companies. As was the case of the terms used to refer to OI practices, in some cases different authors in the literature used different names to refer to the same typologies of practices. Therefore, to facilitate understanding, in the second column of Table 3, where we include the name of the typologies of OI practices, we specify in brackets other names used in the literature to refer to the same OI practice.

OI practices typologies (other terms used for the same practices)		Definition	Recommended references from the literature	Application examples
OIP 1	Corporate venture capitalist	Venture capital initiatives where a parent organisation provides support (finance, human capital, networking, etc.) to external partners (typically start-ups, spin-offs or spin-outs) aligned with a portfolio of specific technologies, of interest for the parent company, for exploring new business opportunities. In exchange of this support the parent organisation may lead either to further value creation, strategic alliances or to the "spinning-in" of a successful initiative (adapted from Van de Vrande et al. 2009)	Kirschbaum 2005; Van De Vrande et al. 2009; Mortara and Minshall 2011	DSM Venturing & Business Development; T-Venture from Deutsche Telekom; Panasonic Venture Group; Samsung venture investment; Dell Ventures; Cisco Investments; Intel Capital
OIP2	Crowdsourcing	Crowdsourcing is the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call (Howe, 2006).	Kleemann et al. 2008; Enkel et al. 2009; Sandulli and Chesbrough 2009; Bartl et al. 2010; Howe 2006; Baldwin and von Hippel 2011; Schroll and Mild 2011; Poetz and Schreier 2012	Fiat 500 and Fiat Mio initiatives from Fiat; Dell's "Idea Storm"; Threadless.com; IBM Innovation Jam; Bamed/ MAM Group
OIP3	Endowed chairs	Research undertaken mainly in universities and/or research centres, using financial support from companies that will benefit from the exploitation of this knowledge in medium-long term (own construction).	Perkmann and Walsh 2007; Buganza and Verganti 2009; Rohrbeck et al. 2009	Deutsche Telekom
OIP4	Innovation contests (Idea competition; Idea prizes)	Time-limited competitions arranged by an organisation, calling on the general public or a specific target group, to make use of their expertise, skills or creativity to submit a solution for a particular task previously defined by the organiser who strives for an innovative solution and offer some incentives for participants (prices can be cash, nonmonetary or mix of both types) (adapted from Terwiesch and Xu, 2008)	Piller and Walcher 2006; Terwiesch and Xu 2008; Ebner et al. 2009; Leimester et al. 2009; Hutter et al. 2011; Adamczyk et al. 2012; Rass et al. 2013	P&G's YET2.com; Salomon Design Contest; BMW's Urban Driving Experience Challenge design competition; Miadidas from Adidas; SAPIens from SAP; Initiative D21 from Siemens; Motorola: Motofwrd; Fujitsu Siemens: Innovation; Henkel Innovation Challenge; "Emotionalize your light" from Osram; Swarovski's jewellery design competition; BMW's Urban Driving Experience Challenge
OIP5	Innovation marketplaces (Intermediaries; Markets for ideas)	IT marketplaces that act as middlemen between searchers (i.e., organisations or individuals who look for a specific solution) and solvers (i.e., organisations or individuals who possess relevant capabilities to solve a certain problem) (Sieg et al. 2010)	Wallin and Von Krogh 2010; Sieg et al. 2010; Rass et al. 2013; Natalicchio et al. 2014	Innocentive; Ideacrossing; NineSigma; yet2.com; IdeaConnection; YourEncore

OIP6	Innovation networks (Networks of creation)	Participants from diverse institutional settings collaborate over longer periods of time to create new knowledge, to learn from one another and to appropriate and build on one another's work-all under the guidance of a network organiser (adapted from Brown and Hagel 2006, Dittrich and Duysters 2007)	Gassmann and Enkel 2004; Brown and Hagel 2006; Dittrich and Duysters 2007; Pisano and Verganti 2008; Tether and Tajar 2008; Chiaroni et al. 2011; Van de Vrande et al. 2009; Di Minin et al. 2010; Lambert and Schaeffer 2010; Lee et al. 2010; Brunswicker and Vanhaverbeke 2011; Mortara and Minshall 2011; Rondani et al. 2013	PortalPlayer; Nokia; TXActive club from Italcementi; Fiat; BMW car control mechanism – iDrive
OIP7	Inward licensing of IP (Purchased licences; IP in-licensing; Licensing-in)	Buying or using intellectual property, such as patents, copyrights or trademarks, of other organisations to benefit from external knowledge (Van de Vrande et a. 2009)	Tao and Magnotta 2006; Chesbrough 2007; Van de Vrande et al. 2009; Spithoven et al. 2010; Bianchi et al. 2011; Parida et al. 2012; De Araújo et al. 2014	Spin Brush from P&G
OIP8	Joined development (Joint research; Joint R&D)	Collaborations along the value chain, targeted at a certain product or market that can be joint research projects, consortia or programs with an exchange of knowledge, people and resources (adapted from Rohrbeck et al. 2009).	Chesbrough 2007; Dittrich and Duysters 2007; Tether and Tajar 2008; Rohrbeck et al. 2009; Spithoven et al. 2010; Mina et al. 2013; Theyel 2013	IBM's Microelectronics Joint Development Alliance consortia; Nokia joint development agreement with Nordea Bank and Visa International
OIP9	Joint venture	A joint venture is used for the transfer of organisationally embedded knowledge which cannot be easily blueprinted or packaged through licensing or market transactions and normally are chosen only for high-relevant long-term projects (Lazzarotti et al. 2013).	Gassmann and Enkel 2004; Tao and Magnotta 2006; Chesbrough and Schwartz 2007; Lazzarotti et al. 2013	Joint venture of P&G with Clorox, one of its oldest competitors; Joint venture of Pininfarina and Webasto to develop convertible roofs; Joint venture of Bosch with MAHLE GmbH to develop exhaust gas turbochargers for gasoline and diesel engines; Joint venture of Bosch with Samsung for the development of lithium-ion batteries
OIP10	Lead user method (User co-creation)	This method consists on systematic identification and collaboration with lead users in new product development (Bart et al. 2010). Lead users are characterised by two fundamental criteria: First, they experience certain needs significantly	von Hippel 1986; Lüthje and Herstatt 2004; Piller and Walcher 2006; Bilgram et al. 2008; Leimester	3 M; Johnson & Johnson Medical; Hilti; Phillips

