

Open Innovation in Utilities: A Study in Sanitation Companies

ABSTRACT

This study aimed at analyzing innovation management in Brazilian sanitation companies and identify open innovation practices in its Research & Development processes. This study is of a descriptive and exploratory nature and data was collected through interviews with R&D managers. The use of a semi-structured script and the contents analysis procedure of the data gathered led to the study's main results. Results showed that companies in the sanitation sector intentionally uses external knowledge flows to leverage their innovation processes, mainly through university partnerships and supplier cooperation. It was also identified that those companies have high levels of absorptive capacity.

Keywords: Innovation, open innovation, services, sanitation.

1. INTRODUCTION

Innovation stands out in the field of organizational studies as an efficient strategic option for companies seeking to increase their economic power. Successful innovations can bring innumerable benefits to the companies that develop them, and thus the pursuit of innovation has become the goal of companies seeking to gain advantage in the markets in which they operate, which may represent their own survival (Chandler, 1993; Drucker, 1986; Porter, 1990).

With the technological leap forward from the second half of the twentieth century, the relentless pursuit of innovation has evolved rapidly, becoming the standard in any market that a company might compete. To overcome this challenge, companies began to invest heavily in their organizational structures in order to establish large internal R&D areas in order to achieve economies of scale and scope. These centers sought to develop products and technologies internally, always at lower costs and with greater speed, so that the sponsoring company could capture the value generated by these developments and establish advantages in the face of competition, either by increasing their revenues or their participation. market (Chandler, 1993; Porter, 1990).

Many companies are turning to open innovation, pushing the boundaries of companies by connecting with external partners, exchanging or sharing information, projects and knowledge. According to Lindegaard (2010), this practice has been used for some years in a more structured way in developed countries and companies that use it tend to perform better than those that do not practice it. The procedure is to maximize resources for externally developed solutions and monetize internally developed technologies that find no application in key business activities.

Initially focused on product and technology development, research on innovation increasingly considered service economics (Gallouj & Weinstein 1997; Sundbo 1997; Salter & Tether 2006; Tidd & Hull 2003; Sundbo & Gallouj 2000), given the importance in creating wealth and jobs that this sector of the world economy has represented (Huizingh, 2011). According to a study published by the OECD, the service sector accounts for over 60% of total economic activity in most of its member countries. In Brazil, according to IBGE - Brazilian Institute of Geography and Statistics found that in 2012 the service sector accounted for 69.8% of Gross Domestic Product (IBGE, 2013).

Similarly, now as a recent phenomenon, there is a growing body of research on Open Innovation in Services (Fasnacht, 2009; West, Salter, Vanhaverbeke, & Chesbrough, 2014; Mina Bascavusoglu-Moreau & Hughes, 2014; Myhren, Witell, Gustafsson, & Gebauer, 2018; Paskaleva & Cooper, 2018). For Chesbrough (2011) open innovation in services presents fundamental aspects very different from those that make up the practices of this model in product development. Services are intangible and different users may have different experiences using the same service. For this

author, "Companies need to think of their business as a service business, engage customers in the innovation process, and employ open innovation as a means of accelerating and deepening service innovation." Service innovations represent an important way for companies to maintain their competitive advantage as products become increasingly commoditized.

In this same context, recent studies seek to address open innovation this time focusing on utilities (Chesbrough & Vanhaverbeke, 2018; Mergel, 2018). Even various levels of government are increasingly seeking to realign their policies toward open innovation (West et al., 2014). Initiatives such as Open Government (Obama, 2009), Wikigovernment (Noveck, 2009) aim to increase interaction between governments and citizens in order to identify real problems and propose solutions to be offered by the government (Fuglsang, 2008; Hilgers & Ihl, 2010; Lee, Hwang & Choi, 2012). Public-Private Partnerships have also been the subject of case studies from the perspective of open innovation (Feller, Finnegan & Nilsson, 2011; Munksgaard, Evald, Clarke, & Nielsen, 2012; Smith, Sochor, & Karlsson, 2019).

Considering its importance to society and its economic relevance, a segment that can contribute to a better understanding of the adoption of open innovation practices in public services in Brazil would be the supply and sanitation services. Figures released in 2013 by the National Sanitation Information System (SNIS), conducted by the Ministry of Cities, show that considering the urban and rural areas of the country, water distribution reaches 82.5% of the population. The sewage collection service reaches 48.3% of the Brazilian population and the generated sewage, only 38.7% receive some type of treatment. When we consider only the basic sanitation data in the urban areas of the country, we find that water distribution reaches 92.5% of the population, with the Southeast and South regions being the best served, with 96.6% and 96%, respectively. For this segment, sewage collection reaches 53.5% of the population, with the Southeast and Midwest regions being the best served, with 76.6% and 50.5%, respectively (Ministério das Cidades, 2014).

Given the above, it can be considered that there is a worldwide trend in examining and evaluating open innovation practices in services as an efficient option for managing innovation in companies. In this sense, it is valid to question if there are initiatives of open innovation in services being carried out in the Brazilian context, applied more specifically in the public services sector. Thus, this study aims to verify how state-controlled companies use open innovation concepts and / or practices in the provision of public sanitation services. To develop this study three specific objectives were defined: a) To identify the use of external sources of knowledge in the innovation processes of state-controlled companies in the basic sanitation segment and to analyze these relationships; b) Describe the open innovation processes of companies in this segment according to the typology of Central Open Innovation Processes proposed by Gassman and Enkel (2004); c) Identify the contributions and eventual barriers inherent to open innovation practices in the context of innovation management in these companies.

