UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
ESCOLA DE ADMINISTRAÇÃO
PROGRAMA DE PÓS-GRADUAÇÃO EM ADMINISTRAÇÃO
DOUTORADO EM ADMINISTRAÇÃO

João Heitor de Avila Santos

THE COORDINATION OF THE INNOVATIVE PROCESS: DYNAMICS OF INTRA-FIRM INTERACTIONS IN AGRI-FOOD SMES

Porto Alegre
July 2017

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Tese de Doutorado apresentada ao Programa de Pós-Graduação em Administração da Universidade Federal do Rio Grande do Sul como requisito parcial para a obtenção do título de Doutor em Administração.
Orientadora: Prof. Dra. Marcia Dutra de Barcellos

PhD Thesis submitted to the Graduate Program in Business Administration from the Federal University of Rio Grande do Sul as a requirement to obtain the PhD title.
Supervisor: Professor Marcia Dutra de Barcellos, PhD.
Co-supervisor: Professor Loïc Sauvée, PhD.

Porto Alegre
July 2017

CIP - Catalogação na Publicação

De Avila Santos, João Heitor
THE COORDINATION OF THE INNOVATIVE PROCESS: DYNAMICS OF INTRA-FIRM INTERACTIONS IN AGRI-FOOD SMES / João Heitor De Avila Santos. -- 2017.
139 f.

Orientadora: Marcia Dutra de Barcellos.
Coorientador: Loïc Sauvée.

Tese (Doutorado) -- Universidade Federal do Rio Grande do Sul, Escola de Administração, Programa de Pós-Graduação em Administração, Porto Alegre, BR-RS, 2017.

1. Inovação. 2. Interações. 3. Coordenação Intra-firma . 4. Conhecimento. I. Dutra de Barcellos, Marcia, orient. II. Sauvée, Loïc, coorient. III. Título.

Elaborada pelo Sistema de Geração Automática de Ficha Catalográfica da UFRGS com os dados fornecidos pelo(a) autor(a).

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Conceito Final:

Aprovado em 04 de Julho de 2017.

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This thesis is dedicated to all the wonderful people that inspired me to be a better person. I specially thank my parents, Gabija, Marcia and Loïc for believing in me during this journey.

ACKNOWLEDGMENTS

I went too far. At my first day as a PhD candidate professor Padula told us to cross a river that was called *Mampituba*, and I did. *Mampituba* is a river that holds the border between Rio Grande do Sul and Santa Catarina. The river is situated more or less 164 kilometers from Porto Alegre, the city in which UFRGS Management School is situated. At that day, I was wondering how far could I go, not just physically but as a researcher and as a person. I went too far.

Moving to Porto Alegre and to UFRGS was the best decision I have ever made in my life.

I would like to thank the kindest person that I know for everything. My adviser and friend, Marcia Dutra de Barcellos, you have been a source of endless knowledge, patience and a role model of what the ideal professional is. Your friendship is cherished and really special not just to me but for Gabija as well.

Working at NITEC was the best experience I had in my career so far. Due to his brilliant mind Professor Paulo Zawislak managed to gather a few of the most talented and smart students in our university and make them work together as a functional structure, even when lacking the proper space to do so. The NITEC growth does not surprise me. This research unit is special and for sure will hold its place as one of the most important research units, in the field of management of technology, in the world. I would like thank professor Zawislak for everything, the advices, the friendship and for believing in me. Also, my colleagues: Fernanda, Denise, Marília, André, Natália, Nathália, Rodrigo, Ariane and Guilherme for learning with me during these last four years.

I went too far. I found myself in Beauvais, France. At last, I found everything that I was looking for. I found the answers for my research, I found new friends, I found old friends and I found love. The guidance of professor Loïc Sauvée enlightened my research, UniLaSalle provided me with everything I needed to perform, to only think about the PhD and to not worry with anything else than working. Dear professor Loïc, thank you for everything, like in French I have no words to express how much our friendship means to me and how was helpful and fruitful was our collaboration, I hope we can extend it for many years. Also, a special thanks to all my friends in Beauvais: Maryem, Zam-Zam, Josselin, Lucian, Marie, Naline, Delphine and Fatma. I felt home at UniLaSalle and it is still strange to go there and to not stay. Maybe I will always feel like this.

I had a family in Beauvais. Professor Paulo Mathias, you and Thais treated me like a son, and I thank you a lot for the support during this ride. With Gabriel and Gabriel, we had a lot of adventures driving around and because of you I met places that were important to my research. Our friendship expanded my horizons and made me realize research is also made outside our working hours. The interactions are the key not just to innovation but also to make our society a better place.

I went too far. I found myself in Lithuania. I met Gabija. I found love. My life changed. From now on it is not just me. It is me and her. I learned to love, to admire and to respect someone, all at the same time. Thank you so much for coming too far with me. You showed me that we will always go too far together and we are already doing it. This work was only possible due to your support and comprehension. I love you so much.

I went too far. Inspired by the kinds such as Odysseus, I finally came back home. Years have passed but I still remember why I started all of this. I still remember why I went too far. It was all because of a dream. A dream in which I made my parents proud. A dream in which I improved and I was capable of being a role model to my brother and my sister. I love them a lot and they always put me higher than they should. They never doubt me, even when I did. Disappoint them was not an option, and I hope I didn't. Thank you, Father and Mother, Brother and Sister. We did this together. I will always carry you and our family with me, no matter where I go.

I went too far, but I will never forget from where I came from. My friends: Cristiano, Victor, Vinicius, Lucas and Matheus, years go by and our friendship survived any distance, no matter how far we go. You guys are family.

My friends of ITS+, we started this journey together and we will end it (almost) together. I was lucky enough to start the PhD with some really special minds. Diego, Almog, Gilmar, Fernanda and Natália, our journey together has come to an end but our friendship must last. Thank you all for the support.

Finally, I thank all the professors of the UFRGS Management School (EA-UFRGS). Thank you for believing and for supporting me all the way. I also thank UFSM for being part of my life for more than ten years. Professors Breno Augusto Diniz Pereira and Kelmara Mendes Vieira were the first ones believe in me and I will never forget that. They guided me to UFRGS and consequently they opened the door for my dreams to come true. Thank you so much. I went too far, but I can't stop and I won't stop.

“Innovation is the highest form of intelligence.”

ABSTRACT

Innovation is recognized as the process of renovation of the company, ensuring its survival and success. Although, to combine and recombine all these aspects is not an easy task. In an ideal and utopic world, a firm would be composed by workers with equal and complete knowledge about all the operations, methods, processes and techniques enrolled in the firm's activities. To the intra-firm perspective, Paruchuri (2010) argues that a firm that can improve the diffusion of knowledge internally will enhance its innovative activity. Aalbers (2015), reflecting on the governance of knowledge sharing inside organizations, suggests that knowledge may be difficult to transfer because of the boundaries dynamics. Due to this dynamic, innovation centered, it is important to create new ways of analyzing and developing the firm's activities, aiming to enhance its performance and to better understand solution enablers for the new challenges to come. Therefore, the research question emerges: *How can firms manage intra-firm interactions to enhance the innovative activities?* To answer this question, we designed and performed a qualitative study with 8 HIFs (Highly Innovative Firms), 4 located in Brazil and 4 located in France. We used the dimensions of interactions and brokerage roles adapted from Aalbers (2015), Tsang (2015) and Indarti (2010) to develop a semi-structured instrument for the interviews. We analyzed the interactions during a project of product development in each firm, and the interactions were classified according to: Hierarchy (Horizontal or Vertical); Reach (Unit or Cross-unit); Type (Formal or Informal) and we used Intensity (Frequency) as the base for the analysis. Our results of the firms' intra-firm coordination for innovative processes showed us three different forms of intra-firm coordination and one specific mechanism for the intra-firm coordination. We hope that this thesis can provide insights to the innovation studies, defining the interactions was a first step and showcasing the intra-firm coordination, at a product development, might help the firms to understand the power that the interactions have to manage the knowledge sharing processes.

Keywords: Innovation, Interactions, Intra-firm coordination, Knowledge.

RESUMO EXPANDIDO

A inovação é reconhecida como o processo de renovação da firma, garantindo sua sobrevivência e sucesso. Devido ao ambiente constantemente em mudança, na era digital, as empresas exigem inovação tecnológica e resposta gerencial para se manterem competitivas. Embora, combinar e recombinar todos os recursos não é uma tarefa fácil. Em um mundo ideal e utópico, uma empresa seria composta por trabalhadores com conhecimentos iguais e completos sobre todas as operações, métodos, processos e técnicas das atividades da empresa. A crescente onda de empresas que cooperaram trouxe sucesso a algumas empresas, mas não a todas. Estudos como os de Nesheim (2015), Chatterji (2014) e Mina (2014) nos mostram que o conhecimento é complicado de se gerenciar e é comum que os pesquisadores identifiquem um conhecimento obtido de origem externa preso em certas unidades. Os autores argumentam que esse fenômeno pode acontecer devido a aspectos comportamentais, mas também devido a padrões de processo ou organizacionais. Do ponto de vista intra-firma, Paruchuri (2010) argumenta que uma empresa que melhore a difusão do conhecimento internamente ira aprimorar sua atividade inovadora. Aalbers (2015), refletindo sobre a governança do compartilhamento de conhecimento dentro das organizações, sugere que o conhecimento pode ser difícil de transferir por causa da dinâmica das interações. Essas dinâmicas podem criar uma relutância em compartilhar conhecimento com pessoas de outras unidades. Vários autores, como Hansen (1999 e 2002) e Cross (2003 e 2004) argumentam que os pesquisadores, em grande parte, que se concentraram no fluxo de conhecimento dentro de uma empresa, têm focado apenas nos indivíduos, independentemente da sua posição na organização, e acabam muitas vezes ignorando os limites das unidades da empresa, como possíveis obstáculos para que o conhecimento seja transferido. Devido a esta dinâmica, centrada na inovação, é importante criar novas formas de analisar e desenvolver as atividades da empresa, visando aprimorar seu desempenho e compreender melhor os facilitadores de soluções para que se gere inovação. Portanto, surge a questão da pesquisa: *Como as empresas podem gerenciar interações intra-firma para melhorar as atividades inovadoras?* Assim, este trabalho tem seu núcleo nas interações intra-firma para fins de inovação. Em outras palavras, exploramos fatores-chave que podem nos permitir analisar melhor as atividades inovadoras da empresa em uma perspectiva intra-firma. O principal objetivo é apresentar os aspectos chave na coordenação intra-firma, baseada nas interações, capaz de melhorar o fluxo de conhecimento para a inovação dentro da empresa. Assim, elaboramos e realizamos um estudo qualitativo com 8 FAI (Firmas Altamente Inovadoras), 4 localizadas no Brasil e 4 localizadas na França.

Utilizamos as dimensões e os papéis de corretagem adaptados de Aalbers (2015), Tsang (2015) e Indarti (2010) para desenvolver um instrumento semiestruturado para as entrevistas. Analisamos as interações de um projeto de desenvolvimento de produto em cada empresa e as interações foram classificadas de acordo com: Hierarquia (Horizontal ou Vertical); Alcance (unidade ou unidade cruzada); Tipo (Formal ou Informal) e utilizamos a Intensidade (Frequência) como base para a análise. Nossos resultados demonstram três formas de coordenação intra-firma usadas pelas empresas em suas atividades relacionadas a inovação e um mecanismo específico para a gestão do fluxo de conhecimento com o uso das interações intra-firmas. A primeira forma teve a hierarquia como base para a estrutura organizacional utilizada no projeto, centralizando o controle das interações no coordenador da unidade de desenvolvimento. A segunda forma foi orientada para as interações, os indivíduos com alta posição hierárquica estavam conscientes da importância do fluxo de conhecimento para os processos inovadores. As interações foram centralizadas e depois descentralizadas, em um movimento de interações que seguia o fluxo baixo para cima e cima para baixo. A terceira forma foi chamada de Coordenação do Fluxo de Conhecimento, pois seguiu uma sequência de interações inter-unidades e intra-unidades, usando interações informais para reunir as informações e as interações inter-unidades verticais formais para divulgar a informação. Além disso, as empresas adotaram uma nova abordagem, única para suas atividades inovadoras, atribuindo uma pessoa designada para reportar as atividades aos altos gerentes em uma interação formal, mas coletando informações com o uso de ferramentas para interações informais. A dinâmica das interações teve mudanças relevantes nas empresas analisadas. O compartilhamento de conhecimento sempre deve ser promovido, mas sem destruir o foco na inovação. No entanto, se é mais proveitoso formalizar as interações para o trabalho de ideação ou tentar usar interações informais de maneira mais sutil é uma questão que cada empresa deve responder. Esperamos que o nosso estudo forneça insights importantes sobre a inovação nas empresas. A definição das tipologias de interações foi um primeiro passo e mostrar a coordenação intra-firma, em um desenvolvimento de inovação, pode ajudar as empresas a entender o poder que as interações têm para gerenciar os processos de compartilhamento de conhecimento.