		earlier than the bulk of the market and thus serve as a "need-forecasting laboratory". Second, they are positioned to benefit notably from innovative solutions (von Hippel, 1986; Lüthje and Herstatt, 2004).	et al. 2009; Wallin and von Krogh 2010; Bartl et al. 2010; Parida et al. 2012	
OIP11	Made own innovation available to others for free (Free revealing; Donation to commons or nonprofits; Open source communities)	The category of revealing captures attempts of companies to reveal innovative resources to the environment in exchange for indirect benefits as opposed to financial rewards (adapted from von Hippel and von Krogh 2006).	von Hippel and von Krogh 2006; Chesbrough 2007; Dahlander and Magnusson 2008; Brunswicker and Vanhaverbeke 2011	Hewlett Packard, IBM, Sun, MySQL
OIP12	OI communities (User community; Community for Innovations)	Voluntary association of actors, typically lacking in a priori common organisational affiliation (i.e., not working for the same firm) but united by a shared instrumental goal—in this case, creating, adapting, adopting or disseminating innovations (West and Lakhani 2008)	Fuller et al. 2004; Dahlander and Wallin 2006; West and Lakhani, 2008; Dahlander and Magnusson 2008; Di Gangi and Wasko 2009; Ebner et al. 2009; Wallin and von Krogh 2010; Rass et al. 2013	Harley-Owners-Group; developers village of Siemens; womensnet of Henkel; Advisory community of Procter and Gamble; Dell's "Idea Storm"; Garage Maemo project from Nokia; Propellerhead
OIP13	Outsourcing R&D (R&D subcontracting)	Buying R&D services from other organisations, such as universities, public research organisations, commercial engineers or suppliers. There is generally a clear customer–supplier relationship between the innovation creator and a firm seeking innovations from external sources (adapted from Van de Vrande et al. 2009)	Gassmann and Enkel 2004; Narula 2004; Cassiman and Valentini 2009; Mortara and Minshall 2011; De Araújo et al. 2014	German MTU Aero Engines and the American engine manufacturer Pratt & Whitney; DaimlerChrysler outsourcing with BASF for varnishing products
OIP14	Outward licensing of IP (Licensing-out; Out-licensing)	Selling or offering licences or royalty agreements to other organisations to better profit from your intellectual property, such as patents, copyrights or trademarks (Van de Vrande et a. 2009).	Gassmann and Enkel 2004; Chesbrough 2007; Bianchi et al. 2011; Lichtenthaler 2010; Wallin and von Krogh 2010; Lazzarotti et al. 2013; De Araújo et al. 2014	IBM; Air Products; Dow Chemicals; Lucent Technologies; Philips; Saab; Schindler
OIP15	Regional innovation clusters	These so-called regional innovation clusters are a specific form of networks and play a central role in generating new knowledge and regional competitive advantage. The concept of geographical clustering has been raised by Alfred Marshall as early as 1921, but especially has recently gained importance in the light of increasing innovation efforts (Bullinger et al. 2004).	Bullinger et al. 2004	The tri-national BioValley along the upper river Rhine valley comprising Alsace in France, South Baden in Germany and the area around Basle, and Switzerland
OIP16	Scientific committee (Advisory review boards)	A group of external specialists on the technologies of interest for the firm, that maintain regular contacts with the firm to bring information about the advances in relation with those technologies, identify experts for arranging collaborations,	Dogson et al. 2006; Chiaroni et al. 2011	Italcementi's Scientific Committee; P&G's Technology Entrepreneurs network; Novartis; Hoffmann LaRoche

		evaluate proposed projects (adapted from Chiaroni et al. 2011)		
OIP17	Shared facilities/facilities sharing	Shared Facility: A joint investment in new facilities by multiple organisations, with the goal to share and exploit the facilities together, to ensure a high level of usage and reduce the overall costs. Facility Sharing: Sharing of existing facilities with third parties, to increase the level of usage and reduce the overall costs (SFFS project 2012)	Mina et al. 2013; EURIS -SFFS 2012	Volvo Group; Philips High Tech Campus Eindhoven (Netherlands); (1) Shared facilities: Automotive Intelligence Center (AIC) from Spain, Lindholmen Science Park - Test Site Sweden - Active Safety Test Area from Sweden, Dutch Integrated Testsite for Cooperative Mobility from the Netherlands, AutomotiveCampusNL – Automotive Facility Brainport from the Netherlands (EURIS project); (2) Facilities sharing: Center of Automotive Research on Integrated Safety Systems and Measurement Area from Germany, Flanders' DRIVE from Belgium, Ford Lommel Proving Ground from Belgium, Benteler Engineering Services from the Netherlands
OIP18	Staff exchanges (Personnel Exchange; Human resource transfer)	Temporary mobility of researchers between different organisations to promote or develop innovation activities (own construction)	Perkmann and Walsh 2007; Awazu et al. 2009; Di Minin et al. 2010; Ili et al. 2010; Lazzarotti et al. 2013	ZF Friedrichshafen AG; Fiat; Pininfarina
OIP19	Technology scouting	Collaborate with external partners to systematically assessing and observing technology trends to detect opportunities and encounter threats in a timely manner (adapted from Parida et al., 2012)	Ili et al. 2010; Mortara and Minshall 2011; Parida et al. 2012; Lazzarotti et al. 2013	The BMW Group's technology scouting office in Palo Alto, California; Daimler and VW 'trend-scouts' in North America and Tokyo

Table 3. Final proposal of typologies of OI practices

Additional interesting conclusions reached from this analysis were the clarification of some relationships between different typologies of OI practices. We realised the confusion in the literature between innovation contest (OIP4) and innovation marketplaces (OIP5). There are several examples of this confusion in the articles

analysed, such as the reference to Innocentive as a user idea competition (OIP4) in Piller and Walcher (2006), when Innocentive mainly offers services to solve technological challenges for their customers with the contribution of external technological experts. We decided to treat them as separate practices because from the review of the literature, we can clearly find differences between both, such as the fact that while innovation marketplaces are IT platforms exploited by an intermediary company that join demand for and offering of innovative ideas and technologies, innovation contests are generally implemented by organisations that look for innovative ideas for their own benefit.

We also realised confusion between innovation networks (OIP6), crowdsourcing (OIP2) and innovation communities (OIP12); a clear example could be Dell's IdeaStorm initiative, which different authors classify in these different typologies of OI practices (Di Gangi and Wasko 2009; Badawy 2011, Adamczyk et al. 2012).