Open innovation is a paradigm shift perspective in the innovation management model. In view of this, there are many methodological and theoretical challenges that need to be addressed. Studies analyzing Open Innovation in the service sector are still scarce (Rohrbeck, Hölzle & Gemünden, 2009; Chesbrough, 2011; Mina Bascavusoglu-Moreau & Hughes, 2014; Randhawa, Wilden, & Hohberger, 2016; Paskaleva & Cooper, 2018). In the Brazilian context, although it is possible to cite several segments of public service delivery that have undergone environmental changes, little academic attention has been given to research on open innovation in these segments.

2. THEORETICAL REFERENTIAL

2.1 Central Open Innovation Processes

For Chesbrough (2006), open innovation is the intentional use of internal and external knowledge flows to accelerate internal innovation and increase markets for external use of innovations. Huizingh (2011), however, emphasizes that open innovation is not necessarily a revolution in the academic and practical field of innovation, but rather an evolution of concepts and

practices of recent decades. This author defends the view of open innovation as an umbrella that encompasses, connects and integrates existing activities related to the innovation process.

In the open innovation model, companies must seek to create value through the commercialization of innovations generated internally and externally, as well as increase the scope of their activities by entering new markets, licensing internally developed technologies for commercialization by third parties (Chesbrough, 2003).

Gassman and Enkel (2004) proposed the framework of open innovation processes carried out by companies. The authors emphasize that companies need to transform their rigid boundaries into permeable membranes through which knowledge generated from the external environment can be captured and, in the opposite direction, to bring their innovations to market and exploit internally produced knowledge to create new sources of profits. In the framework proposed by the authors, companies that practice open innovation can establish three central processes in their innovation strategy: outside-in processes, inside-out processes and joint processes. In these processes the locus of knowledge creation is not necessarily the locus of innovation and the locus of innovation is not necessarily the locus of exploitation (commercialization) of innovation.

2.1.1 Outside-in Process

Outside-in processes occur by "enriching" the company's knowledge base by integrating suppliers, customers, external sources of knowledge to increase the company's ability to innovate. By opting for the adoption of outside-in processes as a central open innovation process, companies choose to invest in cooperation with suppliers, customers, and in integrating knowledge sourced beyond their borders into their innovative project base (Gassman & Enkel, 2004).

Prahalad and Ramaswamy (2000) state that consumers now play the role of co-creators of value and can be seen as a source of competence for companies. The authors developed a co-creation model based on the exchange, access, risk reduction and transparency of information between clients and companies. Customers and suppliers must be integrated as valuable sources of knowledge and skills needed to develop new product and service ideas.

The outside-in process reflects the company's experience that the locus of knowledge creation is not necessarily the locus of innovation. Companies that rely on outside-in processes use the knowledge spillover of high-tech companies (Gassman & Enkel, 2004).

2.1.2 Inside-out Process

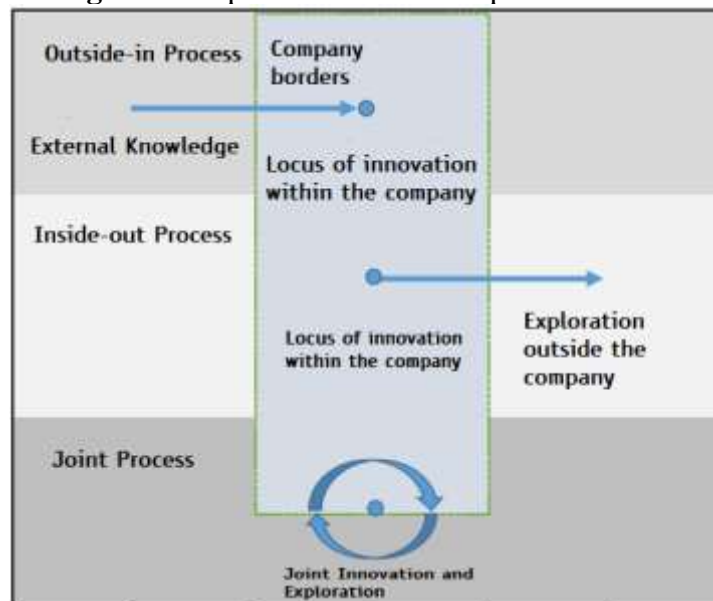
Enterprises that opt for inside-out processes decide to shift the locus of exploring innovation beyond its borders to profit from intellectual property licensing and to multiply technology by transferring ideas to other companies. Commercializing ideas in different industries (cross industry innovation) with a focus on the open-innovation inside-out process greatly increases a company's ability to generate profits. (Gassman & Enkel, 2004).

The open innovation paradigm and especially the inside-out process support the idea and that the locus of innovation is not necessarily the locus of commercial exploitation of this innovation. Companies wishing to create a technology standard can opt for inside-out processes. These companies use the skills of their partners to distribute their innovations in order to set a new standard for a given market (Gassman & Enkel, 2004; Lichtenthaler & Ernst, 2007).

2.1.3 Joint Process

Companies can also choose to adopt these two processes together. This occurs when these companies seek co-creation processes with complementary partners, establishing alliances, cooperation agreements or joint ventures, which may be of the same nature (eg two or more companies) or diverse (eg university-business partnerships), where information exchange is crucial to the success of these initiatives. Companies take forward outside-in and inside-out processes and thus jointly develop and market innovative projects (Enkel, Gassman & Chesbrough, 2009). In this research the Gassman and Enkel Model (2004) was adopted to investigate the elements of open innovation in sanitation companies (Figure 1).

Figure 1 – Open innovation core processes



Source: Adapted from Gassman and Enkel (2004)

2.2. Open Innovation in Utilities

The recent research proposal on Open Services Innovation seeks to elucidate how to innovate in services and how companies can convert the way they traditionally create value and appropriate value created into a service-based business model (Chesbrough, 2003). 2011; Myhren et al., 2018). For the author, the constant need for innovation makes the life cycle and product development process shorter and shorter.

