


Open Eco-innovation. The New Form of Cooperation for Sustainable Future.

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Abstract: This chapter is dedicated to the concept of Open Eco-innovation - an emerging form of cooperation for sustainable development, particularly for environmental sustainability. Our society currently faces a number of environmental challenges that cannot be solved individually and require a collaborative approach. One of the ways to harness the power of collaboration and access the external resources to foster internal eco-innovation capabilities is Open Eco-innovation. This chapter gives an overview of the quickly arising concept, the historical perspective, and the current state of the research. In addition, it draws to the literature on stakeholder theory, industrial symbiosis, and knowledge management to give a theoretical context for this emerging phenomenon. Our research shows that OEI is a critical tool to foster eco-innovation in organizations and sustainable development in our society. Nevertheless, more profound research is needed to prove empirically the viability of the concept and explore its real-life application in the industry.

Keywords: open eco-innovation, eco-innovation, collaboration, cooperation

1. Introduction

Currently, the global society is facing a number of critical sustainability challenges that put into question the quality of life on our Planet in the nearest future, as well as its survival in the long run. Due to several decades of globalization and the continuous intertwining of industries, economies, and cultures, today, these challenges are not isolated in a particular part of the world and affect our society as a whole. This is why they are sometimes called the "Grand Challenges" (GCs) (George et al., 2016). The scope of academic disciplines involved in the sustainable transition and their interconnectedness has significantly increased in the last decades, nevertheless, the GCs remain unresolved (Köhler et al., 2019). One of the possible explanations for the poor

results is that, by nature, GCs are complex problems that require holistic and comprehensive solutions. Also, these challenges are the consequence of many centuries of human development and reckless exploitation of the Planet, and it would be naïve to think that the situation could be turned around fast and through the individual efforts and actions of several corporations, governments, or persons.

In recent years, very close public attention is focused on environmental issues and particularly the danger of Global Warming. The recent reports and UN agreements suggest that the next decade will be crucial for humanity to drastically decrease its negative environmental impacts, cut CO₂ emissions, restore degraded ecosystems and meet Sustainable Development Goals (SDGs). In this context of aligning international policies and increasing political and societal concerns, firms must take proactive measures to develop effective green strategies and improve business competitiveness to continue their existence and thrive. These shifts, combined with an accelerating speed and complexity of innovation, require companies to search for new approaches and business models (Bocken et al., 2019).

An increasing body of academic literature suggests that one of the new forms of cooperation and a viable solution for major environmental challenges is to foster eco-innovation in organizations through open innovation strategies (Guo et al., 2020). We call this symbiosis of two innovation concepts Open Eco-innovation (OEI) and define it as a "purposive use of external resources and commercialization paths to develop and/or adopt innovations that improve the environmental performance of products and processes, reducing the environmental impact caused by consumption and production activities."

Scientific research on the topic of OEI is scattered among different disciplines, represented by intertangling terminology and virtually non-existent. The possible explanation for the lack of theoretical work on the subject is the multi-faceted nature of OEI as it is a construct of several disciplines (Ghisetti et al., 2015) and requires a more holistic approach for its analysis than other topics in innovation management. In addition, this phenomenon was also not yet defined, conceptualized, and located in the current structure of management literature.

Escalating growth of interest towards OEI and its practical implementation by many organizations creates a need for a more comprehensive review of existing literature and case studies. Further knowledge regarding the main drivers, themes, and methods of OEI and potential knowledge gaps is required. This chapter intends to provide an overview of the OEI concept, an understanding of its theoretical origins, and the current development of the research in this area.

2. Theory of Open Eco-innovation.

The importance of inter-firm collaboration to develop technological solutions to environmental problems was long discussed before the appearance of the OI concept (Chesbrough, 2003). Georg et al. (1992), based on Danish Clean Technology Programme, analyzed the development of environmental innovations among polluters, suppliers, and consultants and concluded that government could take a passive role of subsidizing the development of green technologies, as well as taking a more active part as a "matchmaker," that facilitates the process of providing necessary contacts and information to promote eco-innovations. According to Clarke & Roome (1995), firms are required to recognize the interests of stakeholders and search resources to develop environmentally sensitive technology within intra-organizational (within an organization), trans-organizational (with the organizations in the supply chain), and supra-organizational (with organizations at the domain level) networks. Florida (1996) also noted that a close relationship with suppliers and customers facilitates the adoption of environmental innovations. Lenox & Ehrenfeld (1997) stated that the firm's environmental design capabilities are derived from knowledge and expertise, both internal and external to the firm.

