

# A Reference Model for Outside-in Open Innovation Platforms

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## ABSTRACT

The Open Innovation paradigm has spread widely since 2003, and led to the emergence of Open Innovation Platforms as software systems aiming at supporting and facilitating open innovation initiatives and projects. This software domain has matured up to a point where many functional concepts became notably common and used in these platforms. When implementing open innovation platforms, related people often struggle when defining expected functional characteristics due to the general application of the paradigm, making necessary the existence of a model that provide a set of potential functional features expected in the creation and development of this type of platform. Reference models provides a domain-specific set of clearly defined entities aiming at encouraging better communication in the domain. We propose in this paper a reference model for capturing and defining the functional features that could be implemented in outside-in oriented open innovation platforms. For building this reference model, we reviewed some of the already published reports of open innovation platforms implementations in order determine and define the potential functional features expected in this kind of platforms. We believe this knowledge base could ease software development and deployment decisions, especially at early stages where open innovation platforms adopters face development in a domain that as of this writing is still new to many people.

## CCS CONCEPTS

• Applied computing → Enterprise computing.

## KEYWORDS

open innovation, open innovation platforms, reference model

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## 1 INTRODUCTION

The open innovation paradigm appeared formally in 2003 in Chesbrough’s book “Open Innovation: The New Imperative for Creating and Profiting From Technology” [7], which stated that companies should start to seriously consider the value in ideas from outside the organization, as well as opening new markets for inside-developed knowledge [7].

Open innovation platforms appeared as a consequence of the spreading of the paradigm, when many organizations felt the need for software to support the functional aspects of Chesbrough’s idea. Since software systems are so ubiquitous and pervasive these days, we focus specifically on software-based open innovation platforms.

As the software domain of the open innovation platforms started to mature, more common concepts appeared and became used in such platforms. Reference models can capture these concepts by emphasizing the distinction between functionality in elements and data flow among those elements [2]. Key goals of reference models are facilitating systematic software development [2], and supporting the definition of reference architectures [2][16].

This article proposes a reference model for Software-based Outside-in Open Innovation platforms. A careful review of several reports of open innovation platforms implementations showed two broad contexts in this domain: organizations that open their own innovation process, and organizations that act as open innovation intermediaries (such as brokers, agents, and others). The role of an innovator is engaged in any innovation initiative run in any of these two actors.

We expect this reference model to be used by people involved in the design, implementation and deployment of software-based open innovation platforms, and especially supporting initial decisions regarding platform functional aspects.

The reminder of article is structured as follows. Section 2 describes Open Innovation, the main concepts revolving around the paradigm and related work regarding open innovation platforms definition, design and implementation. Section 3 presents and describes the proposed reference model, with references to relevant sources. Section 4 briefly discusses the research approach. Finally, section 5 summarizes and concludes.

## 2 BACKGROUND

As the name implies, open innovation means opening innovation initiatives. In 2003, Henry Chesbrough coined the term in his book “Open Innovation: The New Imperative for Creating and Profiting From Technology” defining it as paradigm in which “*valuable ideas can come from inside or outside the company and can go to market from inside or outside the company*” [7]. Chesbrough contrasted this paradigm with the Closed Innovation one, inwardly focused by its very nature, which is characterized by a vertical integration model where internal innovation activities end up in internally developed products or services that are distributed by the company [9]. Through time, the paradigm and its definition have been dynamic elements, subject to changes and improvements. For example, von Hippel considers open innovation from the point of view of open-source software [9]. For von Hippel, the benefits of an open, distributed innovation eventually allows users, whether they are firms or individual consumers, to innovate by developing what they want and to benefit from innovations developed and freely shared by others [30][31]. “Freely shared” in von Hippel open innovation is key and is something that still needs to get its way through companies [9][11][4].