Although still recent and subject to criticism, open innovation in services has sparked the interest of numerous researchers who have been developing work to contribute to the body of knowledge on the subject (Randhawa, Wilden, & Hohberger, 2016). Fasnacht (2009) conducted studies focused on the financial services industry, he argues the need for banks to integrate customers into their innovation processes and that adopting open business models can bring sustainable returns within this industry. Gianiodis, Ettl and Urbina (2014) also conducted case studies in the banking sector and found evidence of the use of outside-in and inside-out processes related to the performance improvement of two large Spanish banks.

In this context, the advantages provided by the opening of service innovation processes aroused the interest of public managers (Mergel, 2018; Smith, Sochor, & Karlsson, 2019), since this perspective offers viable options to overcome the challenges of bureaucratic barriers. the need for optimization of often scarce public resources (Chesbrough & Vanhaverbeke, 2018).

Feller, Finnegan and Nilsson (2011) argue that open innovation strategies can transform public administration. The authors conducted a case study of the establishment of a Public Private Partnership (PPP) in Sweden and identified that this device can create value and accelerate the creation and exploitation of innovation by the public authority. Munksgaard et al. (2012) also studied Public-Private Partnerships with the objective of identifying the main barriers to open innovation practices in these contexts and concluded that it is necessary to modify the concept of open innovation to be applied in partnerships of this type, due to barriers arising from relevant legislation and conflicts of interest embedded in relations between public and private agents.

Lee, Hwang and Choi (2012) identified initiatives at the national level to open the process of finding solutions to population problems through participatory innovation in countries such as the United States, Australia and Singapore. In their view, open innovation initiatives in utilities are still in their early stages in most developed countries (Lee, Hwang & Choi, 2012).

Regarding the sector to be researched, the scenario of basic sanitation in Brazil presents numerous challenges to companies that provide services in this segment. Growing population,

environmental, social and regulatory issues force these companies to increase their operational efficiency in the short term, producing more, ie expanding their service coverage area, and keeping their cost structures under control and, according to empirical research conducted and reviewed in this study, open innovation practices can assist in overcoming such challenges.

3. METHODOLOGICAL PROCEDURES

The research typology is an exploratory study conducted with the support of a qualitative approach. Exploratory research is oriented to the continuous search for information about the studied subject, not having the intention of testing specific hypotheses, being essentially concerned with understanding the visions and perceptions of the studied individual (Cervo & Bervian, 2002). Exploratory research is the most appropriate method for analyzing and understanding the organizational environment from the perspective of its interrelationships (Richardson, 1999).

The primary data used in this work were collected through personal interviews, based on semi-structured scripts prepared based on the theoretical framework of the work, seeking to respond to the objectives of this research, conducted with the subjects elected for the research (managers and collaborators of Research, Development and Innovation).

Secondary information was also collected provided by the research subjects (internal reports, institutional information contained in documents made available to the financial market in the form of reports, information contained on the websites of the companies studied and information available in the written press), as well as on-site observations by the researcher.

To achieve the objectives of this work, companies with relevant performance and representativeness in the Brazilian sanitation sector were chosen and, simultaneously, met the selection criteria described below: C1 - Being a company providing basic sanitation services in Brazil; C2 - Own Research & Development / Innovation management unit; C3 - To be characterized as a regional service provider; C4 - To be a mixed capital company with state stock control.

In Brazil there are 27 regional sanitation companies operating in the rendering of services. These are large companies operating in several municipalities, which serve the majority of the country's population. Six regional companies that met the selection criteria were identified, with access to representatives of three of them. No authorizations were obtained for the disclosure of the names of the companies and their representatives. Company A operates in 346 Brazilian municipalities and has over seven thousand employees. Company B serves 360 Brazilian municipalities and has more than fifteen thousand employees. Finally, Company C serves 630 Brazilian municipalities and has twelve thousand employees in its staff. Figure 2 presents the study subjects - employees assigned to the Research & Development and Innovation Management units, which included various hierarchical levels and company time.

Figure 2 - Subjects participating in the research

Companies	Interviewee	Education	Position	Time in the Company
Company A	I1	Agronomist Engineer	Manager	14 years
	I2	Agronomist Engineer	Senior Analyst	34 years
	I3	Electrical Engineer	Analyst	5 years
Company B	I4	Civil Engineer	Manager	22 years
	I5	Civil Engineer	Manager	18 years
Company C	I6	Mechanical Engineer	Manager	22 years

Source: Authors.

Aiming at the objectives proposed in this research, the set of interview responses was transcribed and analyzed using the interview analysis method subscribed to the content analysis method, to identify and describe implicit and explicit information within the body of data formed by the answers. received (Bardin, 2006). The interviews were fully transcribed and in the set of data obtained the category analysis was performed, in a process consisting of four phases: i)

identification of key points; ii) formation of meaning units; iii) composition of categories; iv) analysis of the results. For Bardin (2006) it is necessary that the data be categorized respecting the criteria of mutual exclusion, homogeneity, relevance, objectivity and fidelity.

The analysis of the set of answers is presented from the broad categories that were identified a priori, based on the Open Innovation processes proposed by Gassman and Enkel (2004), in addition to the main aspects of the Open Innovation theory contained in the theoretical framework of this paper.

In order to ensure the validity and reliability of the data used in the analysis, triangulation was performed between the different sources of collection. The primary data obtained through personal interviews were cross-checked with secondary data obtained from companies in the form of reports, dossiers and public information inherent to the studied subject.