Palavras-chave: Inovação, Interações, Coordenação Intra-firma e Conhecimento.

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1. INTRODUCTION

Innovation is recognized as the process of renovation of the company, ensuring its survival and success. Due to the constantly fluctuating environment in the digital age[1], the firms require technological innovation and managerial response to remain competitive.

Several authors such as Van de Ven (2000) and Slappendel (1996) understand innovation in organizations as the process development and implementation of new ideas by people who, over time, engage in transactions with others in an institutional context. The interpretation of innovation understood as a *process* is not new. In the 90's Robertson (1997) studied the influence of knowledge and networking in the innovation processes and the author suggested that behavioral aspects could influence the outcome of innovation to the firms. Later, researchers such as Afuah (2002) and Aalbers (2015) suggested that the way the firm uses its technological resources and competences, the ability to combine and recombine components, methods, processes and techniques to offer products and services is the central core of the innovation process.

Hence, the innovation is deeply embedded in a processual perspective. Authors such as Tushman (1977), Kanter (2000) and Conway & Steward (2009) reinforced this perspective and argue that innovation is understood as a process that can be studied and managed. This current come to focus on the social and economic activities encompassing various phases or episodic activities, recursively rather than sequentially related through which different bodies of knowledge are constructed, communicated and exchanged.

Although, to combine and recombine all these aspects is not an easy task. In an ideal and utopic world, a firm would be composed by workers with equal and complete knowledge about all the operations, methods, processes and techniques enrolled in the firm's activities. Something similar to an orchestra in a perfect symmetry.

The reality, however, present us with a world in which information asymmetry, as Aboody & Lev (2000) argues is a reality and the challenges of knowledge sharing inside the firms can make the innovation process face several obstacles. As Hendriks (1999 p. 94) argues, knowledge sharing is: "*Something else than but related to communication. It is also different from but related to information distribution. In a strict*

[1] See: SIEMENS, George. Connectivism: A learning theory for the digital age. 2014.

sense, knowledge cannot be shared. Knowledge is not like a commodity that can be passed around freely, it is tied to a knowing subject."

In other words, the author shows us the idea that to learn something from someone else, i.e. to share the knowledge, is an act of reconstruction that, as Carlile & Rebentisch (2003) argues, relies on the transformation and translation of the information. It is necessary knowledge to acquire knowledge and, therefore, to share the knowledge. Knowledge sharing presumes a relation between at least two parties, one that possesses knowledge and the other that acquires knowledge. The first party should communicate its knowledge, consciously and willingly or not, in some form or other (either by acts, by speech, or in writing, etc.).

Due to the communication aspect of knowledge sharing, interactions have a significant impact on a firm's success. According to Sorge and Warner (1987) the success of a firm, not just to the innovation related activities but to the whole, largely depends on the quality of its relations inside the firm and with external organizations. Interactions with other firms enables a firm to obtain resources, such as knowledge (i.e., know-how), materials, services, personnel, and capital, which are required to achieve its commercial goals and meet the interests of the external and internal stakeholders.

Indarti (2010) points out, the interactions as a key element in the process of gaining access to, acquire, and develop (new) knowledge for the stimulation of a firm's activities in the field of innovation. Interaction with other firms enables organizations to absorb knowledge from external parties more effectively, and use it for creating new goods/services. Interactions can take place within a firm as well as between a firm and other organizations, thus, the idea of coordination become extremely important. If there is interactions among firms, units or individuals, it can be managed, and if it can be managed, therefore, it can be coordinated, as Tsang (2015) points out.

It is important to understand that knowledge, from a firm perspective, can be acquired from external sources and also from internal sources. The literature for acquiring external knowledge is plenty. In the 90s there was a movement of cooperation[2] studies in which absorptive capacity was deeply researched and questions related on how to acquire and manage the knowledge from external sources emerged. Cooperation, networks, joint ventures, partial merges, partnerships, externalization of activities and more ways of

[2] MENON, Tanya; PFEFFER, Jeffrey. Valuing internal vs. external knowledge: Explaining the preference for outsiders. **Management Science**, v. 49, n. 4, p. 497-513, 2003.

acquiring external knowledge were highlighted and a trend of cooperating was established among firms. (FERNANDES & FERREIRA, 2017).

The increasingly wave of firms cooperating brought success to some firms and others struggled. Studies as Nesheim (2015), Chatterji (2014) & Mina (2014) shows us that knowledge absorption is tricky to manage and it is common that researchers identify the external knowledge stuck at certain firms' units. The authors argue that this phenomenon can happen due to people aspects, but also due to process and/or organizational standards.

From the intra-firm perspective, Paruchuri (2010) argues that a firm that can improve the diffusion of knowledge internally will enhance its innovative activity. Aalbers (2015), reflecting on the governance of knowledge sharing inside organizations, suggests that knowledge may be difficult to transfer because of the boundaries dynamics. These dynamics can create a reluctance to share knowledge with individuals from other units. Several authors, such as Hansen (1999 & 2002), Cross (2003 & 2004) and Aalbers (2015) argue that researchers largely focus on knowledge flow inside a firm has been on individuals, irrespective of their position in the organization, and end up often ignoring firm-internal unit boundaries as possible hurdles for knowledge to be transferred.

1.1. Research Question

In light of these authors' insights, some questions emerged: 1) Why the external knowledge, in some cases, does not flow inside the firms? 2) What can firms do to enhance the knowledge flow and benefit from it? 3) Does the knowledge flow influence the outcome for innovation? To explore these questions, we followed authors' approaches that states:

a. Conway & Steward (2009): Innovation can be understood as a process.
b. Aalbers (2015): The knowledge sharing plays a central role in the innovation process.
c. Indarti (2010): The intra-firm interactions are the key to overcome knowledge sharing barriers.
d. Tsang (2015): The intra-firm interactions can enhance the firm's innovative activities.

To operationalize the study of innovation is a hard task. It is generally accepted that innovation is a key variable related to the industry productivity growth and competitiveness. The impacts created by new technologies used or diffused within the industry changes the way we produce, prepare, ship and sell products and in consequence, new managerial challenges emerge every day. The constant search to increase and maintain the competitive advantage lead companies to have innovation as the fundamental process of renovation of the firm, to modify the way it offers and delivers its goods and services. (ROSENBERG, 1986).

Due to this dynamic, innovation centered, it is important to create new ways of analyzing and developing the firm's activities, aiming to enhance its performance and to better understand solution enablers for the new challenges to come. Therefore, the research question emerges:

"How can firms manage intra-firm interactions to enhance the innovative activities?"

Thus, this work has its core in the intra-firm interactions for innovation purposes. In other words, we explore key factors that may enable us to better analyze the firm's innovative activities from an intra-firm perspective.

1.2. Objectives

The main objective here is **to present the key aspects in the intra-firm coordination, interactions based, capable of enhance the knowledge flow for innovation inside the firm**. The following specific goals were set in order to guide the path until the main goal is achieved:

- To describe dynamics of intra-firm interactions in the context of innovation related activities.
- To discuss the obstacles in the knowledge flow from an intra-firm and innovation perspective.
- To present models of intra-firm coordination used for innovative activities.
- To showcase intra-firm coordination practices in highly innovative firms.

With this analysis, we believe that it is possible to formulate new strategies and new managerial tools to better manage the intra-firm coordination in firms from the agri-food sector. We chose the agri-food sector as background and case to perform our analysis

due to the fact that Brazil has become an agricultural powerhouse, and was the world's fourth leading exporter of agri-food and seafood products in 2015. The country is a dominant force in the sugar, coffee and orange juice markets, and is competing with the United States to be the world's largest soybean exporter (Euromonitor, 2016). The Brazilian agriculture sector employs 15.7% of the workforce and is estimated at 5.9% of GDP (World FactBook, 2016). In addition, in 2015, Brazil's agri-food and seafood trade surplus was USD82.7 billion with imports valued at USD12.4 billion, and USD95.2 billion in exports. Between 2013 and 2015, Brazil's agri-food and seafood imports grew by a compound annual growth rate (CAGR) of 3.6%, while exports grew by 4.5%.

Also, as part of a bigger project, we chose to include companies from France in the analysis. In France, the agri-food industry represents €178 billion ($221 billion) in revenue or 20% of the revenue of all manufacturing industries. These figures include small retail business such as local bakeries and delis. The agri-food industry is responsible for the employment of 584,963 people and approximately 60,566 companies. When removing small retailer businesses, the figure adjusts drastically to 425,640 employees at 15,656 companies. The vast majority of French companies (98%) within this sector are small-to-medium sized enterprises. In fact, those with fewer than 10 workers account for 75% of the total number of companies. Meat and dairy farmers are highest in number and together bring in more than a third of the industry's revenue. Beverage manufacturing, including wine, spirits and soft drinks contribute to 16.1% of its revenue.

This reality in France is very similar to Brazil if we compare to the companies' size enrolled in the agri-food industry, but the tradition of innovation among SMEs in the agri-food sector is completely different, in both countries, due to institutions, cultural and social aspects[3].

As for what concerns to structure we performed the study in three steps:

a. A bibliometric part to identify the authors, approaches and methodological aspects that could help us to answer the research question.
b. A theoretical chapter to identify dimensions and develop our model.

[3] See: GOMES, Ramonildes Alves; MIRANDA, Roberto de Sousa. Institutional dynamics and social interactions: the unplanned effects of the modernization of agriculture in Brazil and France. **Interações (Campo Grande)**, v. 17, n. 1, p. 134-144, 2016.

c. A qualitative study with highly innovative firms from both countries, to confront our model and identify practices of intra-firm coordination that helped these companies to manage their knowledge resulting in innovation.

To perform the study, we carefully chosen firms that are recognized as highly innovative and we analyzed a case of product development of each firm, in which the product developed was new not just for the company but also to the market.

1.3. Motivation

There are several aspects that motivate this work. The first aspect is related to the fact that the study of Innovation and Interactions in the intra-firm context is brand new. According to Santos (2016) the first time the terms Innovation, Interactions and Intrafirm Coordination appeared simultaneously in papers was back in 1979. The next entry only appeared twelve years later, and until 1998 the studies on the subject was low. The first production peak appeared only in 2006, showing that theme is only recently explored by the scholars. We can see in the Figure 1 the papers on the themes.