The open innovation paradigm has been subject to some questioning about whether it is really a phenomenon or just a fad [11]. Later, Chesbrough and others advanced the definition stating that open innovation is “*the purposive use of inflows and outflows of knowledge to accelerate innovation in one’s own market, and expand the use of internal knowledge in external markets, respectively.*” [13]. The common issue of considering research and development activities separately from business models motivated the appearance of the idea of Open Business Models which promote a linking between technological innovation and business models [10][14]. More recently, the open innovation community is developing innovation in services, which in some cases is the evolution of products becoming service businesses, and for which service platforms are key [10][8].

A survey of 125 large firms (2,840 companies were invited to participate) in Europe and the United States (annual sales in excess of \$250 million) revealed that a 78% of the respondents are practicing open innovation in both low-tech and high-tech sectors (though the same survey also reported that the degree of open innovation practicing is higher in high-tech manufacturing and in trade and retail firms) [11]. In the same survey, informal networking and university research grants ranked second and third, respectively, in terms of the reported importance for inbound open innovation (co-creation with customers and consumers was rated as first). Outbound open innovation practices were, on average, rated as less important than inbound practices, with joint venture activities and sale of market-ready product idea to another organization ranked as first and second, respectively [11].

A follow-up study (121 usable responses, 73 were from European firms) aimed to get more insights from the open innovation project level which is where many of the critical decisions about open innovation are made [4]. This study revealed a 78% of the respondents practicing open innovation with more than 50% of those firms reporting that they adopted the strategy more than five years ago. The same study also revealed that universities and public

research organizations were involved as partners in 58% of the projects at the problem definition stage and in 60% of the projects at the solution development phase [4].

Embracing open innovation is not always easy. Many times it requires organizations to be open for, and to work towards, a mindset change from all the involved actors. Concretely, this “new” mindset should be based on a collaborative open culture based on trust [12], science with an “intrapreneurial” attitude [25] and organizations’ willingness to invest before starting to see results [24].

### 2.1 Inside-out and outside-in open innovation

An open innovation endeavor is commonly understood as having two processes: inside-out and outside-in. Some authors recognize a third one, the coupled process [19], which is actually the process archetype that recognizes both incorporating and sharing knowledge is crucial for success [19]. As noted by Chesbrough, open innovation is rarely an only-inbound or only-outbound process [4]. Instead, a mix of the two types of open innovation are seen, notwithstanding in some cases one of the processes is more common [4]. Moreover, as Carroll et al. [6] remark, the opening of an innovation process should be understood as a continuum, that is, from fully open to fully closed we can recognize degrees of openness.

Outside-in open innovation refers to the case in which a company’s core innovation approach is based in the integration of external knowledge in the organization [19]. On the other hand, inside-out open innovation refers to focusing on the externalization of company’s internally generated knowledge to the outside [19].

### 2.2 Open innovation intermediaries

Whether being outside-in or inside-out open innovation, organizations that try the paradigm will face some challenges regarding how to make use of the “valuable ideas”. Being more precise, organizations making use of open innovation will eventually face:

- Searching and selecting external knowledge and knowledge providers.
- Searching and selecting appropriate markets for internal knowledge to be carried out outside.

This is where open innovation intermediaries come to play a role. Chesbrough [14] define innovation intermediaries as companies focused on helping innovators to use external ideas more rapidly or helping inventors to find more markets to use their own ideas. A key aspect relies in the words “rapidly” and “more” as we cannot neglect the innovators’ potential abilities to search for external ideas or markets, but we can appreciate the potential of intermediaries as facilitators in the two aforementioned regards. Another possible benefit is that companies could make use of intermediaries as a means for testing external searches before devoting resources to internally adapt companies’ areas to perform external searches [14]. In addition, Hossain [21] recognizes the following more specific tasks for open innovation intermediaries:

- Facilitating internal and external technology commercialization.
- Connecting innovation seekers and innovation providers.
- Helping companies in screening external markets.
- Reducing the costs derived from searching.

- In-licensing, co-developing and acquiring external IP or technologies.

A remarkable point in Hossain’s work [21] is that he explicitly links the concepts of intermediaries with innovation platforms.

