Since Henry Chesbrough introduced the concept in 2003, open innovation (OI) has taken its place as a mainstream innovation process. Although the growing interest in OI since then, there are still many unanswered questions: What framework companies could adopt to implement OI? What are the most important constructs to be considered in the definition of a framework for open innovation? We identify constructs to be considered in a framework for the implementation of open innovation in intensive and non-intensive technology companies, considering strategic, organizational and operational aspects. To reach this goal, a thorough analysis of the knowledge base was undertaken and identified nine constructs for the implementation of open innovation. For each construct research questions were developed to instigate further research on the topic, as well as help in designing a research protocol for future research.

Palavras-chave: Open innovation, Constructs, Framework, Low-tech companies, High-tech companies
1. Introduction

Open Innovation (OI) is an approach to innovation that was conceived by Henry Chesbrough in his seminal work “Open Innovation: The new imperative for creating and profiting from technology” in 2003.

Since then, different researchers have conducted a number of theoretical and empirical studies in order to clarify this concept, whose definition has also undergone a series of improvements and adjustments in order to adapt to the latest findings on the topic. Recently, Chesbrough and Bogers (2014) define open innovation as a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization’s business model.

Despite the growing interest in OI since 2003, there are still many unanswered questions. One of the most persistent for researchers and practitioners alike relates to how OI can be implemented. The literature concerning this issue is growing fast. For example, Mortara and Minshall (2011) tried to answer this question reviewing a sample of 43 cross-sector firms for their OI implementation approaches. The study analyzed how firms moved from practicing closed to open innovation, classifying the adoption path according to the impetus for the adoption of the OI paradigm and the coordination of the OI implementation. Despite the attention it has attracted, they do not answer important questions regarding the OI implementation: what framework companies could adopt to implement OI? Where this process begins? What are the most important constructs to be considered in the definition of a framework for open innovation?

Thus, the aim of this work is to identify the most important constructs to be considered in a framework for the implementation of open innovation in intensive (high) and non-intensive (low) technology companies, considering strategic, organizational and operational aspects.

To reach the goal of this paper, a thorough analysis of the knowledge base was undertaken to identify the most recent and foremost publications on OI about its implementation process, its constructs and their main practices. This analysis of the literature identified nine constructs, divided into strategic, organizational and operational aspects.
2. Open innovation

Most definitions of open innovation in the literature up to now start this concept with two distinguished separate dimensions (Chiaroni, Chiesa and Frattini, 2011): (i) inbound or outside-in open innovation (technology exploration), which is “the practice of leveraging the discoveries of others” and entails the opening up to, and establishment of relationships with, external organizations with the purpose to access their technical and scientific competences for improving the firm’s innovation performance; (ii) outbound or inside-out open innovation (technology exploitation), which suggests that “rather than relying entirely on internal paths to market, companies can look for external organizations with business models that are better suited to commercialize a given technology”. In other words, it is the practice of establishing relationships with external organizations with the purpose to commercially exploit innovation opportunities.

Dahlander and Gann (2010) further divided inbound and outbound innovation to interactions that are pecuniary (resources involving financial transactions) versus non-pecuniary (resources are generated without immediate financial rewards, seeking indirect benefits to the focal firm). The same authors also suggested four different forms of openness. Two inbound processes: sourcing (how firms can use external sources of innovation) and acquiring (refers to acquiring input to the innovation process through the market place); and two outbound processes: revealing (how firms reveal internal resources without immediate financial rewards, seeking indirect benefits to the focal firm) and selling (how firms commercialize their inventions and technologies through selling or licensing out resources developed in other organizations). Finally, van de Vrande et al. (2009) suggested that enterprises might engage in various practices. Figure 1 presents a summary of this typology to open innovation approach.