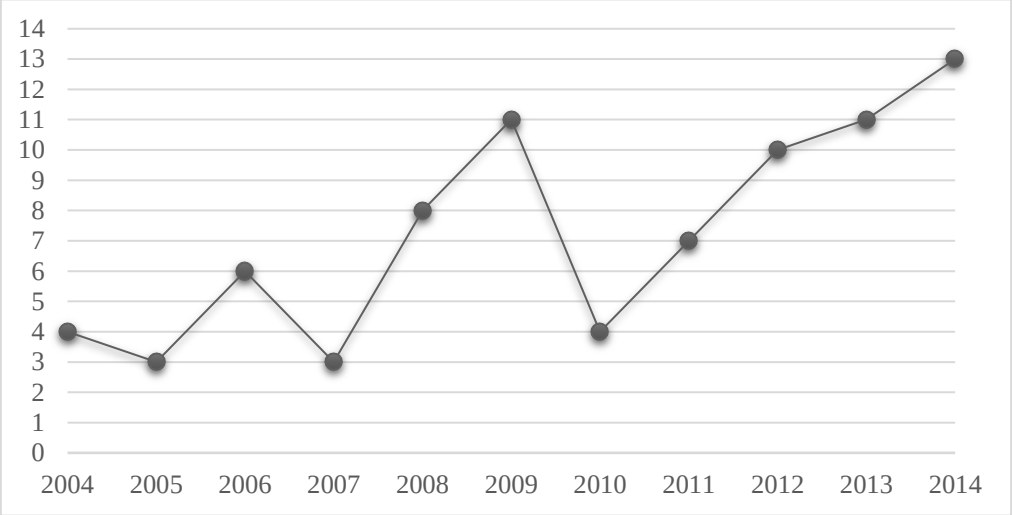

Figure 1 - Number of Papers on Innovation, Interactions and Intra-firm Coordination.
Source: Santos, De Barcellos & Sauvée (2016)

The authors still argue that the number of studies was alternating vicissitudes until 2004, when it reached the peak, exceeded in 2006 and later in 2009, the year which obtained the largest number of historical publications. There is a growing pattern on the themes together in the last five years. After a high peak in 2009, and besides the low peak at 2010, the publications started to grow and reached its peak in 2014.

In Table 01, we find a list of the five most cited papers of the final sample. The five most cited articles are divided in two periods, 1998-2003 and 2015, 1998 which were the first period of growth in the number of publications and the current year, where the subject is being more debated and exposed on the mainstream. The most cited paper on the subject is called: "Social capital and value creation: The role of intrafirm networks" by Tsai & Ghoshal (1998). This study is extreme relevant to our approach, since the authors brought up a discussion that was not present on the mainstream before: **The link between value creation and intra-firm interactions**. Among the top-rated papers, we have a gap of almost twelve years, which shows that the construction of knowledge about the topics innovation interactions and intra-firm coordination are still attached to what was published a long time ago. From the initiators of this research field until the works of Leendert et al. (2015) and Olander et al. (2015) all the evidences show us the field as a new trend and new researchers are using these brand-new works as reference to perform new studies.

R	Authors	Title	Year	Source	Citations
#1	Tsai, WP; Ghoshal, S	Social capital and value creation: The role of intrafirm networks	1998	Academy Of Management Journal	1191
#2	Meyer-Krahmer, F; Meyer-Krahmer, F	Science-based technologies: university-industry interactions in four fields	1998	Research Policy	207
#3	Leendert Aalbers H., Dolfsma W.	Bridging firm-internal boundaries for innovation: Directed communication orientation and brokering roles	2015	Journal Of Engineering And Technology Management	160
#4	Simsek, Z; Lubatkin, MH; Floyd, SW	Inter-firm networks and entrepreneurial behavior: A structural embeddedness perspective	2003	Journal Of Management	60
#5	Olander H., Hurmelinna-Laukkanen P.	Perceptions of employee knowledge risks in multinational, multilevel organizations: Managing knowledge leaking and leaving	2015	International Journal Of Innovation Management	47
				Others	766
				Total	2431

Table 1 - Most Cited Papers on Innovation, Interactions & Intra-firm Coordination
Source: Santos, De Barcellos & Sauvée (2016)

This analysis tells us that we are currently in a moment where the subject of intra-firm coordination and interactions to innovate is gaining attention again. The recent publications are attempting to manage the organizational behavior and the knowledge inside the company instead of just looking to cooperation outside the firm.

Within the great variety of topics approached when studying the intra-firm coordination and interactions to innovation there are a few themes that shine and are the focus for the motivation of this thesis. The aspects/topics/themes explored in depth are Knowledge Transfer, Networks, Technology, Social Capital and Communication, aside of the main themes: Intra-firm coordination, interactions and Innovation. Throughout this thesis, we cross borders with all these themes and we use it as the main guidelines to the analysis we perform and the model we present. The table 02 shows us the main approaches that inspired this work.

Topic	Authors
Knowledge Transfer	Carayannis, E.; Grigoroudis E., Sindakis, S. & Walter, C. (2014). Business Model Innovation as Antecedent of Sustainable Enterprise Excellence and Resilience. Figueiredo, J. C. B., & Grieco, A. M. (2013). O papel da inovação aberta na internacionalização de empresas em rede: o caso Brasil Foods. Ding X-H, Liu H., Song Y., (2013). Are internal knowledge transfer strategies double-edged swords?
Networks	Jones, R., Suoranta, M., & Rowley, J. (2013). Strategic network marketing in technology SMEs. Claro, D. P., Gonzalez, G. R., & Claro, P. B. O. (2012). Network centrality and multiplexity: a study of sales performance. Álvarez, I., Marin, R., & Fonfría, A. (2009). The role of networking in the competitiveness of firms.
Technology	Giroud, A., & Mirza, H. (2006). Multinational enterprise policies towards international intra-firm technology transfer: The case of Japanese manufacturing firms in Asia. Yoneyama, S., Oh, I., & Kim, H. R. (2004). Knowledge integration capabilities of Japanese companies: reconstructing intra-firm networks for technology commercialization. Malik, K. (2003). Distributed capabilities: intra-firm technology transfer inside BICC cables. Bailetti, A. J., & Callahan, J. R. (1993). The coordination structure of international collaborative technology arrangements.
Social Capital	Khoja, F. (2010). The triad: Organizational cultural values, practices and strong social intra-firm networks. Madlener, R. (2007). Innovation diffusion, public policy, and local initiative: The case of wood-fuelled district heating systems in Austria
Communication	Aalbers, H.L., & Dolfsma, W.A. (2015). Bridging Firm-Internal Unit Boundaries for Innovation: Communication Orientation and Brokering Roles Battisti, G., & Iona, A. (2009). The intra-firm diffusion of complementary innovations: Evidence from the adoption of management practices by British establishments.

Table 2 - Main topics related to the intra-firm coordination for the innovation
Source: Adapted from Santos, De Barcellos & Sauvée (2016)

Regarding Knowledge transfer, the works of Carayannis (2014), Figueiredo (2013) and Liu (2013) are used on how to coordinate the dynamics of intra-firm interactions, aiming to enhance the Knowledge transfer in order to generate innovations, new procedures, better performance and value to the firm.

As for networks, we use as basis to the thesis the work of Jones (2013) in which the author discusses the marketing approach in the networks context. The author evaluates how the marketing coordination process can influence the market performance of the firms. Claro (2012), brought us the insights on the evaluation of performance according to the **centrality of the network**, how this can affect its coordination intra-firm and generation of innovation. The role of networks on the competitiveness is discussed by Alvarez (2009), as Dolfsma (2008) research on how the intra-firm networks are capable to make the knowledge flow and generate innovation.

Thus, researchers such as Khoja (2008), Giroud (2006), Yoneyama (2004), Malik (2003) and Bailetti (1993) found many evidences regarding the competitiveness, rivalry, intra-firm technology transfer, knowledge capabilities and the coordination problem within the high technology firms. Many of these works suggested relations between knowledge transfer and the competitiveness intra-firm and we have used them to explore how this can affect the interactions among units.

Yet, other subjects like the work of Aalbers (2015) and Battisti (2009) for instance, contributed to the motivation of this work. In addition, the concept brought by Madlener (2007) that the social capital will play a center role in the matters of innovation, influenced directly the communication, therefore the knowledge sharing, inside the firm express well the main ideas presented in this work.

The motivation for this work is also related to the increase in the number of publications trying to relate, somehow, Innovation, Intra-firm Coordination and Interactions.

Also, we explore the uniqueness of the SMEs from the agri-food sector, a sector that, as Dolan (2000) argues, differs from all the other sectors due to its traditional aspects that are embodied and changes according to each country' culture and roots.

Hopefully this thesis can open new paths to understand how the behavior of human beings can influence the creation of value to the firms. The communication aspect

seems to be the common ground in the search for answers. Therefore, the key to success may rely on how the firms manage to provide an environment and the tools for its human assets to develop and to profit of an enhanced communication experience that may enable the knowledge to flow in a way the will end up generating new ideas and moreover innovation.

1.3.1. Individual Motivation

I was always fascinated by technology. The digital transformation only made me more intrigued by the inventors and how they create new tools, methods and inventions that makes our life easier and more interesting. Later, I discovered that there was an economical factor in this "game" called innovation. Some companies innovate and others do not. But why? Some companies perished in the past even with some of the most brilliant minds of our time working for them. With the time passing I realized that the management of the knowledge, inside a company, is what defines if a company can innovate or not. Having the knowledge is not enough. Firms must use it and make it flow inside the organization so it can enhance the capabilities to solve daily problems and to make their workers innovative individuals.

The question that guides my life as a researcher is simple:

How can firms manage their knowledge to innovate?

The study of innovation has been playing an increasingly important role in the Management Science. From the studies Schumpeter (1961) until today, innovation is recognized as the process of renovation of the firm, ensuring its survival and success. In addition, with a constantly fluctuating environment, the firm requires technological innovation and managerial response to remain competitive. Thus, the management of technological resources, competences, the ability to solve problems in a unique way, the creation of new methods, processes and techniques, to create new demands and solutions for our society are the and plain reason to study the innovation process.

The readings on the previous research by several authors[4] made me eager to find answers. My motivation as an individual is to bring more people into thinking about

[4] For a complete list of the studies, see: Santos et al. (2015) & Santos, De Barcellos & Sauvée (2016)

innovation, knowledge sharing and interactions and how these concepts can help mankind to overcome obstacles and work together to find solutions to old issues like diseases, sub nutrition, transportation systems and etc.

When studying the individualism and collectivism at the cooperation process I investigated the role played by several key managers in the process of cooperation among their companies. I used the cross-cultural analysis present at the framework developed by Hofstede (1990), and by studying the author's work it was possible to understand the role of culture, values and different types of learning at the relationships among firms. Deeply, by using the model of Hofstede et al. (2010) to measure the collectivism, individualism and the role of the culture in the process of cooperation I could understand for the first time that different people are affected by different types of interactions and this brings to firms several different outcomes.

These studies guided me to focus my research on the innovation and interactions. In this work, I use the theory of interactions (Becker, 1974) to better understand how firms manage their knowledge to innovate. By understanding how the knowledge flows inside a firm I hope we can manipulate it, in order to fast develop projects, generate and develop ideas and overcome obstacles and resistance from the market.

The focus of this work is to understand the process of innovation in firms from the food sector. The interactions theory helped me to understand how they are able manage their knowledge obtained from external sources and apply it to their companies. With the qualitative approach, we hope to open the ways to the development of other models of interaction to show the patterns for the firm's nodes of interactions and to show how the units' network and individual roles looks like and how are they important to generate innovation.

In the future, the understanding of the intrafirm networks and how the interactions inside the company's units[5] may affects their innovative activities and innovation. Seeking to understand how the behavior of individuals affects the overall typology of the network of the firms' units is important to explain how the global structure of the network emerges and how their roles influence the local dynamics between the individuals.

[5] Firm's Units: Marketing, R&D, Human Resources and others

Many empirical studies have shown that networks from a wide variety of contexts (e.g. sociology, biology, technology, economics, etc.) have similar statistical properties such as a heavy tailed degree distribution, an abundance of triangles, small diameter, along with other related properties. I intend to take an approach to understanding how these properties changes, by using accurate models of how the individuals attach to other and how these nodes interact with other nodes in order to share the knowledge. These interactions may depend on the context of the networks in question, thus different models may be necessary for different types of networks. Almost all the previous models fail to consider the human nature of the interactions. The literature assumes that individuals inside a firm are almost fully rational players who choose which other individuals to attach per their individual utility functions. The networks that arise at equilibrium have typically a very rigid and hierarchy oriented structure which is filled with formal and informal interactions.

To resolve this dichotomy (formal and informal) in our current understanding of social networks is one of the main objectives of this work but a lot more can be studied. The approaches that can be used to contribute to the filling of this gap in the literature can utilize a diversity of techniques, including: analysis of large data sets, behavioral experiments, theoretical analysis, and simulation. In order to arrive at accurate models of interaction to innovative activities in social networks we must first understand the behavior of the agents, and the tools they use to interact and this is the main individual motivation in this work.