Another interesting finding is that some specific typologies of OI practices, such as innovation contests (OIP4), can be used as a first step for other OI practices, such as innovation networks (OIP6), lead user methods (OIP10) (Piller and Walcher, 2006), or innovation communities (OIP12) (Ebner et al. 2009). Another example of this effect can be innovation networks (OIP6) that may evolve into formal collaborative efforts, such as R&D partnerships (OIP8) (Van de Vrande et al. 2009). This indicates that there are relationships between different OI practices that would be interesting to analyse in more detail in future research.

In relation to the practices excluded from our preliminary list, after this analysis of papers ranked in Topic 2, we did not find reasons to rescue any of them. From this analysis, we also identified another possible OI practice called Living Labs, but after a critical review of papers ranked in Topic 2, we realised that Living Labs are considered infrastructure that can be used to implement some OI practices, such as the lead-user method (OIP10) (Liedtke et al. 2011), and we decided to consider this practice to be a particular form of shared facilities (OIP17).

We also found some similarities between innovation networks (OIP6) and regional clusters (OIP15). Regional clusters (OIP15) seem to be a particular modality of innovation networks (OIP6) characterised by the importance of local proximity (Bullinger et al. 2004). We decided to treat them as separate practices because after

the analysis of the literature, we did not find references that clarify the relation between the two practices.

Finally, it may be interesting to remark that the outsourcing of R&D (OIP13) is the typology of OI practices in which there are more cross references with other streams of research, such as R&D collaboration, that do not explicitly reference the OI concept.

4. Characterisation of OI practices: dimensions and findings

Dimensions can be defined as variables identified to describe open innovation practices (Bellantuono et al. 2013). Our source for identifying the dimensions of OI practices were all the papers included in our database. We review these articles to identify different dimensions and to achieve from each dimension the following information: the references of the literature where the dimensions are proposed or used, the different values that the dimension can take, and a brief definition of each value's meaning. The results of this analysis are presented in Table 4.

Dimension	References	Range of Values	Description
Participation	Pisano and Verganti, 2008	Open	Everyone (suppliers, customers, designers, research institutions, inventors, students, hobbyists, and even competitors) can participate. A sponsor makes a problem public and then essentially seeks support from an unlimited number of problem solvers, who may contribute if they believe they have capabilities and assets to offer.
		Closed	Closed OI practices, in contrast, are like private clubs, where a company shares a problem with a few parties that it selects because it believes they have the crucial capabilities and assets to provide innovative solutions. When you use a closed mode, you are making two implicit bets: that you have identified the knowledge domain from which the best solution to your problem will come and that you can pick the right collaborators in that field.
Governance structure	Pisano and Verganti, 2008; Lazzarotti et al. 2010; Mortara and Minshall 2011	Hierarchical	In the hierarchical form, a specific organisation has this authority, which provides it with the advantage of being able to control the direction of the innovation efforts and capture more of the innovation's value. Hierarchical governance is desirable when your organisation has the capabilities and knowledge needed to define the problem and evaluate proposed solutions.
		Flat	In the flat form, these decisions are either decentralised or made jointly by some or all collaborators; the advantage here is the ability to share with others the costs, risks, and technical challenges of innovating.
Direction of resources flow	Gassman and Enkel, 2004; Rohrbeck et al.	Inbound or Outside-in or Technology exploitation	Purposive inflows of knowledge to capture and benefit from external sources to enhance current technological developments.
		Outbound or	Purposive outflows of knowledge to leverage existing

	2009; Van de Vrande et al. 2009; Lazzarotti et al. 2010; Mortara and Minshall 2011; Rass et al. 2013; De Araujo et al. 2014	Inside-out or Technology exploration	technological capabilities outside the boundaries of the organisation.
		Coupled	Inside-out and outside-in processes are combined and partners share complementary resources.
Types of partners	Poot et al. 2009; Lazzarotti et al. 2010	Competitors	This dimension can take as many different values as there are different types of partners for OI practices.
		Suppliers	
		Clients or customers	
		Consultancies	
		Universities	
		Research institutes	
		Other organisations	
Innovation process stage	Rohrbeck et al. 2009; Lazzarotti et al. 2010; Theyel, 2013	Idea generation	Including any sources and activities that contribute to the development of a new innovation.
		Research	Instruments directed at facilitating research collaboration or in-sourcing technologies.
		Development	Activities aimed at engaging with partners in the creation of new products or new services.
		Commercialisation	Activities that engage with outside partners to bring technologies or products/services to market.
Governance mechanisms or modes of governance	Mina et al. 2013; Rass et al. 2013	Formal	Engaging in contractual arrangements, operating on the basis of market prices, as a formal framework for cooperation.
		Informal	Unstructured interaction with collaborators or sharing un-codified know-how with other firms. In these types of activities, collaboration tends to be based on mutual trust and moral obligations rather than legally binding contracts.
Change impetus for the adoption of OI	Mortara and Minshall 2011	Top-down	A direct intervention of top managers who became convinced of the need for OI practices implementation.
		Evolutionarily	Achieved as a result of adaptation to the environment.

Table 4. Dimensions to characterise OI practices

At this point in our investigation, we decided to continue working on the characterisation of the types of open innovation practices, with only those dimensions that allowed for assigning values for the 19 typologies of practices presented in Table 2, using information from the publications included in our database. Thus, we may have different views of the same typologies of OI practices as a function of the dimensions used to describe them.

In accordance with this criterion, three of the dimensions were selected to continue with our research: direction of resources flow, type of partners, and innovation

process stage. For each of the 19 typologies of OI practices, we conducted in-depth research on the papers included in our database to identify the values that each of these three dimensions can take.

4.1. Direction of resources flow

The most widespread definition of the possible values of this dimension is that of Gassman and Enkel (2004), which describes the following three core process for OI practices:

(1) The outside-in process: enriching the company's own knowledge base through the integration of suppliers, customers and external knowledge sourcing can increase a company's innovativeness.

(2) The inside-out process: earning profits by bringing ideas to market, selling IP and multiplying technology by transferring ideas to the outside environment.

(3) The coupled process: coupling the outside-in and inside-out processes by working in alliances with complementary partners in which give and take is crucial for success.

Assuming these definitions, we reviewed the papers identified in the field "Recommended references from the literature" of Table 3, to find information that confirms the value that this dimension can take for each OI practices typology.