Figure 1 - Typology and practices of open innovation
Three activities related to inside-out dimension practices are distinguished: venturing, outward licensing of intellectual property (IP), and the involvement of non-R&D workers in innovation initiatives (in this paper, we call this practice as ideation); and six practices were distinguished related to outside-in dimension: customer involvement (co-creation), external networking, external participation, outsourcing R&D, inward licensing of IP and co-development (in this paper, we have included this practice for this dimension).

Nevertheless, in our viewpoint, this typology of open innovation covers only the necessary operational aspects for its implementation. There are two other very important aspects that are completely ignored by other studies published in the literature for the implementation of open innovation: the strategic and organizational aspects. These three aspects (strategic, organizational and operational) form the framework for the implementation of open innovation proposed by the present work. However, first, it is necessary to know the constructs, which frame the proposal of a framework for the implementation of open innovation.

3. Constructs of OI

3.1 Top management leadership
Leadership has been viewed as a social process that takes place in a group context in which the leader influences his or her followers’ behaviors so that desired organizational goals are met (Oke, Munshi and Walumbwa, 2009). The leadership research focuses on transformational, transactional and laissez-faire leadership styles. Transformational leaders provide a vision, inspire, and motivate employees, as well as instilling a sense of follower self-confidence. Transactional leaders focus on managing mistakes, have lower performance expectations and do not empower their employees. The laissez-faire style as non-leadership behavior in that a leader tries to relinquish his or her responsibility and does not show concern for followers (Ryan and Tipu, 2013). For this reason, we believe that the leadership style that best suits the open innovation approach is the transformational.

It is without question that leadership plays a vital role in fostering innovation processes and activities in organizations. For innovations to succeed in an organization, they require the commitment of key and strategic resources that are controlled by the top management or leadership of organizations (Oke, Munshi and Walumbwa, 2009).

3.2 Organizational culture

Organizational culture is defined as the deeply seated (often subconscious) values and beliefs shared by personnel in an organization. It is manifested in the typical characteristics of the organization. It therefore refers to a set of basic assumptions (routine behaviors, norms, values, philosophy, rules of the game, and feelings) that worked so well in the past that they are accepted as valid assumptions within the organization (Martins and Terblanche, 2003).

Although Lin and McDonough III (2011) declare that most scholars agree that organizational culture is something holistic, historically determined, socially constructed, soft, and difficult to change, they propose and prove to exist a positive relationship among strategic leadership and organization culture.

Therefore, changing from closed to open innovation approach requires a major change in the organizational culture of a company, whether low or high technology, since it directly affects the beliefs and values of those businesses.
3.3 Business model

Osterwalder (2004) defines business model as a conceptual tool that contains a set of elements and their relationships and allows expressing a company's logic of earning money. Open business models enable an organization to be more effective in creating as well as capturing value. They help create by leveraging many more ideas because of their inclusion on a variety of external concepts. They also allow greater value capture by utilizing a firm’s key asset, resource or position not only in that organization’s own operations, but also in other companies’ business (Chesbrough, 2007).

The adoption of open innovation requires a new way of seeing and doing business. This requires a new business model that allows knowledge to flow both from outside to inside and inside to outside the bounds of the company.

3.4 Organizational structure

The literature suggests that the nature of organizational structure in industrial versus post-industrial firms could be distinguished as mechanistic (inorganic) versus organic. The mechanistic paradigm is effective when environments have a high degree of certainty, technologies tend to be routine, organizations are designed for large-scale, and employees are treated as another resource. Internal structures tend to be vertical, functional, and bureaucratic. The organic paradigm recognizes the unstable, even chaotic nature of the external environment (i.e. post-industrial). Technologies are typically non-routine, and size is less important. Organizations are based more on teamwork, face-to-face interactions, learning, and innovation (Nahm, Vonderembse and Koufteros, 2003).

Hao, Kasper and Muehlbacher (2012) states that six items are employed to represent organizational structure characteristics such as: flexibility, openness and authority, communication, delegation and decentralization and complexity.