Today, the interest in the possible use of Open Innovation (OI) in eco-innovation gradually increases and gains importance in the academic and professional literature (Avellaneda Rivera et al., 2018). However, the research in this area is currently in its infant stage and still offers a very poor and limited understanding of the concept (Perl-Vorbach et al., 2015). One of the first mentionings of the concept in the literature can be attributed to Winston (2010). The author does not provide a particular definition of the term yet but describes it in more general terms as a combination of OI and Sustainability and a way to share ideas and patents among several companies to reduce their cumulative environmental impacts. Ghisetti et al. (2015) uses the term "Open Eco-innovation Mode" (OEIM) and relates it to "eco-innovation friendly" modes of knowledge sourcing and absorption, along with connectedness with environmentally responsible partners and embeddedness in the green-oriented innovation system.

We believe that the rise of interest in the concept can be attributed to multiple benefits of OEI. For instance, Rauter et al. (2017) proved that collaboration with particular stakeholders, including customers, suppliers, universities, and intermediaries, is more common among the top 10% of achieving companies based on their sustainability innovation and economic innovation performance. Mothe & Nguyen-Thi (2016) showed that collaboration with the same set of stakeholders increases the company's chances to develop

radical eco-innovative solutions. Moro et al. (2019) proved that collaboration positively affects the number of patents per capita.

Nevertheless, these are only a few studies that tried to prove conclusively the positive affect of OEI on the environmental and economic performance of the company, thus leaving open several important questions: whether OEI can be a universal strategy for companies to overcome their internal limitations to design eco-innovative solutions, whether there are substantial benefits of OEI strategy in terms of the environmental and economic performance of the company, and whether these benefits offset all the challenges of OEI process. Also, much less is known about the theoretical background of OEI and the main themes that constitute the current academic thought on the matter. Based on our previous research, we have identified three major themes that prevail in OEI discussions, including the dynamics of industrial symbiosis, stakeholder engagement, and knowledge transfer. They are discussed in Section 3.

3. Major themes in Open Eco-innovation Research.

3.1 Stakeholder Engagement and Open Eco-innovation.

Our analysis of major themes showed that academic research on the topic of OEI is commonly performed in the context of Stakeholder theory, and its importance grows with time. The concept originated in the early '60s and was defined and introduced to the strategic management field in the early '80s by Mitroff (1983) and Freeman (1984). Since then, it was a major framework to analyze any kind of interaction of the enterprise with the external environment. It is one of the first theories to talk about the boundaries of the company, and that they can be "fluid" and not necessarily impermeable, and that performance of the firm is affected by internal and external interest groups. Freeman (1984, p. 25) defines stakeholders as "any group or individual who can affect or is affected by the achievements of the firm's objectives" and concludes that a firm has to have a strategic framework to deal with the expectations and power of these groups.

It is essential to mention that Freeman (1984) traces back the Stakeholder theory to the research on Corporate Social Responsibility (CSR) and broadening the notion of stakeholders to non-traditional interest groups, including the public, communities, and employees. In the early '90s, these discussions evolved into the concept of green stakeholders, "green pressure" on corporate activity, and the need for an adequate industrial response. The original objective behind stakeholder interaction was to comply with regulatory policies, prevent potential risks (adverse effects) related to interaction with internal or external stakeholders,

and deal with "green pressure" (Gold et al., 2010). An engagement with partners and stakeholders was performed mostly to communicate about the benefits of new environmental solutions to external stakeholders and to prepare internal stakeholders for expecting changes in production and processes. Another important concept that appeared around this time in the literature was the idea of proactive environmental strategies – a notion that a firm can voluntarily choose to introduce environmental practices that can exceed the regulatory requirements (on a smaller or bigger scale) (Aragón-Correa & A. Rubio-López, 2007).

Consequently, the discussion shifted towards a more proactive role of a firm in collaboration with stakeholders, and environmental strategy being an essential part of strategic management. Environmental practices started to be considered as an opportunity to reduce costs of regulatory compliance, lower waste disposal and save on energy and materials, and as a result, gain a competitive advantage in the market (Sharma & Vredenburg, 1998). An important distinction was made between stakeholder green pressures and environmental cooperation. And it was also recognized that external stakeholders have the power to facilitate green product innovation and contribute to corporate environmental performance and a general transformation towards a sustainable society (Carrillo-Hermosilla et al., 2009). Zhu et al. (2012) add an idea that eco-collaboration can also positively affect the economic performance of the firm and propose Ecological modernization theory (EMT) as one of the frameworks for future research. In addition, collaboration among stakeholders started to be considered as an important factor in the adoption of eco-innovations.

Freeman (1984) talks about 12 major groups of stakeholders, only two of them being internal (owners and employees). According to Carrillo-Hermosilla et al. (2009), radical eco-innovation requires an engagement of suppliers, customers, government, and civil society stakeholders in the innovation process. A particularly big stream of literature on OEI and earlier identified themes focuses on the relationships between buyers and suppliers (Wu & Li, 2019). The green supply chain may lead to knowledge and technology spillovers, which proved to be an important factor in the overall competitiveness of the firm. Other possible partners for eco-innovation include universities, public entities, and intermediaries.