The following figure (Figure 2) summarises the classification of each OI practices typology according to these three possible values for the direction of resources flow:

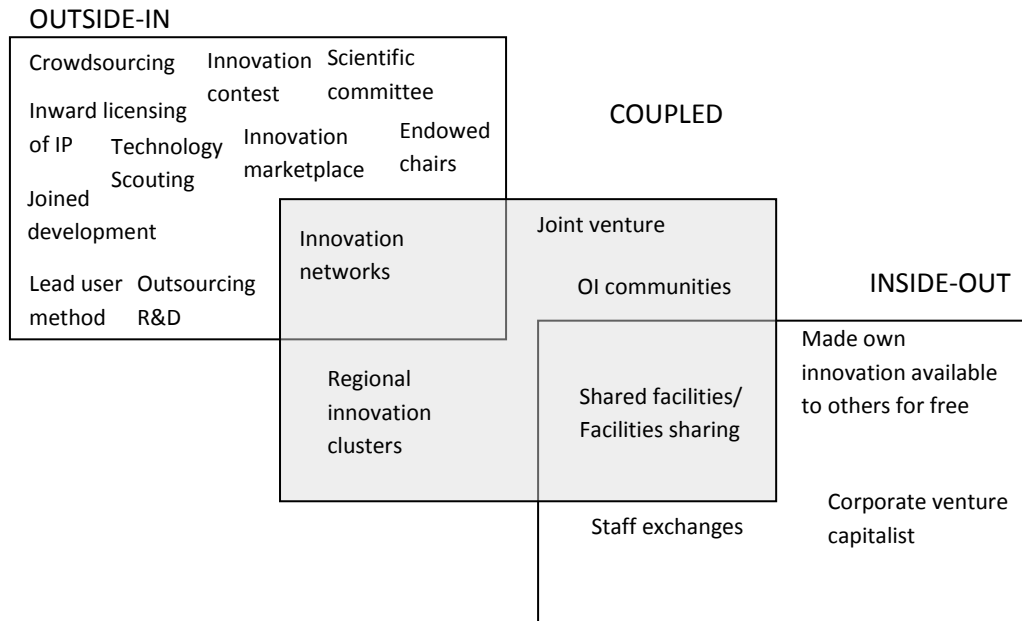


Figure 2. Classification of typologies of OI practices according to the “direction of resources flow” dimension

As seen in Figure 2, there are two specific typologies, innovation networks and shared facilities/facilities sharing, that the literature classifies with dual values on this dimension.

4.2. Types of partners

A starting point for the idea of openness is that a single organisation cannot innovate in isolation. It has to engage with different types of partners to acquire ideas and resources from the external environment to stay abreast of competition (Chesbrough, 2003a; Laursen and Salter, 2006).

The way the innovation process can be opened has been studied in innovation and technology literature based on the number and typologies of partners (von Hippel, 1986; Pisano and Verganti, 2008; Enkel et al., 2009; Keupp and Gassmann, 2009).

From the qualitative analysis of the papers included in our database, we found the several relationships between the dimension “Types of partners” and the 19 typologies of OI practices, which are shown in Table 5.

		Types of partners				
OI practices		Suppliers	Customers/Users	Universities	Competitors	Other companies
OIP 1	Corporate venture capitalist			Vanhaverbeke et al. 2008		Vanhaverbeke et al. 2008
OIP2	Crowdsourcing		Enkel et al. 2009; Kleemann et al. 2008; Poetz and Schreier 2012			
OIP3	Endowed chairs			Chesbrough 2003		
OIP4	Innovation contests		Ebner et al. 2009; Leimester et al. 2009; Hutter et al. 2011	Adamczyk et al. 2012; Ebner et al. 2009		
OIP5	Innovation marketplaces					Natalicchio et al. 2014
OIP6	Innovation networks	Bigliardi and Galatti 2013; Dittrich and Duysters 2007	Bigliardi and Galatti 2013; Brunswicker and Vanhaverbeke 2011; Di Minin et al. 2010; Dittrich and Duysters 2007	Bigliardi and Galatti 2013; Chiaroni et al. 2011; Di Minin et al. 2010; Lambert and Schaeffer 2010; Lee et al. 2010	Dittrich and Duysters 2007	Dittrich and Duysters 2007; Lambert and Schaeffer 2010; Lee et al. 2010
OIP7	Inward licensing of IP			Bianchi et al. 2011		Bianchi et al. 2011
OIP8	Joined development	Theyel 2013	Theyel 2013	Chesbrough 2007		
OIP9	Joint venture	Lazzarotti et al. 2013			Chesbrough and Schwartz 2007	
OIP10	Lead user method		von Hippel 1986; Di Gangi and Wasko 2009			
OIP11	Made own innovation available to others for free	von Hippel and von Krogh 2006	von Hippel and von Krogh 2006		von Hippel and von Krogh 2006	
OIP12	OI communities		Di Gangi and Wasko 2009	Ebner et al. 2009		
OIP13	Outward licensing of IP				Lazzarotti et al. 2013	Lichtenthaler 2010
OIP14	Regional innovation clusters	Bullinger et al. 2004	Bullinger et al. 2004	Bullinger et al. 2004		Bullinger et al. 2004
OIP15	Outsourcing R&D	Rammer et al. 2009	Rammer et al. 2009	Rammer et al. 2009; Narula 2004		
OIP16	Scientific committee			Chiaroni et al. 2011		
OIP17	Shared facilities/facilities sharing	Mina et al. 2013			EURIS-SFFS 2012	
OIP18	Staff exchanges		Awazu et al. 2009; Di Minin et al. 2010; Lazzarotti et al. 2013	Perkmann and Walsh 2007		
OIP19	Technology scouting					

OI practices		Types of partners					External experts
		Research centres	Consultants	Government institutions	Professional associations	General public	
OIP1	Corporate venture capitalist						
OIP2	Crowdsourcing					Bartl et al. 2010; Schroll and Mild 2011; Kleemann et al. 2008	Kleemann et al. 2008
OIP3	Endowed chairs						
OIP4	Innovation contests						Ebner et al. 2009; Hutter et al. 2011
OIP5	Innovation marketplaces	Natalicchio et al. 2013					Natalicchio et al. 2014
OIP6	Innovation networks	Bigliardi and Galatti 2013; Di Minin et al. 2010; Lambert and Schaeffer 2010; Lee et al. 2010;					
OIP7	Inward licensing of IP						
OIP8	Joined development	Spithoven et al. 2010					
OIP9	Joint venture						
OIP10	Lead user method						
OIP11	Made own innovation available to others for free						
OIP12	OI communities						
OIP13	Outward licensing of IP						
OIP14	Regional innovation clusters		Bullinger et al. 2004	Bullinger et al. 2004	Bullinger et al. 2004		
OIP15	Outsourcing R&D	Narula 2004					
OIP16	Scientific committee						
OIP17	Shared facilities/facilities sharing	EURIS-SFFS 2012		EURIS-SFFS 2012			Mina et al. 2013
OIP18	Staff exchanges						
OIP19	Technology scouting	Ili et al. 2010					

Table 5. Relationships between the “Types of partners” dimension and typologies of OI practices

From this table, we can conclude that there are some OI practices, such as innovation networks (OIP 6), regional innovation clusters (OIP15), and shared facilities/facilities sharing (OIP17), that can be implemented with many different types of partners and therefore are much more versatile in relation to this dimension than other practices that generally can be applied with only one or two different types of partners.