I expect that the "*Intrafirm Coordination for Innovative Activities*[6]*: An Analysis by the Dynamic of Interactions*" help the agri-food industry to develop its interactions inside the firms in order to enhance the firm's innovation activities. Broadly, I hope that the scholars from the field of the management sciences and the managers are able to profit from the insights and possible managerial implications in this study.

1.4. Structure

[6] Innovation activities are all scientific, technological, organizational, financial and commercial steps which are intended to, lead to the implementation of innovations. Some innovation activities are themselves innovative, others are not novel activities but are necessary for the implementation of innovations. Innovation activities also include R&D that is not directly related to the development of a specific innovation.

In the next chapters, we will discuss the relation of innovation and Intra-firm Coordination, the dynamics of interactions and knowledge flow. Then, we present the method, model, results and the discussion of possibilities for the intra-firm coordination for innovation in the agri-food sector. In the chapter one, the introduction, we presented some basic definitions, objectives, research question and the structure of the study. In the chapter two we define the innovation process and its presence in the agri-food sector. The chapter three discuss the intra-firm coordination problem, justifying this thesis. The fourth chapter presents the dynamics of interactions, reviewing the main authors and the inputs of why the theory of interactions may be used to help firms to innovate. The chapter five relates the intra-firm coordination, the interactions and innovation in order to show how can we address the intra-firm coordination problem and make it easier for firms to overcome innovation obstacles. The sixth chapter present the method used to perform the study and analysis. The chapter seven present the results of the study. The chapter eight a discussion, in the light of the theory, around the results. The chapter nine present the final remarks. The chapter ten the organizations enrolled at the study and the chapter eleven, the references used. The Figure 2 show the structure scheme, linking each chapter in the theory review with the empirical research.

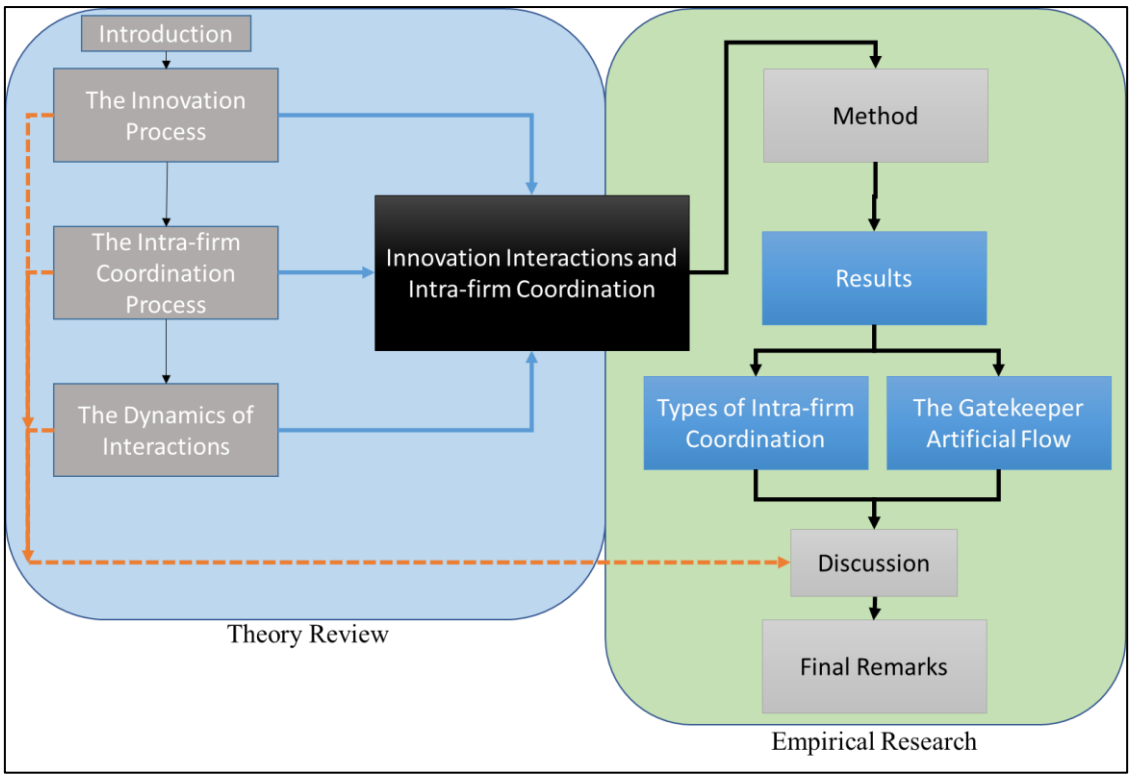

Figure 2 - Thesis Structure
Source: Elaborated by the author

2. THE INNOVATION PROCESS

In a constantly changing environment in which the search to increase and maintain the competitive advantage of firms is constant, innovation has become a matter of survival, not just of differentiation. As Etzkowitz & Leydesdorff (2000) argues the theories of innovation have been at the center of academic concern for a number of decades. In this context, innovation emerges as the fundamental process of renovation of the firm, to modify the way it offers and delivers its goods and services. Schumpeter in 1912 was the precursor to the understanding of innovation as a stimulus for economic development and as a factor of success of firms, an approach that was later followed by several authors. For the author, innovations emerge when the firm represented by the figure of the entrepreneur or, in the current context for the R&D department associated, discovers new ways of combining the factors of production that generate extraordinary profits to the firm. In a broader sense, the author states that what keeps the economy going is the release of new products, new production methods, new forms of organization and new markets (SCHUMPETER, 1942).

It is important to consider, for the understanding of the innovation, according to Schumpeter (1912), that in order to generate value, translated here as superior performance in the market, the firm must create something different, but that should be recognized by the market as such. For this, the firm must understand an internal effort of creating, transforming the knowledge available in a technological change, which necessarily must be the transaction value, thereby generating extraordinary profits. This is the basic reason of why the innovation process exist.

Many authors conceived the idea that innovation could be explained as a process, one of the first authors were Burns & Stalkers (1961) with the classic work on The Management of Innovation, the authors highlighted the importance of organizational design on a firm's ability to innovate. Understanding the innovation process as an organizational phenomenon[7] largely relied on the concept of exploitation of new ideas in the commercial realization for business, as Schumpeter stated from the start. An important

[7] Considering that innovation could be explained as a process, in this work we use the word "management" in the sense of manipulating and making choices in order to make this process happen. The use of the word coordination has a broader sense, it relates to a much more abstract concept, that is the organizational design used to enhance the innovative activities. In other words, we consider them to reflect the same type of managerial actions, although to manage have a "micro" focus and to coordinate a macro nature.

definition of innovation for the context of this work is attached to the knowledge involved in the process. To Herkema (2003 p. 344) innovation is a "*knowledge process aimed at creating new knowledge geared towards the development of commercial and viable solutions.*" The innovation can be considered a process wherein knowledge is acquired, shared and assimilated with the aim to create new knowledge, which embodies products and services. The author also argues that innovation is the adoption of an idea or behavior that is new to the organization. The innovation can be a new product, a new service or a new technology. Thus, innovation is extremely related to change, which can be radical or incremental

To Gloet and Terziovski, (2004 p. 406) innovation is "*the creation of new knowledge and ideas to facilitate new business outcomes, aimed at improving internal business processes and structures and to create market driven products and services*". Innovation encompasses both radical and incremental innovation.

Bessant and Tidd (2007 p. 23) defined innovation as: "*the process of translating ideas into useful – and used – new products, processes and services*". As Dawsan (2009) argues, these innovations range from incremental improvements to radical change, and comprise: product innovations; service innovations; process innovations; management innovations; and market innovations. Currently, the concept of innovation is associated with changes in processes and products in order to solve problems of production and marketing, through the implementation and transformation of scientific and technical knowledge, always aiming to profit (FREEMAN, 1994). Zawislak (2008 p. 18) strengthens this point of view by stating that innovation is defined as "*any and all of the firm's organizational change through the application of new knowledge (...) results recognized as superior, i.e. that are generating profit.*"

For authors such as Christensen (1999) and Cooper (2001) the innovation process that generates new products or services is largely recognized in the literature as one of the most visible types of innovation and as a source of competitive advantage. However, based on Schumpeter (1985) the firm's innovations include other junctures, such as:

a. Introduction of a new product or service in the market or the transformation of an existing asset;

b. Introduction of a new production method, previously unknown by the industry, or a new way of handling a product commercially;

c. Opening of a new market for the industry in question, existing or not;

d. Capture of a new source of raw materials or new suppliers;

e. Establishment of a new form of organization of the industry, changing the positions of existing domain.

This thesis is centered in “a”, and analyze exclusively the process of product innovation, which means the conception, development and introduction of a new product in the market by a firm.

3. THE INTRA-FIRM COORDINATION PROCESS

Innovative knowledge has been identified as the most valuable asset of an organization and a key source for sustained competitive advantage (Grant 1996; Teece *et al.* 1997). Yet innovative knowledge is also commonly viewed as one of the most difficult resources to manage (Hansen *et al.* 2005). In this work, we use this definition of knowledge:

> "*Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms."*
>
> Davenport & Prusak (1998 p. 30)

Firms can improve their innovative performance by taking advantage of knowledge residing in networks of external stakeholders has become a prominent idea in innovation studies, reflected in, for example, recent special issues of Industry and Innovation on "Innovation Networks" (2011), "Offshoring of Intangibles and the Organization of Global Innovation" (2010), "Managing Situated Creativity in Cultural Industries" (2008) and "Online Communities and Open Innovation" (2008)

Despite wide acceptance that intra-organizational networks are important for organizational and individual outcomes, we know surprisingly little about how intra-organizational relationships evolve over time or how a firm's interaction patterns can be influenced by managerial action (Balkundi and Kilduff 2005). Knowledge on this matter is particularly scarce when centering on intra-organizational innovation (Tortoriello 2007; Bartunek *et al.* 2011). Further research therefore can produce understanding of what constitutes success or failure of the intra-organizational innovation network by analyzing several of its structural characteristics (Smith Doerr *et al.* 2004; Kijkuit and Van den Ende 2010).

After establishing a common notion on what defines a network and after identifying the prime building blocks of this dissertation earlier in this chapter, let us now turn to the research structure laid out in this thesis to answer the overall research question. This dissertation is organized around a number of distinct structural network antecedents that are of relevance to organize for innovation, as well as around two distinct types of managerial intervention, each of which will be discussed in further

detail. These elements are addressed in six separate chapters, categorized in three main parts. Each of these parts that together form this dissertation is introduced below.

The innovation is associated with improvement in processes and products in order to solve problems of production and marketing, through the implementation and transformation of scientific and technical knowledge, always aiming to profit (FREEMAN, 1994). Zawislak (2008) supports this view by stating that innovation is defined as "any and all of the firm's organizational change through the application of new knowledge (...) which results in products recognized as superior, i.e. that are generating profit."

In the context of intra-firm coordination, the role of interactions is highlighted by Foss et al. (2010), the author suggest that knowledge may come to be sticky to transfer because of the dynamics among firm's groups. These in-group–out-group dynamics can create a border to share knowledge with individuals from other groups. While stickiness of knowledge is related to the social embeddedness of those who might partake in knowledge transfer, this intra-firm dynamic of knowledge exactly crosses boundaries that has not been the subject of much scholarly attention.

Although, to Salancik (1978), in order to realize its commercial objectives and expand its innovative activities a firm need to develop its own knowledge or acquire knowledge through the interactions within its own environment. Lundvall (1985) was one of the first to point-out the advantages of interacting and the interactions as a big construct. The author put interaction defined as a 'mutual or reciprocal action' it refers to a continuous two-way transfer of information between two parties who have a close relationship. The idea of interaction as a two-way effect, opposed to a one-way causal impact, was present in the work of Wagner (1994). In the various sciences, interaction has differently tailored meanings. In a social perspective, Dyer (1996) argues that spatial and cultural proximity plays an important role in the formation of the informal network.

The importance of intra-firm coordination is discussed also at the work of Paruchuri (2010). The author states that a firm that can improve the diffusion of knowledge internally will benefit from enhanced innovative activity. Even as firms are urged to more readily allow innovative knowledge to cross firm boundaries, innovative

knowledge may not easily move to where it can be used in the firm, however (AALBERS et al., 2013).