Howells [23] defines an open innovation intermediary as any “organization or body that acts as an agent or broker in any aspect of the innovation process between two or more parties”. In addition, the same author recognizes the following activities as part of the intermediaries work: provide information about potential collaborators, brokering a transaction between two or more parties, acting as a mediator or go-between bodies or organizations, and helping find advice, funding and support for the innovation outcomes of such collaborations [23].

Being an innovation intermediary also comes with challenges as Chesbrough notes [14]:

- Balancing the amount of information available for clients to understand what is the problem and potential solution without disclosing all details that could put a company in a risk of losing its advantage.
- The problem of identity: how to manage the identity of the participants involved with the intermediary and when, if anonymous, reveal them.
- How to concretely show the value of the service to the clients.
- How to create access in a market with, perhaps a lot of, buyers and sellers.
- How to build trust so clients get convinced to work with an intermediary.

According to Chesbrough [14], there are two broad categories of intermediaries: agents and brokers. Agents represent one side of an exchange of IP or technology. Brokers, also known as market makers, aim to bring parties together. Brokers may also take part in the transaction between parties.

NineSigma<sup>1</sup> is an example of an agent intermediary. NineSigma. The company searches for potential partners for a solution seeker. Solution seeker means that there is a problem behind the search. Both Chesbrough and Hossain agree in that a key service in intermediaries is to aid in the problem definition [14][21].

InnovationXchange<sup>2</sup> is an example of broker intermediary. The company aims to help member companies in sharing requirements and tries to match them to technologies and initiatives residing in other member companies [14]. InnovationXchange explicitly recognizes and works with an innovation network.

As expected, intermediaries categories should not be viewed as strict classes as many intermediaries could eventually slightly touch characteristics of one or another category. Moreover, we expect boundaries in the categories to be even more diffuse in the future as the companies expand their innovation services (for example, as of this writing InnovationXchange also offers technology scouting and technology watch as their services).

The specifics of the revenue streams for these companies is outside the scope of this work. However, we can mention that the mixed “flat-fixed” and “success” fee model is commonly used [21].

## 2.3 Open innovation platforms

The term “Open Innovation Platform” has been widely used in open innovation literature and initiatives. However, there is no just one definition as the term has been used in many industries and with very varied goals. Still, we can argue that when we talk about a platform here we refer to a software-based platform. Moreover, we mostly refer to an online software-based platform. We can also analyze here common and recurrent published platform functional characteristics. Open innovation intermediaries (see section 2.2) are strongly related to open innovation platforms as their work is mostly supported by this kind of platforms.

Implementing an open innovation platform implies opening the organization to consider ideas and knowledge from external sources such as the crowd. Managers sometimes feel somewhat reluctant to deal with the crowd mainly because they don’t completely understand what kinds of problems a crowd can face better and also how to manage the process [3]. A good understanding of how the crowd can be used for open innovation is key. In this regard, Boudreau and Lakhani [3] propose four models: crowd contests, collaborative community, crowd complementors, and labor market. In the case of a crowded contest, the key idea is a company that identifies a specific problem, offers some kind of prize (perhaps, cash), and broadcasts an invitation to submit solutions [3]. According to the same authors, contests are also good for solving design problems because creativity and subjectivity influence the evaluation of solutions. In a collaborative community, the idea is that a company decides to join forces with a diverse community, where many of the members are customers and users of a product or service, to innovate in general terms. Practice shows that communities work best when members can share information freely so IP is almost impossible [3]. Unlike crowd contests and collaborative communities, crowd complementors provide solutions to many different problems using the concept of core product or technology [3]. This is somewhat similar to what software architecture tries to achieve with components reuse, but considering that the reuse is based on a core product. This implies that there must be some kind of interface that allows complementors to build new products on this core. Finally, crowd labor markets seek to match buyers and sellers of services by employing conventional non-long-term contracting [3]. Boudreau and Lakhani [3] also recognize that many of the aforementioned ideas are quite old, but technology is being a catalyst for the use of crowd-based approaches to innovation. Again, the reader should note that these models cannot be used for strict classification of open innovation business initiatives as many of the endeavors can slightly touch characteristics from other models.