4. DATA ANALYSIS

4.1 Step 1 - Identification of Key Points

For this stage, key points were identified in order to identify the frequency of the words, expressions and periods most cited by the subjects of this research. This identification was based on the topics addressed by the subjects during the interviews, considering the application of a script with open questions. The key points or initial categories are the first impressions about the studied organizational reality. These result from the coding process of the transcribed interviews, and each initial category consists of the selected excerpts of the interviewees' speeches and, having the theoretical framework of the work as support (Bardin, 2006).

4.2 Step 2 - Formation of Meaning Units

In this stage, we identified the elements considered as intermediates of content analysis that are named as units of meaning (Bardin, 2006). The central idea of meaning units is to group the main ideas conveyed by the research subjects. Bardin (2006) states that, firstly, the grouping should be done according to the order of the questions, and then by similarity of answers given in the different points of view of the informants. Therefore, meaning units were created and named based on the similarity of approaches to the themes and the frequency with which they were reported.

4.3 Step 3 - Category Formation

This stage aimed to group the units of meanings in line with the a priori defined categories based on the processes proposed by Gassman and Enkel (2004). Bardin (2006) calls this stage of categorization because they represent classes that bring together a set of elements (units of meanings) under a universal title due to the common aspects of these elements. For the elucidation of the categories derived a priori from the theoretical foundation, we sought to perform groupings through semantic, syntactic, expressive and lexical criteria. Three categories were then obtained which are described in Figure 3.

Figure 3 – Category Formation

Category	Abbreviation	Unit of Meaning
C1 – <i>Outside-in</i> Process	UM1	Technology Collaboration with Universities / Technical Cooperation Agreement
	UM2	Partnerships with suppliers and joint development with suppliers
	UM3	Technology Acquisition
C2 – <i>Inside-out</i> Process	UM4	Prospecting external technologies (in the market)
	UM5	Licensing Activities
	UM6	Technology Commercialization
C3 – Joint Process	UM7	Alliances and <i>joint ventures</i>
	UM8	Cooperation with complementary partners

Source: Authors.

4.4 Outside-in Category Analysis

Category C1 - Outside-in Processes was created by grouping the units of meaning presented in Table 3.

In this category we analyzed the processes performed by companies in order to enrich and broaden their respective knowledge bases, aiming to increase their innovation capacity, as proposed by Gassman and Enkel (2004). Also according to these authors, these processes can occur through the integration of suppliers, customers and other external sources of knowledge to the company base. Actions focusing on cooperation with suppliers, universities and customers were evaluated, as well as the search and integration of technologies that originated beyond its borders to its project base.

Initially it could be verified that there are no corporate units with the specific objective of carrying out R&D activities in all their phases, although these activities occur on a small scale. Established corporate units focus on managing operational needs identification activities; search for external knowledge, mainly through cooperation and agreements with universities and joint action with suppliers; project development in partnership with these same agents; and acquisition of technologies identified through purchase by public notices and bids. These procedures adhere to those characteristics of companies that use the Open Innovation proposed by Chesbrough (2003) in their technological renewal processes.

4.4.1 Technology collaboration with universities

Company A has a body of researchers that carry out studies aiming at the delivery of technological solutions, with a structure that develops technological prototypes. However, considering the magnitude of the company and the scope of its services, it can be said that this structure works on a small scale, corroborating the proposition that there is little internal development of technological innovations in the sector. In this sense I2 (Company A) points out that “[...] *technological demand far exceeds the company's internal research capacity, so a prioritization process and the involvement of other outside institutions have to be established. [...]*”. Also in this sense, I1 (Company A) complements that “*the second strategy we use if prospecting results in non-compliance, [...] It is internal development. Then we develop research internally. [...]*”.

Companies start their innovation process through prospecting activities, mapping the technological solutions offered by the market or research developed by universities and research institutes that can meet certain operational demand once they are incorporated into the company's activities. Thus, I1 (Company A) points out that “*The first strategy is to find out if (idea) it has already been tested, developed by other [...]*”. In addition, I5 (Company B) emphasizes the importance of strategic planning regarding the identification of technologies emphasizing that “*based on the company's strategic planning and we did a technology prospection work*”. I6 (Company C) complements that “*In addition to prospecting for new products and processes offered by suppliers*”.

All these characteristics lead these companies to use cooperation with universities and research institute to prospect for innovative technologies that can be incorporated into their processes to meet the operational demands identified by their R&D management units. I1 (Company A) points out that “*We have been trying to get closer because the work of the academy interests us, while the academy needs case studies and has to be productive*”. These initiatives are also in line with the open innovation precepts proposed by Chesbrough (2003).

4.4.2 Partnership with suppliers

In the outside-in processes of the model of Gassman and Enkel (2004), the role of suppliers in generating technological innovations within companies that perform Open Innovation is valued. In the case of the sanitation sector, based on the companies object of this study, it was possible to confirm the importance of these actors in the leverage of the internal research and development process itself.

These companies were found to be heavily dependent on their suppliers for their innovation processes. It can be identified that most of the innovative technologies incorporated into the companies' operations originate from their suppliers. In this sense, I6 (Company C) points out that *“Our view is that the sanitation sector is not a technology producing sector, it is a technology client sector. Our suppliers, especially equipment suppliers, are constantly improving their processes and optimizing their products”*. In the relationship with suppliers I1 (Company A) complements emphasizing that *“It's very important because suppliers come to us regularly and we come to them, so there's this two-way street. I regularly get suppliers bringing in new technologies and we get them, see, evaluate”*.