In an example of how complex the intra-firm coordination is, Henttonen (2010) argues that, in the multiple networks that constitute a firm, an individual employee may be relatively more internally orientated in one network while being relatively more externally oriented in another. A firm that seeks to benefit from enhanced innovative activity has to manage its intra-firm coordination, in a way that the interactions can provide boundaries that makes the knowledge flow in a proper way within its domain. The success of intra-firm coordination is deeply related on how the firm manages its interactions and provide opportunities to the innovative behavior rise. Thus, all these dynamics of intra-firm coordination and its interactions relies, essentially, on the rhythm of the knowledge flow inside the firm.

3.1. The Importance of knowledge flow for innovation

Plessis (2007) defines knowledge flow is the process that transforms knowledge from constructed knowledge in the source context to translated knowledge embedded in practice in the target context. In other words, it is basically the transfer of knowledge from the place it is created or stored to the place it needs to be applied.

In order to innovate, firms must incorporate the knowledge possessed by the employees to its products or services development. Thus, it is important to understand that the interactions make this knowledge flow happen and this is the reason the knowledge flow is so important to this thesis. Due to the human nature of the interactions and the knowledge flow, several flaws in the process are hard to be explained. As Plessis (2007) states that knowledge acquisition and application is a social process, and social capital plays an important role in knowledge acquisition for several reasons.

Thus, we have to consider that this work is embedded in the complexity involved in the knowledge flow. The social capital is identity-based and relationship-based. There exist many tangible and intangible barriers that separate the activities of innovation between different firms. One of the main barriers and subject of this study is the social identity, which is based on **social interaction**, determining who belongs or does not belong to a social group. Social interaction across different groups can develop a strong sense of social identity, which offers firm access to knowledge stock of other firms.

The second barrier that influences the knowledge flow is **language** and the rules of **communication** that tend to converge in the interaction process but not always happens. As Hansen (1999) argues, in knowledge flow there is a need for convergence that generates relationship-specific heuristics that can expedite the exchange of complex chunks of tacit knowledge which in turn increases mutual understanding and cooperation, and lowers the transaction cost of knowledge exchange, improving the efficiency and effectiveness of knowledge sharing.

As Tsang (2015) points out, the innovation relies on the firm's successful and creative combination of its internal knowledge and other resources acquired beyond its boundary. The relationships built on social capital can not only be understood as a means of acquiring complementary capabilities between partners, but also can act as an efficient mechanism for acquiring and **internalizing** the skills and expertise of partners as acquired knowledge becomes embedded in the organization.

Another aspect that can be a barrier for the knowledge flow is the motivation. Knowledge creation and sharing can only be induced and motivated. It cannot always be supervised or forced. Hayek (1945) argued that knowledge and information cannot be applied without the cooperation and willingness of the knower. Tarun (1998) argues that trust is a necessary condition for any knowledge transfer relationship. The higher the trust involved in the process, the better the outcomes of knowledge and technology transfer. To build up the basis of trust, which can greatly reduce the transaction cost of knowledge sharing and enhance the willingness of partners to share knowledge, ultimately inducing individual or collective action can occur in two ways: The first: Designed by the firms in order to meet the preferences and interests of the social capital and the second: Naturally, emerging without interference of the management. This is an extremely important point for this work, considering that we suggest the management of the interactions to build the trust, the environment conditions and the creation of an organizational behavior innovation oriented in the intra-firm level.

Thus, we recognize that the tacit knowledge plays a paramount role in the innovation process, and as Cohen (1998) states, the "*tacit knowledge is often the source of innovation and competitive advantage*". The complexity, idiosyncrasy, and ambiguity of tacit knowledge generation make it hard to imitate by outsiders. As Wernerfelt (1984) points out, based on the resource-based theory of the firm and knowledge-based theory of the firm (Eisenhardt, 2002), tacit knowledge can be the source of competitive

advantage. Our work here is to propose models and mechanisms to firms so they can make the tacit knowledge be, somehow, exploited at the innovative activities.

For these suggested mechanisms to work it is necessary to understand that due to the nature of tacit knowledge, interactive learning can be used to facilitate its transfer. Interactive learning is defined by Mu; Peng & Love (2008 p. 88) as a "*social process characterized by double-loop learning, which includes trial-and-error experimentation in which the participants can adjust and change its learning behavior and pattern recognition*". The interactions theory can be applied here in the way that, as Becker (1974), Nonaka (1994) and Polanyi (1966) argues, the participants must actively support each other in the learning process, thus learners have to be closely connected, and interact frequently. Du Plessis (2007 p. 24) states that *"The more ambiguous and complex the learning, the more the learners must interact for a successful exchange to occur. Through this interaction process, firms can acquire tacit knowledge by observing, imitating, and interacting with other firms or individuals."*

The importance of the knowledge flow, finally, is attached to the interactions, in the innovation process, due to the complexity of innovation that gets more complex according to the increased in the amount of knowledge available to organizations. In other words, innovation only occur if there is any availability of knowledge and therefore the complexity created by the explosion of richness and reach of knowledge has to be identified and managed to ensure successful innovation. Therefore, the interactions will dictate the rhythm of the knowledge flow and make process of innovation, for the firms, easier or harder.

4. THE DYNAMICS OF INTERACTIONS

The theory of interactions is well known for trying to understand people by its behaviors and environmental contexts. According to Becker (1974), the primary way of understanding others is by understanding their minds through the embodied interactive relations. Scholars such as Indarti (2010), Teece (1992), Becker & Dietz (2004), Faria et. al. (2010) argue that interactions are a key element in the process of gaining access to, acquire, and develop (new) knowledge for the stimulation of a firm's activities in the field of innovation. In other words, interactions with other firms enables organizations to absorb knowledge from external parties more effectively, and use it for creating new goods/services.

The interactions can take place within a firm as well as between a firm and other organizations. An interaction of a firm with other organizations could be explained by using the knowledge transfer, for instance. Salancik (1978) argue that the mechanism called interaction is triggered when a firm is in need of resources from the external environment in order to survive. From this perspective, the main reason for a firm to interact with other organizations is because it cannot solely rely on its internal resources, but also has to acquire additional external means to improve its capabilities and exploit opportunities[8]. In order to realize its commercial objectives and expand its innovative activities a firm needs to develop its own knowledge or to acquire external knowledge through interaction with its environment, such as its buyers, its suppliers, and other parties involved.

Lundvall (1985) was one of the first to point-out the advantages of interacting and the interactions as a big construct. The author put interaction defined as a 'mutual or reciprocal action' it refers to a continuous two-way transfer of information between two parties who have a close relationship. The idea of interaction as a two-way effect, opposed to a one-way causal impact, was present in the work of Wagner (1994). In the various sciences, interaction has differently tailored meanings. These definitions attempt to capture both the interaction among individuals or organizations and between individuals and organizations. The author still defines interaction as reciprocal events that require at

[8] This reason for a firm to Interact was used worldwide as a reason for firms to belong to a network (See: Pereira (2011), we rather think as a reason, only to interact, and not enough to enter in a relationship of commitment.

least two objects and two actions, and the phenomenon occur when these objects, and events, mutually influence one another.

In a social perspective, Dyer (1996) argues that spatial and cultural proximity plays an important role in the formation of the informal network. In a developing country like Brazil where collectivism culture is dominant[9], relationships with others occur frequently in an informal way[10]. In the same perspective, Rummel (1976) define interactions as the acts, actions, or practices of two or more people or organizations mutually oriented towards each other's selves, that is, any behavior that tries to affect or take account of each other's subjective experiences or intentions. In other words, the author argue that interactions are not defined by type of physical relation or behavior, or by physical distance, but it is a matter of a mutual subjective orientation towards each other.

In the light of all these authors, we define interactions, in this thesis, as: The pulse filled with data or information that comes from a source agent to a final agent, where the final agent will retain the information, replicate and use it or not to modify and create new data or information.

This phenomenon called interaction can occur among people as individuals, within a firm and between institutional agents, organizations (as a group of people) and its environment. Based on the discussion, it is reasonable to approach the interactions by the way as it appears in this context. Therefore, as suggested by Aalbers (2014), we address the interactions by its intensity (i.e., the frequency of interactions) among the agents that do the transmission, exchange and the absorption of the data/information until the final result of it (i.e., knowledge) through time and space, internally and externally, from the firm's point of view. For that, in the next section, this thesis discusses what we call the types[11] of interactions.

4.1. Defining Types of Interactions

Several authors define interactions from many perspectives. Becker (1974) was the precursor by bringing the social-economic approach that could be used in the applied

[9] See Hofstede (1984, 1991)
[10] At this point, it is important to highlight that we recognize that informal interactions also enable a firm to absorb relevant external knowledge and may involve informal communication networks.
[11] Even that not comfortable by calling it "types" The literature does not provide better word to describe the chapter.

sciences. To better understand the dynamics of interactions it is important to underline the types or interactions and how they occur. In the next sub-section, we present the definition of interactions according to its source: Internal or External. Later, we explore the intra-firm interactions, focus of this thesis, and its possible forms.

4.1.1. Internal and External Interactions

To define internal and external interactions and to understand the firm's perspective, we take the work of Indarti (2010) as the main reference. The author divided interactions according to the considered "parties involved in interaction" or sources of interactions, then a model has been conceived with two types of interactions:

a. Direct Interaction
b. Indirect Interactions.

Along these two types of interactions, the author included buyers, suppliers, competitors, consultants (**Direct individual's interactions**), government offices, industry associations, religious affiliations, university/research institutions (**Direct institutional interactions**) and Exhibitions, magazines, radio, television, internet as **Indirect interactions**. Figure 3.

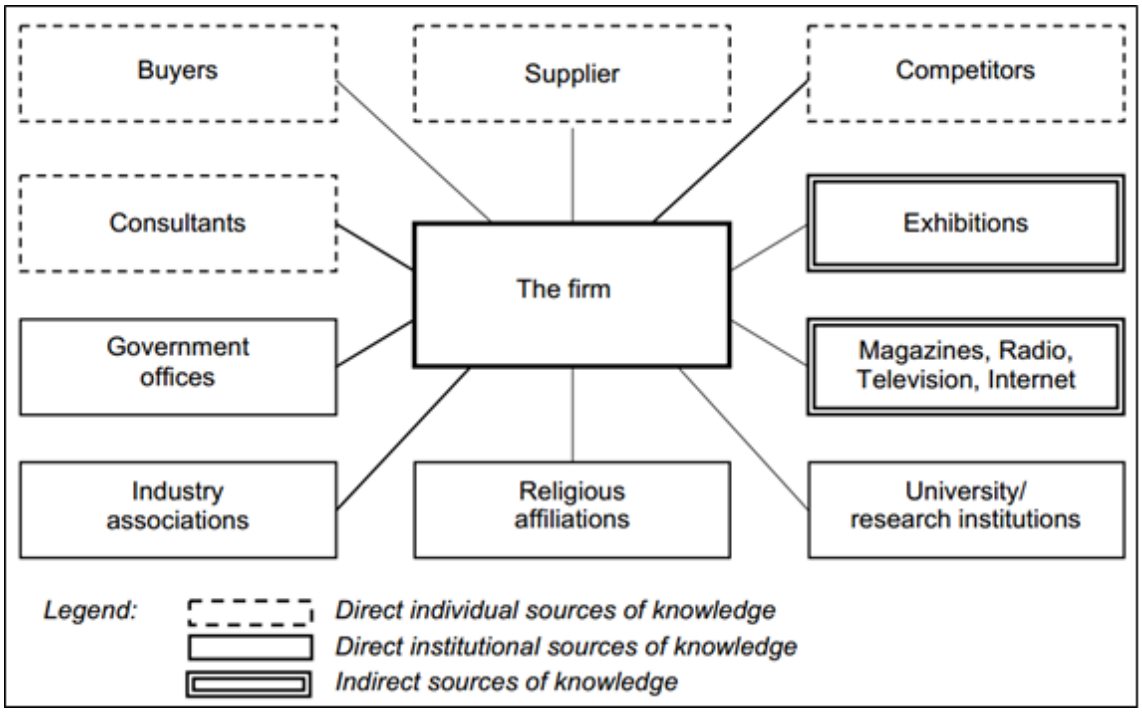

Figure 3 - External Interactions
Source: Indarti (2010)

The author argues that her model is based on the concept of stakeholders, the nature of interaction, and the previous studies (e.g., Smeltzer et al., 1988; Van Geenhuizen and Indarti, 2008). So, the author groups what she called "the various parties" into three categories according to the nature of their interaction, especially regarding the relevance of the knowledge which they bring into the firms (i.e., furniture and software): direct individual, direct institutional, and indirect sources of knowledge. In addition, he pointed all parties involved in interaction and summarizing the expected effects on the innovativeness and absorptive capacity of firms as positive or negative.