Malone et al. [29] propose a “genome” model for what they call “collective intelligence.” They argue crowd-based platforms and their intrinsic models behind can be described by using a set of “genes” that correspond to particular answers to a set of four questions: what, who, why, and how. For instance, one of the genes of the InnoCentive innovation platform is [what: create scientific solutions, who: crowd, why: money, how: contest] (a set of genes build up the genome of the platform) [29].

<sup>1</sup><https://www.ninesigma.com/>

<sup>2</sup><https://www.ixc-uk.com/>

In general, online open innovation platforms facilitate the crowd to work collaboratively for ideation, voting, discussions, and suggestion [22]. Also, key characteristics of the crowd in terms of innovation such as being loose and decentralized [3] are, as expected, also observed in open innovation platforms [22]. In addition, open innovation platforms are also used by companies to better engage with customers, suppliers, employees, partners, citizens, and regulators for ecosystem development [22][20].

Two previous works addressed the need for a systematic approach for the design [26], and implementation and deployment [26][15] of open innovation platforms. These works define generic, broad-applicable models to guide the process of enacting open innovation platforms. The generic, broad-applicable characteristics of these proposals make it necessary to consider more concrete guidance in each of the phases they describe. In particular, they require guidance in the potential concrete functional features an open innovation platform could eventually provide, which is the aim of our work.

### 3 OPEN INNOVATION REFERENCE MODEL

Software-based outside-in open innovation platform contexts can be grouped into two broad classes: (1) organizations (including companies) or a state/government pursuing opening an innovation process, or (2) open innovation intermediaries.

Many of the platform functional characteristics intersect both groups, but we find this distinction useful as their respective platforms users take different roles. For example, in the case of (1), users are usually a subset of a community, whether working for a laboratory, academic setting, or just simply being motivated to engage in the platform for other inner reasons. In the case of (2), users are usually organizations (including companies) seeking intermediary services; in this case, intermediaries are also considered as users (in fact, we would expect the platform to be run and managed by an intermediary).

However, an organization might be deploying an open innovation platform while at the same time seeking services from innovation intermediaries. Therefore, the two groups proposed are presented for practical purposes and should not be taken as an exclusive classification. Moreover, the set of functional characteristics should be seen as one big unified library rather than two separate libraries.

#### 3.1 Functional characteristics

The proposed reference model includes several functional characteristics, all of them with support in the literature; we summarize them in tables that report both functional characteristics and their sources.

Table 1 summarizes functional characteristics that could be expected by open innovation platforms adopters (organizations). Table 2 summarizes functional characteristics that could be expected by intermediaries.

#### 3.2 Actors

Actors describe roles and not kinds of people or organizations, i.e., the same entity can play different (and several) roles at different

**Table 1: Open innovation platforms functional characteristics commonly expected by organizations opening their innovation process.**

Functional characteristic	Reference
Post a challenge or problem.	[6][22][1][5][17]
Submit proposal.	[6][22][1][5]
Screen proposal.	[6][22][1]
Review proposal.	[6][22][1][5]
Sign IP contract.	[6][22]
Manage IP.	[6][22]
See results (of proposal).	[6]
See recommendations.	[27]
Search database.	[27]
Share knowledge.	[22][1]
Share problems and limitations.	[5]
Vote proposal.	[22]
Send inter-user messages.	[27]
See members details.	[5]
See platform news.	[5]
Manage public profile.	[5]

times. For example, an open innovation adopter may become an open innovation intermediary or even an innovator.