Suppliers play an active role in the innovation process of sanitation companies, sometimes exerting a kind of domination over the companies. It can be verified that this is due to the fact that, according to the interviewees, historically, the sanitation sector has been characterized by a conservative position regarding the issue of innovations and not demanding new technologies from its suppliers. Added to this is the small contribution of internally generated technologies making their suppliers gain an advantageous position in the business relationship with these companies. I5 (Company B) points out this evidence stating that *“[...] (innovation) only through supplier. Fully supplier dominated. All our technologies enter the company through suppliers. We would like to change that. [...] What happens a lot is that suppliers we have today are suppliers from other sectors or from other parts of the world who are not concerned with adapting the equipment to the sanitation sector. Make the necessary improvements to the sanitation sector specifically”*.

Because they do not have R&D structures that are compatible with their structure and with the scope of their services, sanitation companies seek to accelerate their innovation processes by using technology equipment suppliers, which have accumulated resources and knowledge, as well as building structures. Active R&D, which often become partners, developing operationally adaptable solutions that enable a business transaction to be made for the developed solution. In this sense, I4 (Company B) endorses that *“Suppliers, from my point of view, I think they often understand the technologies that often offer their products, they, many companies because they have their own research core, to develop some equipment”*.

4.4.3 Customer participation in the innovation process

Customer innovation, initially proposed by Von Hippel (1978) was characterized as one of the foundations of the Open Innovation paradigm proposed by Chesbrough (2003).

In the data analysis process, no evidence of active participation of the customer or end consumer of the services in the innovation processes of the companies studied could be identified. Although some respondents cite their clients' indirect participation in their activities through service channels and ombudsmen, no examples of innovations incorporated into the activities of companies that originated through such channels were mentioned. I5 (Company B) points out that *“In a way, yes, when you have a lot, if you can appropriate the complaints of 195 and such. Indirectly end up coming to us, we do not have this direct contact”*.

The lack of customer participation in knowledge generation can be explained by the scarcity of large customers or lead users, a feature of the provision of basic sanitation services in Brazil, which may directly influence the innovation process of these companies. I5 (Company B) highlights that *“What you can have is by harnessing ideas or even complaints that customers make through customer relationship channels. Our relationship with the customer is via telephone, via internet, via email. There we just listen, let's say, with the voice of the client”*. Thus, the possibility of using customer-generated knowledge in innovation processes is discarded.

4.4.4 Acquisition of technologies in the market

Another device used by companies to accelerate their innovation processes is the acquisition of technologies produced in the market and ready for use in their operations. As previously reported, sanitation industry suppliers have the power to drive innovation in this sector and regional sanitation companies are important customers within their business portfolios. I1 (Company A)

highlights that *“I regularly receive suppliers bringing in new technologies and we receive them, we see them, we evaluate them and have a whole internal normative instruction to deal with any new product or service the company receives. So this goes through a document analysis, goes through a procedure or technology or product analysis”*. In addition to the co-development partnerships already reported, these suppliers are active in providing technological solutions (products or processes) that may be of interest to these companies.

The acquisition of these technologies works similarly in companies in the sector. Initially there is contact with the supplier for knowledge of ready-made technologies available. Subsequently, once the product or process offered is known, they are technically evaluated by operational and R&D specialists, for subsequent approval of the technology and, finally, its acquisition through a public purchasing process.

4.5 Inside-out Category Analysis

Category C2 - Inside-out Processes was created by grouping the units of meaning presented in Table 3.

An inside-out process proposes to exploit the knowledge internally generated by companies, making it available to the market through intellectual property licensing or commercialization of technologies, thus generating new sources of resources and optimizing the management of innovation in organizations. Innovations that could not be integrated into a company's business can generate strategic and financial advantages if they are well accepted for commercialization in markets. The Open Innovation paradigm, and especially the inside-out process, supports the idea that the locus of innovation is not necessarily the locus of commercial exploitation of this innovation.

4.5.1 Patents and Licenses - Intellectual Property

It was not possible to find a pattern in the intellectual property management of the companies studied. It can be seen that there is no consensus in the sector about which model is best for patent management and licensing, and each company presented a different policy with different nuances.

Company A has a policy of not patenting its projects and technological developments, all interested parties may use these technologies. I2 (Company A) reinforces that *“Anything that researches has to be published what is not published doesn't exist so all the research projects we started since 1988 they all ended up with at least one publication”*. However, the company aims to make public all the studies and developments carried out by its researchers, through scientific publications, congress books, etc. In this sense I1 (Company A) complements reinforcing that *“Everything we create here we make public. We do not have a defined patent policy, so technologies that are generated, we, eventually partners from other non-private institutions, which are public companies, we open the doors”*.

Company C presents an Intellectual Property policy that could be considered more adherent to an inside-out process pertinent to the model of Gassman and Enkel (2004). This company has as its corporate policy to register all technological projects developed in conjunction with university or suppliers and that reach their final stage, seeking to protect this intellectual property through the current patent law, creating knowledge assets and enabling the eventual verification of royalties. I6 (Company C) states that *“The intellectual property of the patents developed herein and the trademarks of the company. Everything that is developed internally and constitutes an intellectual property asset, the company, together with the employee who developed it, (the company) seeks to register the patent officially”*.

Company B's intellectual property management presents initiatives, although still incipient, for the creation of new sources of income through licensing and commercialization of technologies. I4 (Company B) shows that *“It is conflicting to have a new idea and at the same time not be a manufacturer and we have to license to several agents. So how do I appropriate this invention? The company registers patents on a small scale and actively seeks to operate in this market, especially*

licensing, however its managers have indicated that there are numerous barriers, such as the formalization of internal lawsuits and legal issues, which still need to be overcome before these initiatives become successful". I5 (Company B) also points out that "We are trying to make a model, which does not exist in the company, regarding the royalty, involving new business and financial area, because it is a field that we are not specialists, which is the market. Even in the legal aspect we have no specialized personnel. There has never been in the company (the discussion) of this part of licensing, royalties, etc".