In a search for the understanding of the nature of interactions and its relation with the firm process of innovation, the elegant work of Indarti (2010) emphasized a concern related to the source of interactions. The author argues that internal interactions are the ones that occur inside the firm, within the assets that flow within the firm structure, not only the material structure, but considering also the departments, internal knowledge, internal projects and similar as a firm's property. The external interactions occur when these firm's assets cited upon end-up interacting with outsiders.

At the individual level, internal interactions can occur when an individual from a certain department search for answer in a different department or even with a coworker in the same room. The external interaction in this case occurs when a firm's worker search for outsiders (and this could be considered as a magazine, internet, for instance) to solve a problem, these kinds of interactions can (and it will) happen not only in function of the firm but spontaneously, in a simple conversation.

At firm level, the internal interactions happen among departments, projects and it is related to all the flow of information around the firm, normally, is conducted by managers, for instance, the price defining of a new product. The external interactions in this case occur when a firm search for expertise, knowledge or technology from other firms in an attempt to learn, the horizontal networks are a good example of external interaction at firm level.

Finally, we have the institutional level of interactions. These kinds of interactions occur when workers, firms, government, financial institutions, associations and other agents are converging its efforts to a work for a specific sector or goal. Internally, we have firms that work in secret projects with the government or assets that cannot go public, as nuclear projects. At external level, as an example, firms, institutions and government may work together to develop projects that can end-up adding value to an

industry as a whole and not just to one firm. The table 3 summarize, with examples, the purpose for a new Interactions' typology.[12]

Types of Interactions		
Level	**Internal**	**External**
Individual	Interactions among internal works of the same department, resolution of internal problems not necessarily market or product oriented.	Interactions between internal workers and outsiders, i.e. debating a common issue in the industry, this kind of interaction often appears in a form of an informal conversation.
Firm	Interactions among internal departments, meetings, presentations and similar, debating regular problems and ideas regarding the firm issues.	Interactions between internal workers and experts from other companies, i.e. seminars, consulting, coaching, new technologies (absorption of)
Institutional	Interactions created by projects involving internal workers, this kind of projects aims to develop specific assets for the firm only (not shared).	Interactions that emerge by projects involving internal and external workers and experts, this kind of projects aims to develop assets for an industry as a whole.

Table 3 - Types of Interactions
Source: Adapted from Indarti (2010)

These types of interactions will allow us to better perform the field study and to identify the actors embedded in the value-adding process. We will be able to understand which types of interactions occur more often according to the firm's stage on the value-adding curve. And if the firm is not innovation, which kind of interaction will allow it to do so? Is there a clear path? In the next sections, we will explore how this dynamic can be addressed.

For this thesis, we chose to adopt the firm's point of view inside its environment, as Salancik (1978) and Lundvall (1985) have suggested. We focus our efforts on what Indarti (2010) calls **Internal Interactions**. The internal interactions may vary according to several dimensions. The table 4 shows the typology used in this work:

Unit	Hierarchy	Mechanism	Intensity
Intra-Unit	Horizontal	Formal	
Interunit	Vertical	Informal	

Table 4 - Types of Internal Interactions
Source: Elaborated by the authors

Internal Interactions or Intra-firm interactions may vary according to four dimensions: Reach, Hierarchy, Mechanism and Intensity. Note that we use intensity as a guide measure in this work. In the next sections, we will explore this classification.

[12] It would be possible to explore this typology more and more, but for the purpose of this thesis this model presents an overview of the basic types of interactions according to its source/origin.

4.1.1.1. The Intra-unit and Interunit Interactions

Each firm uses a different structural arrangement to develop their internal tasks, its intra-unit and interunit interactions takes place in this context of arrangements, therefore, different consequences for knowledge sharing comes out of the way the firm manage their interactions to find the structure that better suit its needs.

As mentioned before, interactions can be, first, internal and external of the firm. Internal interactions are all the interactions that occur within the employees and internal members, including the board, shareholders, directors, managers and others. The external interactions are the interactions that occur with third party members. We can include here, all the interactions that occur with a member of the firm and its external stakeholders, for instance, government bodies, associations, consultants, clients, suppliers and others.

Considering the internal interactions, there are two different types, according to their source and destination inside the firm: Intra-unit interactions and Interunit interactions[13]. The intra and inter-unit interactions occurs only from an intrafirm perspective. For Tsai (1998), intra-unit interactions are interactions that occur inside the firm's unit, such as marketing, R&D, Human Resources, General Management, Operations, IT and any other firm's unit. Interunit or Cross-unit interactions are interactions that happen in between two or more firm's units.

Several authors studied the impacts of interunit interactions in the innovation process, Mäkelä et al (2009) revealed the relevance of interpersonal social capital for the interunit interactions, the authors also suggested that the interunit interactions are influenced by the hierarchy. In the light of these insights we may suggest the influence of vertical interactions and the informal interactions in the whole firm's knowledge sharing.

As Gagné (2009) argues the intra-firm interactions have been studied with the goals of managing conflicts, motivating units and to enhance value creation. The author argues that for units to succeed the knowledge sharing must happen in an "inside-out" flow, which means that, if the knowledge does not flow inside the unit it will be difficult to make it external to the unit and all the firms internal coordination of the knowledge sharing will be affected and the structure for innovation compromised.

[13] Interunit interactions can also be found in the literature as cross-unit interactions. Intra-unit interactions can also be found as unit interactions. Although, the borders of each are not clearly defined by the authors, thus it was needed to work the definitions in this study.

It is important to highlight that understanding what is intra-unit and interunit interactions may allow firms to recognize where the problems of communication are happening and how to create mechanisms, structures and tools that can solve the issue. For instance, as Mäkelä et al (2009) states, interunit interactions are oriented for interpersonal relations, which mean that informal interactions mechanisms may be the key to manage the knowledge in firms with barriers or obstacles for interunit knowledge exchange. To address issues like this, the dynamics of informal and informal interactions and its definitions are presented in the next section.

4.1.2. Formal and Informal Interactions

Formal interactions are all the interactions that are developed within an institutional structure or within a bureaucracy background. In other words, as, Kruttschnitt (2000, argues, formal interactions are a structured process, with reason, objective, a start point, a defined way to conduct the interaction and an end, firms many times have even a handbook defining all the interactions that are held among the employees, stating what is possible and what is not. In an example, a formal interaction occurs when a manager gives direction or shares information with an employee. An employee evaluation is an example of a vertical, inter-unit formal interaction. When employees share requested input, or provide feedback to a manager on task progress, they engage in formal interaction. Colleagues on a work team or co-workers across department lines engage in formal horizontal communication to complete projects, tasks and activities.

The formal interactions were studied by several authors. Such as Atkinson (1982) and Bose (1998), mainly in the field of psychology and sociology. The authors studied the role of formal interactions in the industrial production process and the influence of formal interactions as social control. In the economic and the management sciences, authors as Mom (2009), Tanaka (2009) & Giannakis (2012) studied the influences of formal interactions as mediating for the organizational culture management and also the role of formal interactions to the managers' styles of coordination.

As Mom (2009) argues, the formal interactions play a central role in the structure and personal coordination mechanisms. The author argues that the formal structural coordination mechanisms are one of the most important mechanisms for coordinating activities. They can be used on decentralization and formalization, in an attempt of

changing and facilitating knowledge flow at an organization but they can also have a negative effect in the organizations and become and obstacle to the activities.

The formalization of the interactions in a company refers to the degree to which rules and codes describe a particular task; provide guidelines for decision making and provide rules for conveying decisions, instructions, information and the degree to which the manager has to conform to the task description. When a firm increases the formal interactions in its activities, it increases the possibility that its employees become less receptive to decision-making, and stimuli or ideas that are not monitored by formal systems. Thus, as Miller (2004) points out, the higher are the levels of formal interactions the lower is the range of different opportunities and goals diversification that the employees are likely to pursue. In addition, in other example of how formal interactions affects the firms, the dominance of formal interactions is negatively associated with their level of ambidexterity[14]; ambidextrous managers pursue a range of different goals and "have the ability to understand and be sensitive to the needs of very different kinds of business". Several authors hold the position that the ambidextrous managers are directly related to the firm's capability of innovation.

Informal interactions are often undervalued and the literature rarely bother to define them, yet, studies in the management sciences show that they play an important role in successful collaborative processes. The informal interactions have as its characteristics the lack for a formal structure or backup, they are spontaneous and have an unplanned nature. For instance: Conversations that takes place from time to time at the firm with participants from the same or different units and about one or several topics, without a proper agenda for debate. None of these characteristics—timing, participants or agenda are scheduled in advance. As Kraut et al (1990) suggests, the nature of informal interaction is truly interactive, with all the participants in the communication being able to absorb and/or respond to what they perceive to be the current state of affairs, including the communication up until that point and their perception of the other participants' reactions to it.

Informal interactions are all the interactions that occurs without a formal script, schedule or formal goal, it can occur by using digital ways or with interpersonal exchange,

[14] See: GIBSON, Cristina B.; BIRKINSHAW, Julian. The antecedents, consequences, and mediating role of organizational ambidexterity. **Academy of management Journal**, v. 47, n. 2, p. 209-226, 2004.

same as formal interactions, the difference is that informal interactions have no rules, just the social agreement in which is stablished by society.

An important study to illustrate how the informal interactions influences the work environment was performed by Backhouse & Drew (1992), the authors videotaped interactions in a workplace and discovered that over 80% of the communication were informal. It was explained the informal interaction in the workplace and set out: "When one worker is in motion and the other is at a visible workplace, the deciding item between an unintentional interaction and no interaction is nonverbal cues". The authors discovered that unplanned interactions are discouraged if the employee in motion is focused and looking ahead, or if the employee at the desk is leaning forward and focusing. Similarly, the authors also discovered that unwitting interactions are encouraged if the employee in motion is looking nearby or if the employee at the desk leaned back and looking around. This aspect is really important for this thesis, considering that it is the insight needed to assume that firms should create and maintain mechanisms that encourage informal interactions or discouraged when the informal interactions are too much. While these findings weigh on the notion that movement encourages unplanned interactions, there is still the argument related to the distance and centrality and the need to visibility in order to the interactions occur. We argue that visibility[15], even if not physically, is a better predictor of face-to-face interactions than movement. However, it is important to highlight that scholars such as Penn et al. (1999) considered that the lack of visibility also can increases unplanned informal interactions between a seated and a moving person. Thus, it is important to understand that if two workers cannot see each other, then the only way they can interact and to know whether or not the other is available for interaction is by the use of specific mechanisms.

Regardless the lack of the over presence of formal or informal interactions, the hierarchy plays an important role in allowing/developing or not the interactions. Sometimes, firms can have difficulties in making the knowledge flow due to the impossibility to handle interactions along its hierarchy. Vertical interactions are tricky to manage, we define vertical and horizontal interactions in the next sections, as well as the

[15] See: KLEINBAUM, Adam M. Organizational misfits and the origins of brokerage in intrafirm networks. **Administrative Science Quarterly**, v. 57, n. 3, p. 407-452, 2012.

possibility for the use of mechanisms to enhance formal and informal interactions and the role of centrality and distance when interacting inside a firm.

4.1.3. Horizontal and Vertical Interactions

Scholars such as Gruning (1992), Argenti (1996), Smidts (2001) and others have stressed out the study of communication up and down the line of authority, considering hierarchy as one of the most important aspects when coordinating the interactions inside the firm. Grunig (1992) stated that we should attempt to understand how internal communication makes organizations more effective. The author proposed symmetrical communication as a way to improve effectiveness and achieve excellence and he also highlighted several gaps in the literature on internal communication[16].