3.2 Industrial Symbiosis, Positive Spillovers, and Open Eco-innovation.

At the beginning of 2000, several important ideas emerged in the literature on OEI. The first is that eco-innovation has a propensity for positive spillovers (double externality problem). Knowledge spillovers tend to disincentivize firms to invest in green technologies, as different agents may appropriate and benefit

from the knowledge, without being involved in the initial R&D process and investments (Rennings, 2000). However, they can also have a "win-win" effect for various stakeholders if firms have an adequate green knowledge management system in place and search for more optimal business models to solve appropriability problems and combine environmental concerns with competitiveness objectives (Porter & van der Linde, 2018).

The concept of unintended and voluntary spatial spillovers in the form of locally bounded and territorially rooted interactions among actors (Capello, 2009) is closely related to another important analytical concept – industrial symbiosis (IS). It is defined as "local initiatives attempting to make use of spatial proximity of industrial activities to respond to environmental concern and work for catalyzing inter-organizational collaboration among local economic actors to harvest environmental improvement potentials present at the inter-organizational interface" (Mirata & Emtairah, 2005). IS in the form of eco-industrial parks proved to increase resource efficiency and promote synergic and circular business models, facilitate knowledge transfer and technology spillovers, diffuse eco-innovations, and simultaneously provide economic benefits for the firm (Tseng & Bui, 2017). IS is especially important in the development of radical eco-innovations (Levidow et al., 2016).

The concepts of positive spillovers and industrial symbiosis brought several important ideas to the literature on OEI. First, that green knowledge and technologies have a propensity to cross the borders of the firm. Thus, both inside-out and outside-in knowledge flows have to be properly managed. Second, those eco-innovations evolve due to interactions between various actors of innovation systems, including firms, universities, and intermediaries, as this cooperation provides opportunities to access knowledge and business networks.

3.3 Knowledge Management, Absorptive Capacity, and Open Eco-innovation.

The third central theme that we want to discuss in this chapter is OEI from the perspective of knowledge management and absorptive capacity. In the evolutionary literature, innovation is characterized as a knowledge, which creation and exploitation is highly dependent on available resources, including capabilities and time (Carrillo-Hermosilla et al., 2009). In its turn, knowledge management is one of the most important capabilities of the firm. According to the resource-based view of the firm, resources and capabilities of the firm, including assets that are hard to imitate, individual skills, and accumulated knowledge, enable the firm to attain a competitive advantage in the market (Gold et al., 2010). As a result, access to knowledge and information, as well as other capabilities, is a major incentive for companies to pursue various types of

partnerships (Gulati, 1999). The need for an official and structured R&D cooperation is especially important, as the knowledge-based resources of a firm are hard to imitate due to high knowledge and information barriers. Extra- and intra-organizational knowledge also showed to be essential components of eco-innovations. First, because it tends to have more dispersed knowledge bases; therefore, it requires a more comprehensive approach to knowledge management (Wagner & Llerena, 2011). Second, because it requires knowledge of particular sustainability-related issues that R&D departments may not possess.

Traditionally, among all the possible stakeholders (partners), suppliers tended to be the main "knowledge partners" for the firm. They help a firm to broaden and diversify its internal knowledge of the manufacturing process and increase its ability to recognize, access, and utilize external knowledge (Geffen & Rothenberg, 2000). It proved beneficial in green product innovation as it brings different perspectives, knowledge, and approaches to find new solutions. Exchange of knowledge that provides environmental and competitive benefits is a core stone of industrial symbiosis (Mirata & Emtairah, 2005).

4. Conclusions.

In conclusion, we would like to summarize several important ideas that emerged during our investigation. First, Open Eco-innovation is a new form of cooperation for sustainable development. Its importance is growing exponentially in recent years. Second, OEI recognizes the internal limitations of any organization to create sustainable environmental solutions and searches for strategies that could bring external resources like knowledge and financial resources to potentialize the internal processes. Third, OEI searches for close partnerships with the stakeholders in their business environment and tries to strategically involve them in every stage of the value creation, where this collaboration may yield the best mutual results. Forth, these kinds of collaborations may be organized on much bigger scales and with much more significant synergies in the form of industrial symbiosis. And fifth is that the transfer of knowledge and an absorptive capacity of an organization to internalize the external knowledge becomes a crucial factor in building more sustainable, resilient, and environmentally friendly organizations.

Conflict of interests (multiple authors).

(X) *The authors declare they have no conflict of interest*

Authors' contribution statement.

We, Valery Chistov, Sunita Tanwar and C.S. Yadav, hereby declare that we have all participated in study conceptualization, methodology, study design, and editing. All authors approve the final version of the manuscript and are responsible for all aspects, including the guarantee of its veracity and integrity.

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