Company B also had peculiar characteristics in its intellectual property management. In certain situations, when there is an interest in the production of a technology, the company allows the free use of its patents by its suppliers. I5 (Company B) highlights that "In fact she was a partner in development, but this company did not want to go with us on patenting so we cleared it to produce without the need for payment. A kind of free licensing".

4.5.2 Marketing technologies in the market

For Gassman and Enkel (2004) companies can practice open innovation by bringing internally generated knowledge to different markets, making them available to the external environment in the form of technologies and intellectual properties. This practice is configured as an inside-out process within the open innovation central process model proposed by these authors. In this process, internally generated innovation is exploited beyond the boundaries of the parent company, through the commercialization of intellectual property or finished technologies, generating new sources of profit (Gassman & Enkel, 2004).

No evidence was found to indicate that sanitation companies practice commercializing internally generated technologies. In addition to observing institutional obstacles, such as the absence of internal regulations and operational capacity, it was found that this type of initiative is outside the scope of activities and priorities of the managers of the companies studied. I6 (Company C) points out that [...]When a given project innovation proposal reflects on a product that it eventually does not have, it finds no use within the sanitation process, it is outside our policy of technological development. [...]. Another point that may justify such feature in the sector is the fact that these companies are service providers, having no ability to market technology products within their operations.

4.6 Joint Processes Category Analysis

Category C3 - Joint Processes was created by grouping the units of meaning presented in Figure 5.

Companies perform joint or coupled processes (Gassman & Enkel, 2004) when they combine activities related to out-of-in and inside-out processes, simultaneously developing and marketing innovations in a shared way. The joint process demands intense information exchange between the partners, considering that the complementarity between them can bring strategic advantages for both.

The companies surveyed do not perform the Joint Open Innovation Process as proposed by the model of Gasmann and Enkel (2004). This statement can be made, because in the analysis of Category 2 - Inside-out processes, no evidence was found that companies in the sector practice the commercialization of internally generated technologies. In these companies, there are no institutional arrangements such as strategic alliances or joint ventures that configure, according to theory, initiatives to practice outside-in and inside-out processes simultaneously.

However, during the research were identified some co-development initiatives, shared patenting and benchmarking and sharing of royalties through partnerships, generated in the management of intellectual property of these companies that deserve to be highlighted.

Company A has the publicity of its developments, including research, prototypes and eventual patents, as its main objective in its intellectual property management. This company presents several cooperative actions with suppliers in technology development, as can be identified in the following excerpt. I2 (Company A) reinforces the strategies for the search for technological

innovation emphasizing that *“And yet a third strategy that we use a lot to pursue technological innovation is the national and international technical cooperation. So we made cooperations that are in covenant format, technology renewal agreement to expand our responsiveness. So we seek expertise from other professionals where we do not have and also provide expertise. When we make a covenant, we also assume exchange. So sometimes a common object where it presupposes the participation of both in the development of some product”*.

The reported practice resembles the co-development actions proposed by the model of Gassman and Enkel (2004), it was possible to identify the exchange of knowledge between the internal and external agents of the company. Nor could it be said that Company B performs the Joint Open Innovation Process according to theory. Several co-development and co-production initiatives were identified, but it was not possible to conclude from this research whether these initiatives were successfully carried out. I5 (Company B) reinforces that *“The company can be anyone, as long as it makes a cooperation agreement with joint development, without crossing resources. But the company doesn't want to do that either, without having the counterpart that it can make a sale and use it in the market”*.

Company C also opts for technology co-development as a viable option within its innovation processes. Although the procedure cannot be fully considered as a Joint Process by Gassman and Enkel (2004), there is an intense exchange of information between agents, company and supplier, which stands out for its complementarity aspect. I6 (Company C) highlights that *“We already had patents generated in partnerships with private suppliers, that already had [...] through a technical cooperation agreement term with some supplier, for example. She (the company) develops some kind of innovative product, artifact or assembly that possibly will be acquired by the company itself. We come in with part of the development cost and later even get this innovative product to be developed, along with private partners”*.

A point to note is that, unlike a Joint Process, the successful developments made by these partnerships are not brought to the market for profit. I6 (Company C) also points out that *“When a given project innovation proposal reflects on a product that it eventually does not have, it finds no use within the sanitation process, it is outside our policy of technological development. Our policy is to develop the best possible technologies for the sanitation sector. That is, our own internal processes”*. Projects that meet the company's internal technological demands are incorporated into operations, otherwise they are abandoned.

5. Contributions and barriers to opening innovation processes

Among the objectives of this work was the identification of contributions and eventual barriers to open innovation practices within the context of innovation management, research and development in companies in the sanitation sector. The analysis of the data obtained shows that companies in the sector maintain contact with the environment beyond their borders, seeking to enrich and accelerate their innovation processes. It was observed that this openness to the external environment brings advantages to overcome resource constraints available for research and development, as companies can use resources allocated to their partners.