To define horizontal and vertical interactions we use the definitions by Aalbers (2015) and Indarti (2010). Horizontal interactions are interactions among individuals at the same level of hierarchy, these individuals can belong to the same unit or not, even to the same firm or not but they are horizontal interactions only if they held an equivalent position according to its level in the organizational structure of hierarchy. Vertical interactions are interactions among individuals from different positions or levels in the hierarchy.

To understand the dynamics of vertical and horizontal interactions at the management science from an organizational perspective, Smidts (2001) explain that in the classical economy points that in order to an organization work, instructions move down and information moves up. When two people from the same level interact, they were supposed to do it indirectly or informal. If it involves a supervisor, the source must communicate in a formal way with the supervisor and the interactions move up, then down or up according to the need, but this only occur due to an organizational mechanism which may vary from firm to firm. According to this view, there is little direct communication among equals, except small talk, which is not related directly to work problems.

[16] Some scholars refer to what we call internal interactions as internal communication. Aalbers (2015) solves the issue by defining that internal interactions involves all the internal communication and it is not limited by it.

This view is an extremely valuable insight to this work. Firms should learn how to engage employees and make these interactions called "small talks" becomes work related, trying to add value or generate innovation or solving organizational problems. As Miller (2004) argues although interactions between departments on the same level occurs, theoretically it is not supposed to be direct. Reports, desires for services, or criticisms that one department has of another are supposed to be sent up the line until they reach an executive who heads the organizations involved[17]. They are then held, revised, or sent directly down the line to the appropriate officials and departments. The reason for this circuitous route is to inform higher officials of things occurring below them.

Miller (2004) even infers that most interactions not only should be, but are, vertical rather than horizontal, but this appears to have been assumed, not demonstrated. If we examine the forerunners of modern writings on industry and bureaucracy, it is easy to see how such a belief has arisen. To Welch & Jackson (2007), the major part of the authors working with intrafirm interactions hold much of the same viewpoint in that they are concerned with control, accountability, and authority. Bureaucracy, to them, is efficient because it specifies who is responsible to whom, for precisely what activities. From this implicit perspective, it is easy to assume that the great advantage of bureaucracy and the great desideratum in managing one is the centralization of control so that those on top know exactly what is going on beneath them. Bureaucracy only benefits vertical interactions.

According to Miller (2004) the control is best achieved when the vertical formal interactions domain the organization, it might seem, due to the fact that in these types of firms, everyone adheres strictly to the chain of command. In this sense, it is understandable that we see a strong mindset of scholars and managers, following this orientation, adopting it as their own and assuming further that what ought to be, is.

In this thesis, we shall explore this assumption. In the next section, we will explore dynamics of the interactions: Intra-unit/Interunit, Formal/informal, vertical/horizontal. First, we discuss the role of centrality and distance, then we analyze real cases of intra-firm coordination of the interactions and finally we propose our main propositions for the dynamics of interactions. In the next chapter, we explore the relation Innovation-

[17] This is a suggestion that interunit interactions should only occur by vertical interactions.

Interactions-Intra-Firm Coordination and finally we present the multiple case study and our findings.

4.2. Centrality and Interactions: The role of technology

One of the most important aspects when studying interactions, whether in the context of organizations or not, is distance. Scholars like Kraut (2002) and Olson (2000) argued that being in close proximity and common areas may create social obligation for individuals to interact. Several authors such as Kaplan (1996) and Schroeder (2006) recognize the importance of proximity for informal interactions, the authors argue that informal interactions are foundational social processes that underpin informal learning.

To perform an analysis of the internal interactions it is important to understand that there is, as a matter of fact, an influence that is the centrality of the interactions. As several authors, such as Ibarra (1993); Bjork (2009) and Tsai (2001), stated a group that is more central within a network has a greater possibility of reaching a wider expertise available within the network. Everett and Borgatti (2005) argues that ideas, in most of the cases, are generated by people that have worked with others and consequently have access to more information and knowledge from what to draw when innovating if comparing with less connected individuals or groups.

Also, it is important to understand that, nowadays, interactions happen in different ways, not just face-to-face but also by using several technological settings, mechanisms and tools. Acoording to Giroud & Mirza (2006) the technology changed the conditions for the interactions, in other words, it differentially affects how interactions can occur and the ways in which individuals can work with each other. Interactions occur faster, intensively and almost with no restrictions whether is time or geography.

Although, in an intra-firm context, as Kraut et. al. (2006 p. 60) states *"proximity and co-presence are common triggers for informal interactions in face-to-face environments, especially if people have shared purpose for being somewhere"*. Fayard (2007) with the same point of view argues that being in close proximity in places such as a computer laboratory, library, office space or other common area may create social obligation to interact while a sense of co-presence a sense of belonging and closeness with others involves mutual awareness of other people's availability for engagement. However, we have to consider that it is less obvious how these conditions of informal

interaction proximity and co-presence are negotiated in technological settings, tools or mechanisms for the purposes of informal learning. One of the main points of this thesis is to explore how this dynamic works in highly innovative SMEs.

According to Ferriani (2008) the individuals located at the periphery of the network of informal interactions, which means distant from the core of the interactions, may not have as much recognition or legitimacy, but they might be more likely to have access to external and diverse knowledge given their connections at the fringes of the network, which enhances their creative and innovative performance. In the same meaning, Schilling (2005) argues that it is needed to be careful when managing individuals' positions in terms of distance of interactions, core or peripheral in a given network. By doing this kind of management we assume that the patterns of interactions in which they are embedded are exclusively informally-based. So, designing or redesigning an organization and assigning an individual to a position at the core instead of a periphery may take into account the context of formal organizational arrangements in which the individuals operate.

For instance, if a firm with predominant informal interactions in its social structure and formal patterns of interaction that are non-overlapping, the core and the periphery of the firm organization may look substantially different. As a result, an actor identified as part of the core in the informal, might belong to the periphery in the formal since the same organization can have multiple centers and multiple peripheries defined by, for example, geography, functions, units, and divisions. This is an important aspect to understand how the centrality can influence the outcome of the knowledge flow inside the firm.

Welch & Jackson (2007) showed at his work that as the number of formal boundaries crossed increased, acquiring knowledge through informal interactions became progressively more difficult. Therefore, the author argued that the difficulties of acquiring knowledge across formal boundaries were positively moderated by the strength of informal connections and the range of network connections in which individuals were embedded Individuals located at the core of the network of informal interactions benefit from cohesive ties with each other, in terms of recognition, acceptance, and legitimacy.

Thus, for the analysis of interactions, centralization refers to the extent to which knowledge is accessible. When a firm have a structure extremely formal it indicates the extent to which the rights and duties of the members of the firm are determined and the

extent to which these are written down in rules, procedures and instructions (Schminke, Ambrose & Cropanzano, 2000). Both these aspects are considered to be negatively related to knowledge sharing. According to Chen (2007) the intra-firm coordination mechanisms based on centralization and formalization are less appropriate for knowledge sharing than mechanisms that are based on decentralization and low formalization. As Tsai (2002 p. 182) states: "*Centralized and formal coordination are found in the form of hierarchical coordination (centralized and formal) and formal systems (formal and mostly centralized) such as plans, procedures, standards and goals*". These kinds of formal oriented coordination determine and restrict which and how much interactions and knowledge should be exchanged. They determine for instance the knowledge flow in the different steps of a production process or even an innovative project inside the firm. This coordination is considered to be effective and low cost but has limited possibilities for enhancing knowledge sharing in a flexible way (Grant, 1996; Lam, 2000). Furthermore, decisions about the sharing of specialized knowledge can only be effective if the centralized decision-maker knows which knowledge is held individually (Bogenrieder & Nooteboom, 2004).

Thus, this is one of the main concerns that we must take in this thesis. The functioning of social interactions as the point zero of this work and it is the assumption we use to investigates the possible ways to manage the interactions among units, in order to reduce this gap of centrality in the firms and then enhance the innovative activities, consequently, the quality of the innovation ideas generated.

In addition, we have to consider the emerging of new types of intra-firm coordination. As we are in the digital age, the startup phenomenon grows and highly innovative firms are created and developed with enhanced innovative activities by using informal interactions and tools such as mobile apps to connect their employees. Breaking geographical barriers, we have totally dispersed firms emerging, then, how to define their interactions? Centrality takes part in a digital environment and the coordination mechanisms are now tools with better control than the regular hierarchy. These tools are discussed in the chapter 5. In the next section, we present classical examples of intra-firm coordination mechanism and how the dynamic of interactions changes in each example.

4.3. Intra-firm Interactions: Coordination Mechanisms

In this section, we explore three types of intra-firm coordination changes that are extremely popular in the literature, they are not directly related to the innovative activities but they provide us an overview on how the intra-firm coordination takes place in the firms. The management of intra-firm interactions has several managerial implications and due to the lack of the studies, organizations sometimes chose the wrong type of mechanism for their needs and end up not foreseen the long-term effects.

The first, Task Force, is a mechanism of intra-firm coordination that fully changes the dynamics of interactions for the individuals that takes part in it. Strebel (1987) suggested the use of task forces in an attempt to organize the innovative activities inside the firms. Task forces consists in taking the individuals from their original positions and will force them into a system characterized by vertical, formal interunit interactions. Its effectiveness is highlighted as situational by several scholars but the system remains used even nowadays.

The second mechanism of intra-firm coordination is Downsizing, Dougherty & Bowman (1987) and Amabile & Conti (1999) studied the effects of organizational Downsizing on product development and noticed that sometimes specific cuts in the social capital may enhance innovative activities. This managerial mechanism is mainly used by organizations that seek corporate changes, such as mergers, bankruptcy risks, outsourcing, human resources efficiency, among others. The central goal is to build an organization that is as efficient and capable as possible, which will keep it “lean”. Studies have stated that downsizing should be put into practice as a last resort in cases of crisis, in order to rebuild the company, adapting it to changes in the environment. Nègre (2017) argues that Downsizing emerged at the 70’s in the US and now is returning due to the high number of mergers and acquisitions related to the phenomenon of technological startups. As for the intra-firm coordination, Downsizing is characterized for the simple cut-down, reducing the flat intensity of interactions of any kind and according to Aalbers (2012) drastically reducing the intensity of informal interactions, making the employees focusing their efforts mainly in formal interactions.

The third intra-firm interaction coordination mechanism is called job rotation. Ortega (2001) and Laursen & Foss (2003) argued that job rotation can and should be use for innovative purposes, considering that is an extremely powerful learning mechanism.

Job rotation is a mechanism used by medium and big companies in special occasions, such as, relocating an employee, hiring new employees or briefing directors and managers with high positions. As Eriksson (2006) explains, the job rotations enhance the individual intensity of interactions, formal and informal, by breaking the first barrier for communication, in an intra and interunit context. It is one of the most effective ways to manage the interactions inside a firm, making the employees willing to share their knowledge by using a mix of formal-informal interactions.

4.3.1. Formal Task force

Taskforces consists in groups typically comprising experts in specified areas of knowledge or practice. Usually they are small groups of people that are gather together with the resources needed to accomplish a specific task, with the expectation that the group will disband when the objective has been completed. According to Grigsby (2006) whereas committees are typically defined in organizational by-laws, charters, or other formal documents, task forces are created on an "as needed" basis.

The main reason for the creation of a task force is often the result of some event, often unexpected or unanticipated, causing the need for an organization to acquire knowledge as to how to best respond to the event, related events, or to a similar situation. One of the main differences between task forces and regular committees is the assignment of "forces and resources. That is, specific personnel and assets needed to enhance the outcome of the interactions of the task force are put to work simultaneously. Task force work products are collective and address the specific charge to the group.

In an example, to respond to a decline in the quality of a product, a firm can assemble a task force composed of experts in the areas of development, promotion, and production to explore options for improving the process for developing a new product or improve the old one. The charge to the task force is to review processes and to report on how the organization can have state-of-the-art development. The task force report will need to include a strategy, operational plan, and related budget.