Furthermore, from this information we can also conclude that the types of partners with whom a company can establish a wider range of types of OI practices are users/customers and universities.

4.3. Innovation process stage

Several authors from our literature review refer to the relationship between the stages of the innovation process and OI practices (Rohrbeck et al. 2009; Lazzarotti et al. 2010; Theyel, 2013). Each of these authors proposes a different model for stages of innovation process, as seen in Table 6.

Stages of innovation process	Literature references		
	Rohrbeck et al. 2009	Lazzarotti et al. 2010	Theyel, 2013
Idea generation			
Research		Exploration	Technology development
Development		Development	Product development
			Manufacturing

Table 6. Innovation process stages proposals from the literature

After reviewing the publications ranked in our database in Topics 1 and 2, we proposed the following classification of innovation process stages in relation to OI practices typologies: (1) Opportunity identification: This is the first stage of innovation process, where the company can identify opportunity gaps in the market and make sound decisions regarding which ideas of innovative products/services to develop (Fetterhoff and Voelkel, 2006; Parida et al. 2012). Usually, a firm sets up knowledge exploration processes after perceiving unexploited opportunities (Lichtenthaler, 2011). Therefore, from our point of view, this stage of the innovation process can be considered a keystone of openness and should be included in our research. (2) Idea generation: This is the creative stage where new ideas of innovative

product/processes are generated (Rohrbeck et al. 2009). (3) Concept and product development: The focus of this stage is to transform the ideas into workable concepts. A concept could be developed from different combinations of different ideas (Theyel, 2013). (4) Prototype: The concepts developed in the previous stage are further developed in this phase, through the use of prototyping and modelling to check the market feasibility of the new developments (own construction). (5) Commercialisation: This stage includes activities that engage with outside partners to bring technologies or products/services to market (Rohrbeck et al. 2009).

In Table 7, we present the relationship between OI practices and the dimension called “innovation process stage” as a result of the qualitative analysis of the literature included in our database. From the contents of Table 7, we can conclude that the number of possible OI practices to apply on each “innovation process stage” is quite balanced for all the possible stages. “Concept and product development” is the stage in which more different practices are reported, but the difference with the other stages is quite low.

We also observe that most of the OI practices can be used in more than one innovation process stage and that there are two specific OI practices, crowdsourcing and OI communities, that stand out because they can be used in four different stages of the innovation process.

		Innovation process stage	
		Opportunity identification	Idea generation
OIP1	Corporate venture capitalist	Kirschbaum 2005; Vanhaberbeke et al. 2008; Mortara and Mindshall 2011	
OIP2	Crowdsourcing		Bartl et al. 2010; Kleemann et al. 2008; Poetz and Schreier 2012; Sandulli and Chesbrough 2009
OIP3	Endowed chairs	Vanhaberbeke et al. 2008	
OIP4	Innovation contest	Ebner et al. 2009; Leimester et al. 2009	Piller and Walcher, 2006; Adamczyk et al. 2012; Leimester et al. 2009; Terwiesch and Xu 2008; Ebner et al. 2009
OIP5	Innovation marketplaces		Natalicchio et al. 2014
OIP6	Innovation networks		Van de Vrande et al., 2009; Lee et al. 2010; Rondani et al. 2013
OIP7	Inward licensing of IP		
OIP8	Joined development		
OIP9	Joint venture		
OIP10	Lead-user method	Bartl et al. 2010; Bilgram et al. 2008; Parida et al. 2012	Bartl et al. 2010; Bilgram et al. 2008; Piller and Walcher 2006
OIP11	Made own innovation available to other for free		
OIP12	OI communities	Ebner et al. 2009; Di Gangi and Wasko 2009; Hutter et al. 2011	Di Gangi and Wasko 2009; Hutter et al. 2011
OIP13	Outsourcing R&D		
OIP14	Outward licensing of IP		
OIP 15	Regional innovation clusters	Bullinger et al. 2004	
OIP16	Scientific committee		Chiaroni et al. 2011
OIP17	Shared facilities/facilities sharing		
OIP18	Staff exchanges		
OIP19	Technology scouting	Parida et al. 2012; Rondani et al. 2013	Parida et al. 2012; Rondani et al. 2013

		Concept and product development	Prototype	Commercialisation
OIP1	Corporate venture capitalist			
OIP2	Crowdsourcing	Kleemann et al. 2008	Sandulli and Chesbrough 2009; Kleemann et al. 2008; Bartl et al. 2010	Kleemann et al. 2008
OIP3	Endowed chairs			
OIP4	Innovation contest			
OIP5	Innovation marketplaces	Natalicchio et al. 2014		
OIP6	Innovation networks		Brown and Hagel 2006	
OIP7	Inward licensing of IP	Tao and Magnotta 2006; Bianchi et al. 2011		
OIP8	Joined development	Dittrich and Duysters 2007; Rohrbeck et al. 2009		
OIP9	Joint venture	Lazzarotti et al. 2013		Chesbrough and Schwartz 2007; Lazzarotti et al. 2013; Tao and Magnotta 2006
OIP10	Lead-user method			
OIP11	Made own innovation available to other for free		Dahlander and Magnusson 2008	von Hippel and von Krogh 2006
OIP12	OI communities	Dhalander and Wallin 2006; Di Gangi and Wasko 2009; Hutter et al. 2011; Rass et al. 2013	Hutter et al. 2011	
OIP13	Outsourcing R&D	Narula 2004; Cassiman and Valentini 2009		
OIP14	Outward licensing of IP		Bianchi et al. 2011	Bianchi et al. 2011
OIP 15	Regional innovation clusters			Ferrary 2011
OIP16	Scientific committee			
OIP17	Shared facilities/facilities sharing	EURIS-SFFS 2012	EURIS-SFFS 2012	
OIP18	Staff exchanges	Awazu et al. 2009; Lazzarotti et al. 2013		Di Minin et al. 2010
OIP19	Technology scouting			

Table 7. Relationship between “innovation process stage dimension” and typologies of OI practices

5. Theoretical framework to classify OI practices

From the results of our research on the characterisation of typologies of OI practices, using the dimensions presented in previous section, we explored different graphical representations that could provide a theoretical framework that, on the one hand, could provide an easier understanding of our research findings for scholars of OI and, on the other hand, could help managers to select the most appropriate practices according to their needs and resources.