There is also the assessment that the sector has a conservative feature in the use of technologies and, in this sense, the practice of open innovation would bring the benefit of inducing companies in this sector to access new knowledge and internalize it, making their processes more innovative. I4 (Company B) emphasizes that *[...]So we understand that this is a questionable model, but I am not questioning the law. What we put in that article is that we understand that law enforcement is wrong. So what do we understand? I think her interpretation is wrong. Because the law itself says that for good, the best buy, what defines the best buy for the public administration? [...]*

Regarding the barriers faced in the opening of the innovation process, it was verified that the sanitation companies are subject to strict bureaucratic compliance and restrictive legislation arising from their state control, which, in the view of their managers, prevents companies from intensifying the interaction actions with external agents and consequently leverage the research and development

of the sector. I3 (Company A) points out that [...] *Now it is obvious that it is not trivial to make this interface, and what makes us very difficult in this interface is the bureaucratic process [...]*,

6. DISCUSSION OF THE RESULTS

Corporate R&D management units established in Brazilian sanitation companies intentionally use external knowledge flows to accelerate their innovation process through activities to identify operational demands; search for external knowledge; project development through partnerships and co-development; besides the acquisition of the identified technologies, in line with the Open Innovation model proposed by Chesbrough (2003). The author points out that one of the main differences between open and closed innovation is how companies map and get their ideas and how they capture the value generated by innovations (Chesbrough, 2006).

Also in this sense, it was found that companies in the sanitation sector in Brazil start their innovation processes through prospecting activities, mapping the technological solutions offered by the market or research developed by universities and research institutes that can meet certain operational demands. This observation is in line with what Laursen and Salter (2006) propose. These authors concluded that companies that practice Open Innovation can adopt strategies for seeking external knowledge through surveys of breadth (focus on number of sources) and depth (focus on intensity of partnership) (Laursen & Salter, 2006). In this research it was observed that these companies use mainly the search strategy, accessing numerous external sources of knowledge, such as the various universities and research institutes, as well as the numerous suppliers with whom they have commercial reactions.

One of the principles of Open Innovation proposed by Chesbrough (2006) is access to valuable human resources in the pursuit of innovation. According to the author “one should work with competent people inside and outside the company” (Chesbrough, 2006). It was observed that the companies studied use cooperation with universities and research institutes for the exploration of innovative technologies, accessing the best professionals working in basic and applied research in their area. These cooperations were also observed in European telephone service companies, according to studies by Rohrbeck, Hölzle & Gemünden (2009) and Sato (2014).

This study also identified that the sanitation companies in the country have established a consistent relationship with their suppliers in their technological innovation processes, given that most of the internalized innovative technologies originate from them. In addition to being classified as an outside-in process by Gassman and Enkel (2004), this feature is in line with that proposed by Wynstra, Van Weele & Weggemann (2001). These authors pointed out that concrete engagement with suppliers brings operational and strategic benefits to technology purchasing companies, as they can optimize the use of internal resources.

Prahalad and Ramaswamy (2000) state that consumers can play an important role in generating ideas and value for companies. This feature could not be identified within the evaluation of the innovation processes of the companies studied in the sanitation sector. Although there are channels to access the flow of ideas generated by consumers there is no systematization of this process and no innovations generated from the integration of the customer in the process were found.

The acquisition of these technologies was also identified as a relevant part of the sanitation companies' innovation process. These companies seek technologies offered in the market to meet their operational demands, a fact that highlights the role of suppliers in the process of technological innovation and, once again, this assertion is in line with Chesbrough's (2003) Open Innovation model. This procedure led companies in the sector to develop a high level of absorptive capacity. Defined by Cohen and Levinthal (1990) as the ability to recognize the value of new information, assimilate it and apply it for commercial purposes, absorptive capacity is one of the foundations for open innovation practice. In order to assimilate innovations from external agents, organizations need to have accumulated knowledge in their area of expertise so that these innovations can have the desired positive effects. In the case of companies in the sector studied, it was observed that externally generated innovations are readily internalized and assimilated by operational areas. This

capacity derives from the long operating history that these companies present, another feature of the sector in the country, where knowledge about basic sanitation operations has been solidifying over decades of service provision.

The Open Innovation paradigm pays special attention to the value created by the knowledge generated internally within organizations as well as the registration of intellectual property (Chesbrough, 2006). It was not possible to identify the existence of an intellectual property management standard carried out by companies in the basic sanitation sector, it was observed that each company presented a different IP policy from the others and several peculiarities. While Company A preaches the full publicity of its R&D, ruling out an inside-out process by Gassman and Enkel (2004), Company C, in the opposite direction, chooses to be able to register as many patents as possible, including with the establishment of a corporate incentive program, thereby capturing licensing and profit generation opportunities, consistent with the Open Innovation model. Regarding IP management, Company B is still seeking a position in line with its strategic planning and specific limitations. In this company were identified patent applications for proprietary technologies, shared patenting with suppliers and cases of free licensing, so there was no profit generation through the management of intellectual property.

The commercialization of internally developed technologies was also considered in the analysis of innovation processes of companies in the Brazilian sanitation sector. Technology commercialization initiatives are part of Chesbrough's (2003) Open Innovation model and are proposed by Gassman and Enkel (2004) as one of the inside-out processes. The authors argue that companies can generate new sources of income by making available to the market technologies that could not be used in the company's core business.

During the analysis of the research data it was not possible to identify the realization, by the studied companies, of technology commercialization processes according to the mentioned models. Also because of this finding, it could be concluded that the participating companies do not carry out the Gassman and Enkel Joint Open Innovation Process (2004). The open innovation central process model proposed by the authors emphasizes that companies can opt for outside-in, inside-out processes, or for their adoption simultaneously. In a joint process, or coupled process companies combine activities related to outside-in (access to external sources of knowledge) and inside-out (simultaneously making their intellectual property available to the market) processes, simultaneously developing and marketing innovations in a shared way. process information exchange is crucial to its success (Gassman & Enkel, 2004). This process can also take place in different organizational forms, especially through alliances, joint ventures and cooperation agreements with complementary partners.