There may be many subtypes of actors. For example, a university could be working towards opening up its innovation processes, and

**Table 2: Open innovation platforms functional characteristics commonly expected by innovation intermediaries.**

Functional characteristic	Reference
Post a challenge or problem.	[3][21][28][18][17]
Submit a solution.	[3][21][28][18]
Review a solution.	[3][21][28][18]
Manage challenge or problem.	[3][21][28][18]
Contact innovation partner.	[21]
Sign disclosure agreement.	[21]
Sign IP contract.	[28]
Manage IP.	[28]
Manage innovation partners.	[3][21][23][28][18]
Manage innovation network.	[3][21][23][18]
Manage innovation ideas.	[3][21][23][18]
Manage technology.	[21][23]
Manage technology transaction.	[21]
Manage innovation process.	[23]
Manage innovation consortium.	[21]
See advice about funding.	[23]

thus play a role of open innovation adopter. Nevertheless, for the sake of simplicity, we only consider three generic kinds of actor:

- **An innovator:** Any entity playing a role as an innovation partner in an innovation initiative, a people sharing an idea to be screened for inclusion in an innovation initiative, or a people just collaborating in any stage of an open innovation initiative.
- **An open innovation adopter:** Any entity working towards opening its innovation processes, that is, embracing the open innovation paradigm. Open innovation adopters are expected, most of the time, to be organizations.
- **An open innovation intermediary:** Any entity aiding innovators in outside-in, coupled, or inside-out innovation initiatives. Open innovation intermediaries also work helping innovators in defining their ideas.

### 3.3 Scenarios

We describe the functional characteristics using a scenario-based approach. Scenario-based approaches are commonly used in software engineering to describe actors making use of a software system in order to achieve some goal.

*3.3.1 Post a challenge or problem.* Organizations opening their innovation process might expect a platform that allows them to present to the crowd a challenge or problem so the community provide potential proposals for facing or solving the posted challenge or problem. The main and primary actor here is the organization opening its innovation process.

*3.3.2 Submit proposal.* Organizations that post a challenge or problem for the crowd to engage in its solution will expect the community members to submit proposals which describe potential solutions to the challenge or problem presented. The main and primary actor here is a member of the crowd. More specifically, a peer.

*3.3.3 Screen proposal.* Organizations might expect several proposals, especially if the platform is widely promoted and managed by a well-known company. Some authors report that before an organization starts to review proposals, they run a screening process before [6][22][1]. The organizations will therefore expect functionality that will allow them to screen proposals. In this sense, the screen proposal functionality will allow the organization to list, search, perhaps filter, and mark as accepted, rejected or delayed a proposal. The main and primary actor here is the organization opening its innovation process.

*3.3.4 Review proposal.* Screening a proposal aims at an initial selection in order to reduce the amount of proposals to be worked on. After a screening, the platform is expected to provide means for supporting the reviewing of a proposal. At least, the organization should be able to select a proposal for reviewing, managing related documentation and managing the defined stages in the reviewing process. The main primary actor here is the organization opening its innovation process.

*3.3.5 Sign IP contract.* Although the specifics of intellectual property contractual issues are beyond the scope of this description, we remark that the open innovation platform should provide means

for signing and storing an intellectual property contract. The main primary actors here are the organization opening its innovation process and a peer from the crowd.

*3.3.6 Manage IP.* Signing an IP contract by some means provided by the platform implies the organization will also expect some functionality for managing the IP contract. As in other cases, the particular characteristics of this functionality are a matter of concrete implementations. The main primary actor here is the organization opening its innovation process.

*3.3.7 See results of proposal review.* The platform should allow a peer from the crowd to see the results of the review of his or her proposal (if previously selected in the screening process). The specifics of the way the organization presents the review results are a matter of concrete platform implementations. The main primary actor here is a peer of the crowd.

*3.3.8 See recommendations.* The users of the platform should be able to see recommendations regarding some of the many entities worked in the platform. For example, the user could see recommendations of funding, innovation partners, research partners, among other entities. As noted in [27], a platform can provide fast (short) or full recommendations. The main primary actor here is an innovation partner.

*3.3.9 Search catalog.* The users should be able to search for the entities allowed to be searched in the catalog (e.g., funding applications, projects ideas, among others). Of course, the specific searchable entities is a matter of specific implementations. The main primary actor here is an innovation partner.

*3.3.10 Share knowledge.* Users of the platform might be able to share knowledge. Here, knowledge refers to any kind of concrete way in which a user could express a belief (e.g., comments about proposals, comments about other topics, opinions, answers to open questions, etc.) Here the main primary actor is an innovation partner. Eventually, a secondary actor could be a moderator.