Two of the analysed dimensions, the direction of resources flow and the innovation process stage, were easier to represent graphically, and a tree diagram seemed to be appropriate for it. However, the third dimension analysed, the type of partners, was too complex to represent due to the amount of different values that could take.

At this point in the discussion of our results, we propose a new dimension that, in some ways, is related to the type of partners. We named this new dimension “type of relationship”, and it can take three different values, which are described below:

- One-to-one: When a company needs to involve only one partner for the implementation of the OI practice.
- One-to-many: When a company should involve more than one partner in the implementation of the OI practices.
- Many-to-many: When the implementation of the OI practice involves the participation of a set of partners who cooperate with each other in win-win conditions.

This dimension reflects, in opinion of the authors, the complexity of implementing an OI practice, which in general increases with the number of partners, and moreover can be represented easily in a tree diagram complementing the other two dimensions.

In Figure 3, we present the theoretical framework that synthesises the results of our research work. We consider that this theoretical framework is a didactic classification of typologies of OI practices because it easily displays relevant aspects, such as versatility of practices in relation to the objectives that we can achieve with their implementation, alternative typologies of OI practices to look for results in different

innovation process stages, or comparing different typologies of OI practices in relation to the complexity of their implementation.

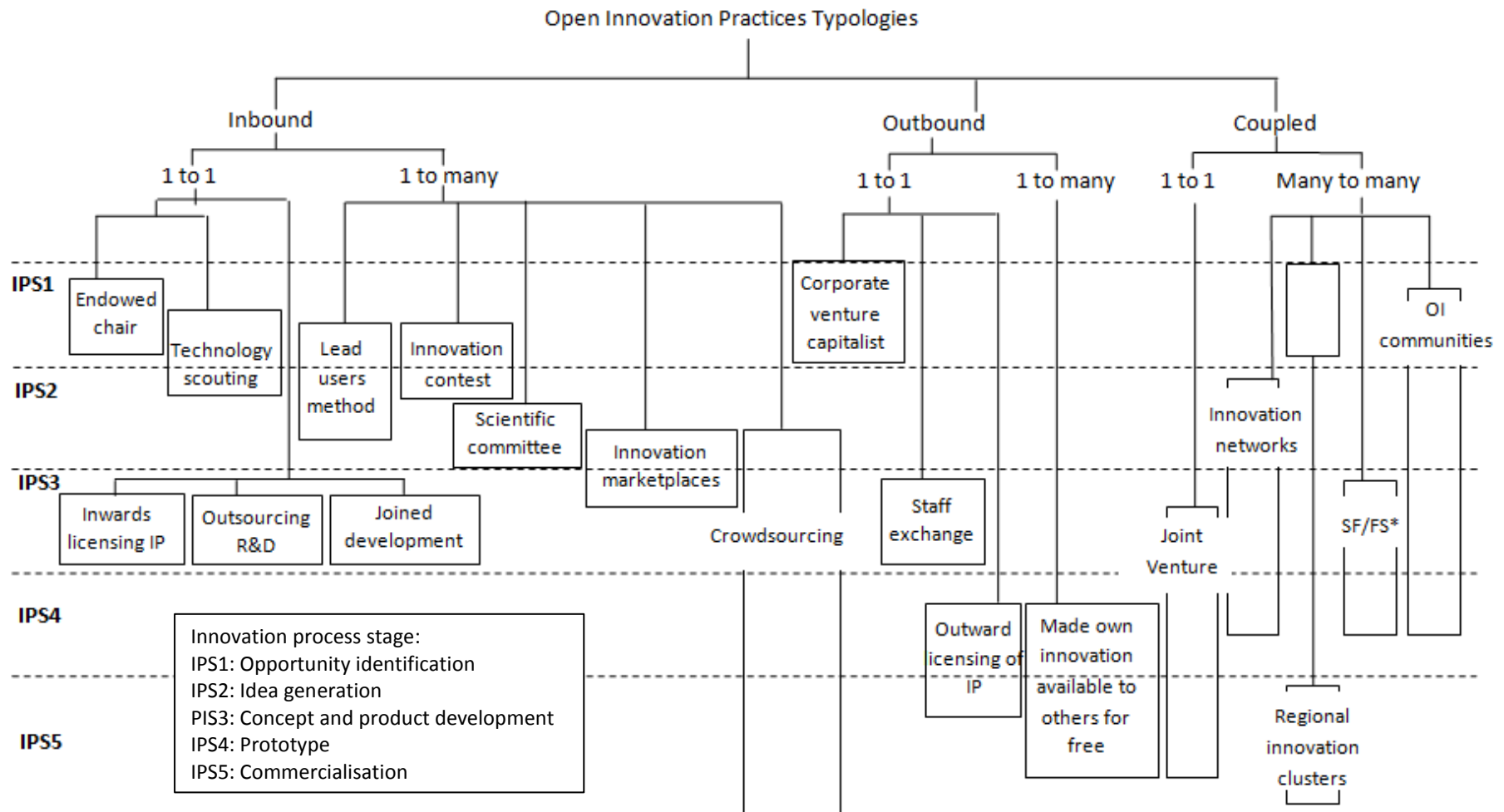


Figure 3. Theoretical framework that classifies typologies of OI practices according to three of their dimensions

6. Discussion

In the introduction of this paper, we identify a relevant gap in the literature of OI, the lack of a comprehensive and unified list of typologies of OI practices, which has been highlighted repeatedly in the literature (Van de Vrande et al. 2009; Lee et al. 2010; Lichtenthaler 2011; Bellantuono et al. 2013; Rass et al. 2013) and has negative consequences for advancing the research and understanding of the OI paradigm.

We faced this challenge rigorously, choosing the method of literature review as a medium to exploit all the knowledge about this subject that had been previously generated in a heterogeneous form by the research community.

The main result of our work is the identification, characterisation and classification of 19 different typologies of OI practices, but far from these typologies, we think this strategy of research can serve as a reference for future research on the field of OI that can exploit existing literature with clarification objectives.

6.1. Implications for theory and future research

We propose a comprehensive list of 19 different OI practices typologies, which have been reported by researchers in both qualitative and quantitative studies, enriched with clear definitions and references from the literature, that provide a path to deepen the existing knowledge around each typology.