3.5 Knowledge management

Knowledge management is an emerging field that has commanded attention and support from the industrial community. Many organizations currently engage in knowledge management in
order to leverage knowledge both within their organization and externally to their shareholders and customers. It encompasses much more than technologies for facilitating knowledge sharing. In fact, practitioners are beginning to realize that people and the culture of the workplace are the driving factors that ultimately determine the success or failure of knowledge management initiatives (Žemaitis, 2014).

Firms believe that obtaining complementary external knowledge is an effective way of providing them with a source to renew their in-house knowledge in order to innovate. From the knowledge based view of the firm the acquisition of external knowledge must be considered more as a learning opportunity than as a cost (Díaz-Díaz and Saá-Pérez, 2014).

3.6 R&D team organization

The organization of research within large firms typically takes on one of three structures: centralized, decentralized or hybrid. In the centralized structure, there is a single executive in charge of the firm’s research activities who reports directly to a corporate-level executive such as the CEO or President. In the decentralized structure, research is conducted exclusively within divisions or business units, and R&D directors report to division general managers. In the hybrid structure, research is conducted both within a centralized function whose leader reports to corporate management, and within the firm’s divisions or business units. An R&D director at the divisional level reports to his/her division general manager, who in turn reports to corporate management (Argyres and Silverman, 2004).

When examining the influence of open innovation on the choice between either centralizing or decentralizing R&D, corporate R&D structures seem to play a significant role. Considering, however, the influence of open innovation on the internal structure of R&D, it should be stated that the open innovation strategy emphasizes the integration of knowledge (external or multidisciplinary) rather than the deepening of sectorial scientific knowledge and so leads to the adoption of matrix or network structures rather than functional structures (Petroni, Venturini and Verbano, 2012). The way the company organizes its R&D team may be important for driving innovation projects.
3.7 OI dimensions

The outside-in process, which Gassmann and Enkel (2004) defined as one of the three core processes of open innovation in R&D management, includes all activities for external technology sourcing. During this inbound open innovation process, companies monitor the environment to source knowledge and technologies from stakeholders, such as users or suppliers and to license IP from other firms (Inauen and Schenker-Wicki, 2011). The ideas on R&D results that are external to the firm, stemming from suppliers, customers and other external actors (through technology in-licensing, acquisition or joint development), increases the innovativeness of the firm (Spithoven, Clarysse and Knockaert, 2010).

Another core process, the so-called inside-out process by Gassmann and Enkel (2004), refers to outward technology transfers. In such an outbound open innovation process companies initialize technology and IP out-licensing, make sales, divest and found spin-offs. The commercialization of in-house technology is the main purpose of this process (Inauen and Schenker-Wicki, 2011). By means of outbound open innovation, firms attempt to achieve monetary and strategic opportunities. This strategy involves major risks because it may weaken a firm’s competitive position based on transferring relevant knowledge (Lichtenthaler, 2009).

3.8 OI practices

The nature of firms’ innovation processes can vary. This variation may be due to the different ways of conducting the process of open innovation implementation. Such different ways of conducting (or operationalize) the implementation process of OI is called open innovation practices. van de Vrande et al. (2009) identified nine practices of open innovation, which may be pecuniary or non-pecuniary, as shown in Figure 2. These practices are discussed below.

Figure 2 – Practices of OI
According to Figure 2, we initially address the four practices that are considered pecuniary: outsourcing R&D, inward licensing, venturing and outward licensing.

Outsourcing R&D begins with selecting contractual modes for undertaking either some or all of the R&D activities by external firms during the NPD process (Huang, Chung and Lin, 2009). Outsourcing R&D is concerned with the antecedence, processes, and implications of sourcing innovation from players outside the firm’s boundaries. The resource-based perspective suggests that firms conducting expensive, risky or complex research projects will seek R&D co-operation. In turn, these firms tend to be concentrated in high-tech sectors (Miotti and Sachwald, 2003).

Venturing is defined here, like van de Vrande et al. (2009) say, as starting up new organizations drawing on internal knowledge, i.e. it implies spin-off and spin-out processes. Support from the parent organization may also include finance, human capital, legal advice, administrative services, etc.