*3.3.11 Share problems and limitations.* In some cases such as in [5], open innovation platforms could implement specific ways in which real users with real problems and experiencing limitations to share their thoughts on real problems and limitations. The main primary actor here is an innovation partner.

*3.3.12 Vote proposal.* If allowed, an open innovation platform could allow users to vote on proposals. The specifics of the voting system and the way the organization will use the votes are a matter of specific implementations. Here the main primary actor is an innovation partner.

*3.3.13 Send inter-user message.* Organizations might allow users to communicate between them. This functionality should allow users to send messages between them. The main primary actor here is an innovation partner.

*3.3.14 See member details.* If users register for having accounts and profiles in the platform, the software should allow them to see details about the members. What and how many details should be exposed to members is a matter of concrete implementation. The main primary actor here is an innovation partner.

**3.3.15 See platform news.** This functionality provides the users with news that the organization would want to share with the community. News can be personalized, private or public. This functional characteristic also implies the organization will be able to store and publish news. Here the main primary actor is an innovation partner.

**3.3.16 Manage public profile.** If users are required or motivated to register in the platform before making use of other functionality, a public profile is naturally expected. This functional characteristic recognizes a user managing his or her public profile (e.g., adding, deleting or modifying personal info).

**3.3.17 Post a challenge or problem.** Unlike in the case in which an organization is pursuing opening its innovation process, in this case it is an open innovation intermediary which, after careful working on a submitted problem by a client, can post a challenge or a problem for the innovation network it maintains see it. Main primary actor here is the innovation intermediary which manages and runs the platform.

**3.3.18 Submit a solution.** If an innovation partner finds a challenger or problem worth to be engaged in, it can submit a solution. Main primary actor here is the innovation partner.

**3.3.19 Review a solution.** The intermediary should have available functional characteristics that facilitate the review of a submitted solution (by an innovation partner). Main primary actor here is the innovation intermediary.

**3.3.20 Manage challenge or problem.** A challenge or a problem is expected to be characterized by several attributes. The intermediary should be able to manage the challenge or problem in its attributes or even delete it. Thus, the platform should allow the innovation intermediary to modify or even add attributes and information. Main primary actor here is the innovation intermediary.

**3.3.21 Contact innovation partner.** Depending on the rules established by the open innovation intermediary, the platform could allow innovation partners to contact other innovation partners. Again, depending on the rules, the contact may be anonymous. Main primary actor here is the innovation partner.

**3.3.22 Sign disclosure agreement.** Customers will expect the platform provides some means for signing, storing and managing a disclosure agreement. The particular degree of disclosure, whether being complete non-disclosure or disclosure at some degree, is a matter of concrete implementation and even of a particular innovation endeavor. The main primary actor here is the innovation partner. Eventually, the intermediary could be a secondary actor.

**3.3.23 Sign IP contract.** As in the case in which an organization is opening its innovation process (see scenario 3.3.5), here we consider the functionality to facilitate signing and storing of intellectual contracts. In this case, the main primary actors are the innovation partner and the intermediary.

**3.3.24 Manage IP.** As in the case in which an organization is opening its innovation process (see scenario 3.3.6), the intermediary will

expect some means for managing the IP contract. Unlike the aforementioned case, here the main primary actor is the open innovation intermediary.

**3.3.25 Manage innovation partner.** This functionality treats the innovation partner as an important entity in the platform. As the open innovation intermediary will deal with many partners (in more general terms, clients), the platform is expected to provide some means for managing individual innovation partners. In addition, innovation partners could be also part of innovation networks also managed by the intermediary. The main primary actor is the intermediary.

**3.3.26 Manage innovation ideas.** Innovation ideas are also treated as entities in the platform. This functionality reveals generic characteristics related to managing innovation ideas: reception (if sent for evaluation by an evaluation partner), modification, assignation, among others. The main primary actor here is the intermediary.