During the research, no organizational arrangements were identified, such as strategic alliances or joint ventures, that configured initiatives for the practice of simultaneous outside-in and inside-out processes, which may be partly explained by the state control of the companies studied. Feller, Finnegan and Nilsson (2001) carry out a case study on the creation of a Public-Private Partnership (PPP) and concluded that this device can accelerate the creation and exploitation of innovation by the public power. Munksgaard et al. (2012), also in a study conducted in a PPP, concluded that the concepts of Open Innovation would need to be flexed to be applied in such partnerships, due to barriers related to legislation and conflicts of interest embedded in the relations between public and private agents.

As stated earlier, sanitation companies do not undertake joint open innovation processes, however, some co-development, shared patenting and benchmarking initiatives were identified through partnerships generated in the management of these companies' intellectual property. . Chesbrough & Schwartz (2007) argue that co-development partnerships are beneficial and can reduce R&D spending, expand production and open new markets. The characteristics of the sanitation companies' co-development initiatives mainly seek to reduce the costs of these processes and accelerate their technological renewal, actions that are in line with what is proposed by Tidd and Bessant (2005). These authors highlight that joint development partnerships bring benefits such

as reduced technological cost, reduced development risk, economies of scale, reduced development time and others.

Considering the state control that characterizes the providers of sanitation services in Brazil, from this perspective, the barriers and contributions to the opening of innovation processes of these companies were analyzed.

Data analysis showed that companies in the sector maintain contact with the external environment, seeking to enrich and accelerate their innovation processes, in order to overcome resource constraints available for research and technological development, through the use of resources such as knowledge, manpower and infrastructure allocated to its partners. This feature was considered by R&D managers as the most relevant contribution of Open Innovation practices in these companies. It was also possible to assess that the sanitation sector in the country has a conservative feature in the use of technologies in its operations and, thus, Open Innovation practices would have the benefit of inducing companies in this sector to access new knowledge and internalize it. These statements are supported by research that argues that the openness of innovation processes in public organizations provides opportunities to overcome restrictions inherent in state control. (Fuglsang, 2008; Feller, Finnegan & Nilsson, 2011; Lee, Hwang & Choi, 2012).

For Munksgaard et al. (2012), innovation in the public sector may take advantage of outsourcing new ideas from within and outside the organization, but the authors argue that open innovation concepts are not fully applicable in innovation partnerships in this area. sector due to barriers arising from legislation and the relationship between public and private actors.

Companies in the sanitation sector are subject to strict bureaucratic compliance, in addition to the restrictions inherent in the legislation arising from their state control, this would be, in the view of their managers, one of the main barriers faced by these companies in opening innovation processes, preventing companies from intensifying interaction with external agents and consequently leveraging their research and development.

7. FINAL CONSIDERATIONS

This study aimed to conduct a research on innovation management, under the Open Innovation paradigm (Chesbrough, 2003), using the Open Innovation Center Processes model (Gassman & Enkel, 2004). The research included the most representative companies providing basic sanitation services in the national sector. The main objective of this work was to verify the implementation of Open Innovation practices in the research, development and innovation processes of companies providing basic sanitation services in Brazil. To achieve the main objective three specific objectives were formulated. Firstly, we sought to verify the use of external sources of knowledge in the innovation processes of companies in the sector; Then it was proposed to describe these processes according to the typology of Gassman and Enkel (2004); Finally, we sought to identify contributions and barriers related to the opening of the innovation processes described.

In order to meet the general objective and specific objectives, a qualitative exploratory and descriptive research was carried out, whose companies object of study were the providers of basic sanitation services, controlled by the state, operating in the Brazilian territory. The respondents chosen were the managers and employees with relevant experience, working in the respective R&D management areas of these companies. Interviews were conducted based on a semi-structured script, built from the theoretical framework of this work. The collected data were analyzed according to the content analysis methodology (Bardin, 2006).

With reference to the first specific objective, it can be stated that the sanitation companies intentionally use external sources of knowledge in their innovation processes. These companies seek to overcome human resource, knowledge and infrastructure limitations by using interaction with the environment beyond their borders. It can be seen that these interactions occur mostly through agreements with universities and research institutes and cooperation with suppliers. As the researched companies do not have units dedicated exclusively to Research and Development, they use their R&D management units to, after identifying priority operational needs, and leverage their

innovation capacity through the establishment of cooperation with external agents and integration of originated technologies and your borders.

The application of the Gassman and Enkel Central Open Innovation Processes (2004) model, concerning the second specific objective, showed that companies in the sanitation sector predominantly use outside-in processes, rather than inside-out processes and that therefore do not perform the coupled process. This implies that the companies studied are better able to seek externally generated knowledge to accelerate their technological innovation than to create new sources of profit by commercializing internally generated technologies.

Through the third and last specific objective we sought to identify contributions and barriers concerning the opening of innovation processes in the basic sanitation companies in the country. It was observed that this openness to the external environment brings advantages to overcome resource constraints available for research and development, since companies can use resources allocated to their partners. It can also be said that the sector has a conservative feature in the use of technologies and Open Innovation practices bring the benefit of inducing companies in this sector to access new knowledge and internalize it. As main barriers, it was found that companies in the sanitation sector are subject to bureaucratic duties and restrictions of legislation related to their state control, which make it difficult to open their innovation processes and more productive interaction with external agents.

This study has methodological limitations, as it is a qualitative and exploratory research carried out in a limited number of companies and respondents, and the resulting results are not generalizable. Still as a limitation of this work it can be indicated that this was a research whose subjects are managers who do not work directly in the operational areas of companies. Considering the breadth and specificity of the services provided, it can be suggested that in these areas there should be activities related to innovation and specifically the exchange of technological knowledge between service providers and external agents.

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