Moreover, from now on researchers working in the field of OI can design their quantitative research studies using these typologies of OI practices. This common terminology will allow them to perform consistent comparative analyses to find synergies, complementarities and differences.

Several areas for future research emerge from this work. Once we have a common terminology to identify typologies of OI practices that help us to answer to the question “How to implement OI?”, scholars can use these typologies as a starting point for answering new questions such as “When to implement specific typologies of OI practices?”. This research stream could advance the analysis of factors that influence in the process and results of implementing different typologies of OI practices and in the identification of the main barriers and enablers for each of them.

Another interesting finding is the fact that some specific typologies of OI practices, such as innovation contests (OIP4), can be used as a first step for other OI practices, or that some practices, such as innovation networks (OIP6), may evolve into more formal practices, such as R&D partnerships (OIP8). This indicates that there are relationships between different OI practices that would be interesting to study in more detail in future research as far as it could reveal a dynamic vision of OI practices that can indicate the existence of favourable paths for a successful change from closed to open innovation.

Obviously, this proposed list of 19 typologies of OI practices is not static, which means that surely at this moment there are companies in the world developing and implementing new typologies of OI practices that are not included in this work, due to the delay between practice and academic research. Therefore, the path that we open can be travelled in the future by other researchers to define and characterise new typologies of OI practices.

6.2. Implications for practice

From the managerial point of view, we identify two main contributions of our work. The first one is the detailed knowledge, resulting from our review of the literature, that enriches the identification of the 19 typologies of OI practices, and more specifically, the references to case studies of companies that have successfully applied each of these practices. Learning from other companies' experiences is a common practice for managers and can also facilitate the diffusion of these experiences inside their companies as best practices.

The second one is the new theoretical framework that graphically classifies the 19 OI practices typologies. The main advantage of this theoretical framework is that it synthesises much of the information about typologies of OI practices, which is currently dispersed in the literature. This synthesis enables managers to compare OI practices and use this knowledge to select the more appropriate practices, considering their needs and capabilities. Obviously, this theoretical framework does not include all the dimensions and factors that can influence decision to implement one or another typology of OI practices, but we believe this can be a first step in the decision process, which can help a manager to delimit the number of typologies of OI

practices of interest to a smaller group and consequently reduce the cost of this explorative phase.

Appendix A.

Articles ranked in Topic 1 of our database

Reference	OI practices typologies proposed	Fundamentals of the proposal	Comments
Pisano and Verganti (2008)	The authors proposed four basic modes of collaboration: (1) Elite circle: A closed and hierarchical network. (2) An innovation mall: an open and hierarchical network. (3) Innovation community: an open and flat network. (4) A consortium: A closed and flat network.	The authors proposed that there are two basic issues that executives should consider when deciding how to collaborate on a given innovation project: - Open or closed collaboration - Flat or hierarchical governance structure According to these two dimensions, they proposed a framework that reveals four basic modes of collaboration.	The authors suggested that by figuring out which mode is most appropriate for a given innovation initiative, a firm could consider the tradeoffs of each and assess the organisational capabilities, structure, and assets required to manage the challenges of developing the initiative.
Van de Vrande et al. (2009)	The authors proposed nine different technology exploitation activities: (1) Venturing (2) Outward licensing of intellectual property (IP) (3) Involvement of non-R&D workers in innovation initiatives (4) Technology exploration activities (5) Customer involvement (6) External networking (7) External participation (8) Outsourcing R&D (9) Inward licensing of IP	The selection of practices was generated from a literature review. The authors specified from which references each typology of OI practices came.	The authors proposed that future attempts to survey OI in broad samples of enterprises should delineate the several practices in a more detailed and accurate way. However, the list of OI indicators is probably not a complete list. Past studies have proposed other practices that were not included in the survey.
Poot et al. (2009)	The authors constructed four different modes of collaboration: (1) Internal collaboration: Collaboration with other enterprises within the enterprise group. (2) Horizontal collaboration: Collaboration with competitors. (3) Vertical collaboration: Collaboration with suppliers of equipment, materials, components or software, and clients or customers. (4) Knowledge-intensive collaboration:	The authors constructed four different modes of collaboration according to the different types of partners with whom a firm has engaged in a formal collaboration.	The authors just relied on inflows of knowledge, while not considering outflows. Moreover, they just considered one of the possible dimensions for identifying OI practices, the type of partner.

	Collaboration with consultancies, universities, other research institutes		
Leimester et al. (2009)	The authors proposed three practices for integrating customers into the early stages of the innovation process: (1) Lead-User Method (2) Internet Toolkits (3) Ideas Competitions	The selection of practices was generated from a literature review. The authors specified from which references each typology of OI practices came.	The authors only referred to OI practices for integrating customers into early stages of the innovation process.
Rohrbeck et al. (2009)	The authors identified 11 OI instruments: (1) Foresight workshops (2) Executive forums (3) Customer integration (4) Endowed chairs (5) Consortia projects (6) Corporate Venture Capitalist (7) Internet platforms (8) Joined development (9) Strategic alliances (10) Spin-outs (11) Test market	The instruments were identified from the case study of Deutsche Telekom combining the following two dimensions: - Innovation process stage (according to Deutsche Telekom innovation process). - Types of OI processes (according to Gassmann and Enkel (2006) archetypes).	The authors' classification of OI instruments in relation to the proposed two dimensions provides an interesting reference for a systematic approach to OI.
Lee et al. (2010)	The authors identified three collaboration modes and two different possible objectives on each of them: (1) Customer provider: Exploration: Funding, licensing, outsourcing, etc. Exploitation: Outsourcing, etc. (2) Strategic alliance: Exploration: R&D partnership, joint ventures, etc. Exploitation: Partnership, etc. (3) Inter-firm alliance: Exploration: Network, etc. Exploitation: Network, etc.	The authors specified that these typologies of practices came from the following references: Chesbrough 2003 and Narula 2004.	One of the conclusions of this research is that the several terms used to describe collaboration modes, such as strategic alliance, collaboration, co-operation, networking, etc. – which are used together to point to the same or different patterns and thus are quite confusing – need to be clearly defined in future research.
Hilgers (2011)	The author identified four instruments of OI: (1) Lead user method (2) OI communities (3) Online toolkits (4) Innovation contests	The author did not specify the references used for identifying of these OI practices typologies but specified examples of companies that use each of these OI practices.	