**3.3.27 Manage technology.** As in the case of innovation ideas, this functionality also treats technology as an entity subject to management in the platform. The main primary actor here is the intermediary.

**3.3.28 Manage technology transaction.** As open innovation intermediaries could also offer technology brokering services, an open innovation platform could also provide means for managing technology transactions. Transactions can take the form of processes which should also be considered when providing functionality for managing technology transactions. Main primary actor here is the intermediary.

**3.3.29 Manage innovation process.** This functional characteristic proposes typical characteristics for managing an innovation process in which many innovation partners could engage. For example, managing activities, roles, milestones, work products, among other entities. The main primary actors here are the intermediary and the innovation partners.

**3.3.30 Manage innovation consortium.** Whenever the intermediary forms a consortium, the platform should provide functionality for collaborative working between the innovation partners. Document sharing, innovation partners incorporation, among others are examples of expected characteristics. The main primary actor here is the intermediary.

**3.3.31 See advice about funding.** In case in which the intermediary running the platform would like to share funding applications available, the platform should provide functionality for an innovation partner to see this information. The particular characteristics to be considered are a matter of concrete implementations (e.g., filtering, searching). The main primary actor here is the innovation partner.

## 4 RESEARCH APPROACH

In the context of a software-based open innovation platform implementation, we deemed necessary to count with guidance about expected functional characteristics for the software system supporting these kind of platforms.

We started searching for peer-reviewed papers, book chapters, and articles published in well-known sources such as Harvard Business Review.

For the peer-reviewed papers we used the following sources: Springer<sup>3</sup>, ScienceDirect<sup>4</sup>, ACM Digital Library<sup>5</sup> and IEEE Xplore<sup>6</sup>. In addition, Google Scholar<sup>7</sup> indexes journals (e.g. Research-Technology Management by Taylor & Francis) that proved to be valuable resources.

Google search engine was used to find other non-peer-reviewed articles and book chapters. We only deemed to be acceptable for this paper articles that appeared published in well-known, reputable sources (e.g. Harvard Business Review).

The articles and book chapters were first screened by one of the authors. In this screening process, some papers were removed mainly due to lack of validation and consistency problems. Citations, as noted by Google Scholar, was also used as an indicator for removing or accepting a paper in this first screening process.

In a second round, the articles and book chapters that reached this phase were read and analyzed. The analysis allowed us to build this proposed reference model. This phase was carried out by all of the authors.

A third phase consisted in a cross-checked review from all of the authors. This third phase also ended up in improving the structure and argument of the reference model.

## 5 CONCLUSIONS AND FUTURE WORK

There is enough support in literature to argue that open innovation is a paradigm that is more than a simple fad. It has proven to be very useful for many organizations, especially large companies, mainly due to the access to externally created knowledge, an asset that is not always found within the organization. This search for talent and collaboration is necessary today, in a market in which aspects such as reducing costs, risks, and deadlines, in addition to increasing competitive advantage goals, are essential for the companies to survive. Innovating instead of reducing costs more than the competition, seems to be one of the formulas to survive in this changing market in which we live.

We hope that this model can serve as a starting point and as a guide for organizations that are committed to implementing and deploying a software-based outside-in open innovation platform. We expect the leader for these initiatives find useful information in this reference model which can be also associated to other proposals already published to aid in the journey to having one of these platforms in production.

As this reference model clearly resembles the main open innovation related tasks, we believe this proposal could also greatly contribute to understanding innovation processes, as well as identifying and regulating relationships between different and multiple stakeholders involved in these processes.

Having defined this reference model, we plan, as a next step, to use this proposal for defining a reference architecture for open innovation platforms.

<sup>3</sup>Springer: <https://www.springer.com/>

<sup>4</sup>ScienceDirect: <https://www.sciencedirect.com/>

<sup>5</sup>ACM Library: <https://dl.acm.org/>

<sup>6</sup>IEEE Xplore: <https://ieeexplore.ieee.org>

<sup>7</sup>Google Scholar: <https://scholar.google.com/>

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