There are three mechanisms suggested by the literature via which venture capital should lead to higher rates of new business incorporation. First, venture capitalists may directly assist the birth of new firms. Second, nascent entrepreneurs may recognize the need for capital in the future and only establish firms when they have reasonably high expectations of obtaining such funding. Third, firms may be engaged in spin-offs (Popov and Roosenboom, 2013).

Outward licensing allows companies to profit from their intellectual property (IP) when other firms with different business models find profitable, external paths to the market. Outward licensing generates revenues in the form of licensing payments, but current profits might decrease when licensees use their technology to compete in the same market (van de Vrande et al., 2009).
Figure 2 also presents five practices that are classified as non-pecuniary: external network, co-development, co-creation, external participation and ideation.

External networks are particularly important in industries where technology changes rapidly and product life cycles are short (Dittrich and Duysters, 2007). The focus on openness and interaction in studies of innovation reflects a wider trend in studies of firm behavior that suggest that the network of relationships between the firm and its external environment can play an important role in shaping performance (Westergren and Holmström, 2012). R&D cooperation in networks has obvious challenges: firms involved in joint R&D projects often have heterogeneous and competing interests and have a limited resource base. Accordingly, appropriate techniques to manage joint R&D is a challenge and need to be in place, especially in an environment of open innovation.

Fliess and Becker (2006) affirm that co-development processes are an instrument used in several industries to gain a competitive advantage and to reduce development costs.

Co-creation is an interactive, creative and social process between stakeholders that is initiated by the firm at different stages of the value creation process. Co-creation activities are a form of collaborative innovation and facilitated social interaction involving employees, suppliers, consumers (or customers more specifically) as well as value adding experiences (Roser, DeFillipini and Samson, 2013). Co-creation is especially relevant for value creation with customers.

External participations enable the recovery of innovations that were initially abandoned or that did not seem promising (van de Vrande et al., 2009). This is called external corporate venturing, where companies use external partners for the creation of new ventures. External corporate venturing allows a company to monitor, firsthand new technologies and applications and to have a window on the latest technological developments. Apparent time to market shortens when a company can spin in a promising venture compared with the situation in which it has to commercialize an innovative idea from scratch (van de Vrande, Lemmens and Vanhaverbeke, 2006).

Employee participation in the innovation process leads to a low cost tactic, which still has a positive point in increasing the motivation of the workforce in the improvement of products, processes and technologies.
3.9 Implementation process

For driving the implementation of open innovation approach, we adopt the same process of Chiaroni, Chiesa and Frattini (2011) that divides this task into three phases: unfreezing, moving and institutionalizing. The first phase implies the creation and communication of the new vision to both internal and external stakeholders. The second phase concerns the actual implementation of change through the establishment of new procedures and patterns of behavior consistent with the new vision. Finally, the third phase involves the institutionalization of the new order, through consolidating the improvements achieved in the previous stage and preventing a slip back to the antecedent status quo.

4. Framework for OI implementation

The framework proposed by this paper is initially composed of three hierarchical structures that we call aspects: strategic, organizational and operational. Each of these aspects contains constructs (white boxes) for OI. The set of aspects and its constructs for OI implementation are shown in Figure 3.

Figure 3 - Aspects and constructs for OI implementation
The strategic aspect relates to the direction that the company decides to take towards the paradigm shift from closed to open innovation process. For this aspect, three constructs are aligned: top management leadership, organizational culture and business model.

The organizational aspect relates to the way the company is structured to implement the open innovation process, from its organizational structure and R&D team, so as it ensures that key information is managed as lessons learned.

Finally, the operational aspect handles with the implementation of OI practices that are relevant for the company’s innovation process, both pecuniary and non-pecuniary. For this aspect, we identify three constructs: OI dimensions, OI practices and implementation process.