Parida et al. (2012)	<p>The authors proposed four inbound OI activities:</p> <ol style="list-style-type: none"> (1) Technology scouting (2) Horizontal technology collaboration (3) Vertical technology collaboration (4) Technology sourcing 	<p>The authors specified that these typologies of practices came from the following references: Chesbrough et al. 2006; Gassmann 2006; Henkel 2006; Lichtenthaler 2008b, 2011; Van De Vrande et al. 2009.</p>	
Mina et al. (2013)	<p>The authors proposed fifteen typologies of OI activities grouped in two main categories:</p> <p>Informal (non-contractual) activities:</p> <ol style="list-style-type: none"> (1) Engaging directly with lead users and early adopters (2) Participating in open source software development (3) Exchanging ideas through submission websites and idea “jams”, idea competitions (4) Participating in or setting up innovation networks/hubs with other firms (5) Sharing facilities with other organisations, inventors, researchers, etc. <p>Formal (contractual) activities:</p> <ol style="list-style-type: none"> (6) Joint R&D (7) Joint purchasing of materials or inputs (8) Joint production of goods or services (9) Joint marketing/co-branding (10) Participating in research consortia (11) Joint university research (12) Licensing in externally developed technologies (13) Outsourcing or contracting out R&D projects (14) Providing contract research to others (15) Joint ventures, acquisitions and incubations 	<p>The authors referred to 15 typologies of OI activities performed by firms that take into account both formal (contractual) and informal (non-contractual) activities. No clear reference to how they constructed this list of activities is provided.</p>	<p>The authors suggested that further theoretical work on the purpose and nature of OI activities with different partners is a potentially fruitful area for research. So too is the nature of the link between OI activities and the choice between informal and formal modes of mediating such activities.</p>
Rass et al. (2013)	<p>The authors proposed four categories and five different OI instruments:</p> <p>Acquiring:</p> <ol style="list-style-type: none"> (1) Innovation marketplaces (2) Intermediaries 	<p>The authors argued that the literature does not provide a conclusive list of OI instruments, but there are some categorisations of OI activities that help to structure existing instruments along different dimensions:</p>	<p>The authors referred to OI instruments as concrete means to implement OI and highlighted the lack of a conclusive list of OI instruments in the literature.</p>

	<p>Sourcing: (3) Innovation contests</p> <p>Selling: (4) Licensing activities</p> <p>Revealing: (5) Open source communities</p>	<p>- Direction of resource flows (Gassmann and Enkel, 2004)</p> <p>- Modes of governance (Fey & Birkinshaw, 2005)</p> <p>A combination of these dimensions by Dahlander and Gann (2010) provides a categorisation of OI instruments in 4 categories: Acquiring, sourcing, selling and revealing.</p>	
Remneland-Wikhamn and Wikhamn (2013)	<p>The authors proposed six different OI activities:</p> <p>(1) Lead user (2) Open source development (3) Innovation communities (4) Innovation contests (5) Crowdsourcing (6) Innovation intermediaries</p>	<p>Detailed description of the bibliometrical analysis of the literature from which the authors identified two clusters of publications: the firm perspective and the ecosystem perspective.</p> <p>Then, they developed a qualitative analysis of 272 open innovation papers and from the cluster of the ecosystem perspective identified those six different OI activities.</p>	<p>The authors stated that this paper aims to initiate a critical discussion about which activities can/should be called “open innovation” but also how different notions under the umbrella of OI are related to each other. Further research was suggested to continue this quest.</p>
Theyel (2013)	<p>The authors proposed twelve different OI practices:</p> <p>Technology development: (1) Joint technology development with customers (2) Joint technology development with suppliers</p> <p>Product development: (3) Joint product development with customers (4) Joint product development with suppliers</p> <p>Manufacturing: (5) Sharing equipment with customers (6) Sharing equipment with suppliers (7) Joint manufacturing with customers (8) Joint manufacturing with suppliers</p> <p>Commercialisation: (9) Serving new markets with customers (10) Serving new markets with suppliers (11) Joint bidding for new contracts customers (12) Joint bidding for new contracts suppliers</p>	<p>The analysed OI practices emerge from the combination of the two following dimensions:</p> <ul style="list-style-type: none"> • Type of partner, which reveals collaboration with customers or suppliers. • Type of value chain activities, where the collaboration is applied, which can takes four different values: <ul style="list-style-type: none"> ○ Technology development ○ Product development ○ Manufacturing ○ Commercialisation 	<p>The authors said that prior research on OI has concentrated on the analysis of external knowledge channels instead of researching specific practices.</p>
De Araújo et al. (2014)	<p>Inbound: (1) Employed the internet to search for new</p>	<p>The selection of practices was generated from a literature review. After screening research</p>	<p>This article proposed a new approach to measure OI, on the</p>

	<p>trends or technology (2) Reading technical magazines (3) Used information from trade organisations (4) Participated in innovation-related fairs or shows (5) Purchased R&D work from others (6) Purchased licences, patents or know-how (7) Worked with lead users (8) Used innovation brokers Outbound: (9) Actively participated in other's innovation projects (10) Sold patents, licences or know-how (11) Made own innovations available to others for free</p>	<p>addressing OI topics (Bahemia and Squire, 2010; Chesbrough and Garman, 2009; Van de Vrande et al., 2009), a comprehensive list of 11 practices was identified, with the aim of building an extensive rather than a compressed list of practices.</p>	<p>basis of a practice perspective, to offer a more comprehensive approach than the general actor-based measures currently available, which rely on inter-organisational relationships as a proxy for openness.</p>
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Appendix B.

First attempt to construct a list of OI practices typologies from papers ranked in Topic 1 of our database

ID	OI practices	Pisano and Verganti 2008	Van de Vrande et al. 2009	Poot et al. 2009	Leimester et al. 2009	Rohrbeck et al. 2009	Lee et al. 2010	Hilgers 2011	Parida et al. 2012	Mina et al. 2013	Rass et al. 2013	Remneland-Wikhamn and Wikhamn 2013	Theyel 2013	De Araújo et al. 2014
1	Corporate venture capitalist		√			√								
2	Crowdsourcing											√		
3	Endowed chairs					√								
4	Innovation contests		√		√			√		√	√	√		
5	Innovation marketplaces					√					√	√		√
6	Innovation networks	√	√				√			√				
7	Inward licensing of IP		√				√			√	√			√
8	Joined development			√		√			√	√				√
9	Joint venture					√	√			√			√	
10	Lead user method		√	√	√	√		√	√	√		√	√	√

11	Made own innovation available to others for free									√	√	√		√
12	OI communities	√						√		√		√		
13	Outward licensing of IP		√											√
14	R&D partnership		√	√		√	√		√	√				√
15	Shared facilities/facilities sharing									√			√	
16	Technology scouting					√			√					

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