Jansen, Vera and Crossan (2009) state that transactional leadership behaviors (a style of top management leadership) facilitate improving and extending existing knowledge management. Žemaitis (2014) affirm that there is a relationship between knowledge management and R&D team organization, especially for the outside-in process, which can be described as knowledge internalization. Figure 4 shows the links between strategic and organizational aspects constructs.

Figure 4 - Links between strategic and organizational aspects constructs

5. Discussion and conclusion

The present work aimed to contribute to a gap identified in the literature in research on open innovation. The gap was the absence of a framework for analyzing the implementation of
open innovation in low and high-tech companies that treats not only the operational aspects, but also the strategic and organizational aspects of the process.

We consider operational aspects the dimensions of open innovation, its practices and its implementation process, which are the subject of most studies published in the knowledge base on this topic.

Few studies in the literature, aiming to contribute to a framework or describe how different segments of companies have implemented the approach of open innovation have bothered to consider what we call strategic and organizational aspects.

In our point of view, these aspects are equally or more important than the operational aspects, and cannot be studied separately when trying to describe the process of adoption of the OI or the transition from closed to open innovation approach.

The study identified nine constructs for the proposed framework. For each construct, identified in the available literature, initial research questions were formulated to instigate further research on the topic, as well as indicating hints in designing a research protocol. These research questions are showed in Table 2.

Under the proposed framework, we assume that the implementation of open innovation starts by strategic aspect. The high-level decisions generated by the identified constructs allow the necessary organization of the company that organizational aspect constructs can be put into practice. Finally, with both aspects defined and implemented, begins to operationalize the framework implementation by the last aspect.

The current study has a number of limitations, some of which, however, offer opportunities for future research and publications.

**Acknowledgements**

The authors would like to thank CAPES for the doctoral DS CAPES scholarship that enabled made this study. We would also like to thank CNPq for the the resources offered for the realization of this work through the processes 478509/2012-0, 304628/2012-3 and FAPEMIG for the support in the form of process TEC PPM-00058-13.
Table 2 - Research questions for future directions
<table>
<thead>
<tr>
<th>Construct</th>
<th>Research questions</th>
</tr>
</thead>
</table>
| Top management leadership       | • What is the role of top management leadership in the implementation of OI?  
• What kind of leadership is best suited to lead this process? |
| Organizational culture          | • Is it necessary to change the company’s organizational culture to implement the OI approach?  
• What have to be changed?  
• What is the role of top management in conducting this process?  
• What assumptions have to be changed?  
• How this new culture is communicated throughout the organization? |
| Business model                  | • Is this current business model needs to be redefined?  
• How this new approach to innovation affects the revision of the business model?  
• How new innovation practices influences the company’s current way of doing business?  
• How the new forms of revenue arising from OI affects or promote changes in the organizational culture? |
| Organizational structure        | • What items that represent organizational structure characteristics change during the implementation of OI?  
• How the participation of researchers coming from the outside the company change its organizational structure layers of hierarchy during the implementation of open innovation? |
| Knowledge management            | • How company manages such large amount of information so that no vital information leak to competitors and guarantee that technological information is documented for internal use in current and future projects? |
| R&D team organization           | • What type of organization is ideal for R&D teams in an open innovation environment?  
• If the company is making the transition from the closed to the open model, the structure of its R&D team has to change? |
| OI dimensions                   | • What is the dimension most commonly used by companies?  
• Is this level of use may vary according to the market segment of the company?  
• May it also vary if the company is low or high tech? |
| OI practices                    | • What should be the first practice to be used in the implementation of open innovation approach?  
• What practices should be implemented next?  
• How many practices are necessary to implement to know that a company is an open innovation user? |
| Implementation process          | • This process can be adopted by both low and high-tech companies to transition from the closed to the open innovative approach?  
• Moreover, if the company will start now its innovation process?  
• How this model can be adapted to meet this need?  
• Will be necessary to assign a team to conduct the implementation process?  
• What should be the composition and competence of this team?  
• Is the procedures established for this new open approach should be documented? |
References