Task forces are a big example of changing the dynamics of interactions, as Katzenbach (1993) argues, with a task force, firms reduce the distance among individuals, forcing them to interact and to brainstorm to a unique goal. Moving individuals out of their original positions to work in a task force have an impact on the pattern of their

interactions, first, the firm reduce the interunit interactions, formal and informal, once that the individual will reduce his or her time at his or her original unit, second, task force have formal interactions as its core, it is built to complete the task through formal interactions, which makes individuals more inclined to informal interactions to be less inclined to express themselves and likely to retain information instead of sharing. Also, considering that formal interactions are predominant in task force, vertical interactions will take place once that all the informational flow occurs in a hierarchy oriented way.

As Gann & Salter (1998) argues, task forces emerged at 1941, with the militaries and even nowadays are used by companies to develop specific tasks or to complete short-term deadlines. Some firms succeed and others do not by using task forces but the dynamic of interactions in this mechanism of intra-firm coordination tells us that a transition between informal to formal interactions can be needed in specific cases.

4.3.2. Downsizing

In the 80's downsizing was the trend among schools and also in the practical field. The 90's brought what is known today as the downsizing decade. As Dolan (2000) argues, as a strategic managerial tool, downsizing has changed tens of thousands of companies and governmental agencies and the lives of millions of workers around the world. The literature on downsizing is substantial, and emerged from a number of disciplines and draws upon a wide range of management and organizational theories. While downsizing has developed into a popular term, we use the definition of Cameron (1994), the author defines downsizing as: "A set of activities, undertaken on the part of the management of an organization and designed to improve organizational efficiency, productivity, and/or competitiveness"

It is important to understand that this definition is not unanimous among scholars and it is even seen as an attempt to reduce the impact of the real effects of downsizing. Cascio (1993) argues that downsizing is simply "the planned eliminations of positions or jobs", the author ignores the primary purpose of downsizing, the search for effectiveness and brings the idea that the only goal is the reduction of the workforce and thus, a merely cost-reduction tool.

As Gandolfi (2009) argues, downsizing has a direct effect on the interactions. If a firm downsize 10% of their employees the interactions of any kind will be reduce. The

whole dynamics of intra-firm coordination will change and will have to be rearranged. Some companies can profit from that, even considering that usually the firms that go through a process of downsizing are not contemplating its best moment but as Indarti (2010) points out, a drastically drop in the intensity of intra-firm interactions is never good for the company. Downsizing is an obstacle for the knowledge flow and a mechanism that is not usually seen in innovative firms. The challenge from the point of view of the interactions, in downsizing is to make the right cuts and identify tools that enable firms to reduce its personal but maintain the knowledge flow inside and not lose information in the process.

4.3.3. Job Rotation

Job rotation is a trend that started recently, in the 90's, according to OECD (1999). Its effects vary from firm to firm, Ichniowsky (1999) argues that job rotation has a positive effect on innovation and on performance. The author explains that the positive effect is due to fact that job rotation fosters employee learning and increases human capital accumulation. According to this reason, it is reasonable to assume that job rotations gives managers exposure to a variety of experiences and may in this way contribute to their professional development. Ortega (2001) states that job rotation increases motivation due to the fact that it may take employees' out of the "boredom" and keep them interested in their job by getting in touch with different perspectives.

It is important to highlight that job rotation has important implications for firm the intra-firm interactions, when employees change their units, position and role, the firm receives information about various units and even discover job-employee matches. On the other hand, without rotation, the firm is able to maintain its interactions as they are, not changing or creating issues like conflicts or information asymmetry. Thus, a trade-off is existent between the variety and the intensity of interactions available to the firm and to a given employee. Moreover, according to Eriksson (2006), job rotation is particularly relevant for companies where innovative production processes are being implemented or new products are being launched. In these cases, we could assume that employees' rotation makes it more difficult for the firm to interact, learn or to develop innovative activities but it actually makes employees more willing to share and to criticize projects in which they are not a part or have no commitment.

Job rotation is a mechanism that has in its nature an inter-unit, informal and vertical nature. It is characterized by the increase in the intensity of the interactions of an individual in order to force him into the knowledge flow, to learn and to make the knowledge flow around the firm or in the unit that he will end up working. It also brings an important insight to the studies of innovation: Mechanisms such as job rotation could be more explored to enhance firm's innovative activities. In the next chapter, we will explore this assumption by addressing the relation of innovation, intra-firm coordination and the interactions.

5. INNOVATION, INTERACTIONS AND INTRA-FIRM COORDINATION

In the previous sections the innovation process, the interactions and the intra-firm coordination problem were stressed. In this section, we explore how they entangle in a relation that is yet to be explored to its fully potential in the literature.

As Quirke (2000) argues, in the digital transformation age, the firm's assets include the knowledge and the interrelationships of its people, this interrelationship here emerge as what we call interactions. The Intra-firm coordination for the innovation purposes is the management of the firm's intellectual assets, in order to process it to generate value for the firm, this value can be expressed in the form of new products, services or improvement in any of the firm's processes. Intra-firm or Internal interactions are the core process by which business can create innovation and share knowledge. By the interactions among the employees, firms take the input of information, ideas, new insights and/or perform the regular daily communication.

According to Tsai (2001) the intra-firm knowledge flow[18] have a positive effect on innovation, new product development, improved processes and organization best practices, strategy and operations. As Ambos (2006) argues, previous research shows us that the effectiveness of knowledge exchange is influenced by the properties of the knowledge, its sender, its receiver and the channel of transmission. The author explains that there are specific functions executed by the firm and its members that may act as a facilitator effect or barriers to the interunit knowledge transfer.

For Easterby-Smith (2000) the social learning theory stats that learning occurs and knowledge is created through conversations and interactions between people. Hence, coordination takes a special place in this thesis, the choices that firms do regarding its organizational structure directly influences the behaviors of the employees and specific intra-firm coordination mechanisms define how the knowledge sharing will impact not just the innovative process but the way that the firm executes all its activities.

The relationship of intra-firm coordination, interactions and innovation is a relationship of dependency. The outcome of firm's interactions and thus, the innovation that result from it, will rely on the several mechanisms of intra-firm coordination used by

[18] According to Hansen (1999) the knowledge flow is the result of knowledge absorption, knowledge transfer and knowledge integration to the firm.

the firm. Also, the effectiveness of the coordination, as Nonaka (2006) states, will depend on the level of specialization in the organization and in particular, the complexity, interdependency and unit's differences[19].

To Nonaka (2006), successful firms are able to manage the right combination of coordination mechanisms. This includes a combination of centralized and decentralized interactions, formal and informal, vertical and horizontal, intra-unit and interunit and the intensity of each kind of interactions. To better understand this dynamic and why the innovation process can be influenced and defined by intra-firm coordination, in the next section, we debate the understanding of innovation as a result of firm's interaction.

5.1. Innovation as a result of Interactions

De Mello (2011 p. 56) explain that the discussion of innovation in the management literature suggests "*a focus on the microeconomics side of innovation, as they explore the firm-level determinants of competitiveness*". The author highlights that the innovation, for classical scholars is merely "*the means of achieving competitive advantages able to meet client's needs*" translated into new products and services. Even though, authors often explore innovation from the organizational perspective, the understanding and the use of interactions management in the innovation systems and models of coordination may yield some important insights on the impact on firm's competitive performance through innovation.

A deep looking into the innovation process through the lenses of the theory of interaction, Tsai (2001), allows us to understand that the innovative activities are the knowledge exchanged trough a shared social context. Thus, the intra-organizational interactions, that forms networks, facilitate the creation of new knowledge within organizations. Yet, Aalbers (2014) argues that the capability of a firm to innovate is defined by the management of the social capital. The author argues that firms face barriers to innovate in two possible scenarios, in the first one they do not possess the social capital to do so, which means the firm does not have the knowledge to innovate. The second situation is when the firm have the knowledge but due to a specific obstacle the knowledge is not reaching the point needed to become an innovation. Thus, innovation

[19] For instance, it may be hard, according to scholars, to manage the interactions between two units that have a high difference in the specialization level between it.

can be understood as a result of the complex interactions that occur before, during and after the idea, conceptualization, development and commercialization of a new product or service.

5.2. Managing the Interactions for the Innovation Process

To study the management of interactions for the innovation process in an intra-firm perspective requires insight into how organizational structure influences and shapes the interactions in which knowledge sharing takes place. For this reason, we propose an analytic model to understand all the intra-firm coordination mechanisms. This analytic model is based on the four classic organizational structure dimensions: Coordination, centralization, formalization and specialization. These classic organizational structure dimensions are underpinning the differentiation–integration balance, which has been the major focus in the classic organization theory literature for authors such as Lawrence & Lorsch (1969) and Mintzberg (1979).

The coordination, centralization, and formalization are tuning and integrating units' tasks and behavior, while specialization is causing differentiation among units. Although very classic, these dimensions are still frequently used in organizational design research[20]. Huang (2007) used these dimensions to review several of the classic organization structure dimensions to explain knowledge sharing. The author studied the relationship between organizational structure and knowledge management mediated by the interactions.

Albers (2014) argues that there are two different perspectives to study intra-firm coordination. The first one is structure embeddedness, which means quantity and configuration of the intra-firm relationships, interactions structures, distance, conduct, performance and firm's individual characteristics. The second one, and the focus of this thesis, is the relational embeddedness, which means the quality and contents of intra-firm interactions and it deals with intra-firm interactions as being the source of innovation. Although, it is important to understand that this perspective is inimitable and causal ambiguous, making the development of a proper methodology for studying a complex task.

[20] See: Tsai (2002) and Cunningham (2001)

To perform this research, we have looked at the organizational structure in the light of the theory of interactions and in the next section we present the propositions of our analytic model for the management of the interactions for the innovative process. As scholars such as Indarti (2010), Tsai (2001), Tsang (2015), Dolfsma (2014) and Aalbers (2015) managing the organizational structure for a better knowledge flow directly influences the firm's innovativeness, thus, understanding how to manage it by the use of tools and mechanism may enable firms to rethink their structures to better fit the needs of a society in the age of the digital transformation.

5.3. Propositions for Intra-firm Interactions Analysis

As we presented at the chapter four, there are several types of interactions, any of which can directly influences the outcome for the innovation processes. What we aim with the definitions previously presented is to provide to consultants, executives and researchers the toolset needed to identify barriers and obstacles in the intra-firm knowledge sharing and to understand how to proceed to address the issues. Our proposition to the analysis of the intra-firm interactions status is based on four angles of the interactions: Hierarchy, Reach, Nature and Intensity. In the next subsection we present them, starting with Hierarchy.

5.3.1. Horizontal and Vertical Interactions: Hierarchy

As seen in the chapter 4, the interactions may vary according to the hierarchy difference involved in the process. If the individuals involved in the interactions are from the same hierarchy level we have a Horizontal Interaction, if they are from different hierarchy levels, we have a vertical interaction.

The literature is vast in the study of vertical interactions and scholars such as Dutton (1994), Goldhaber (1993) and Downs (2004) argues that vertical communication helps to define an organization and convey what it stands for. Different kinds of vertical interactions help employees to determine their position in the organizational structure, in other words, it helps the individual to locate itself inside an organization, it gives the idea of self-awareness and belonging. As Postmes (2001) argues the vertical interactions main importance is to support the command chain in the organizational structure and regardless top-down or bottom-up it is crucial to conflict management and knowledge flow control.

To the management of intra-firm coordination, we have to understand the role of vertical interactions, which may include qualitative aspects of interactions such as "adequate information provision", "support of top management" and "reliability of top management". Vertical interactions involve the information sent from the work floor to the management level and encompass, for example, employee opportunities to participate in decision-making and to offer solutions to organizational problems that due to the distance other individuals in different hierarchy levels are not able to identify. Also, the vertical interactions can reduce uncertainty about the information inside the organization and help employees to understand and define organizational culture. The vertical interactions are mainly responsible to keep employees informed about the firm's mission, goals, issues and accomplishments, and to feed the employees with information enough to recognize the firm's specific characteristics.

Horizontal interactions are mainly task-related and occurs between individuals on an equal hierarchy level. These interactions are usually characterized by an exchange of information to develop daily activities, solve regular tasks and not particularly vital for the overall firm's performance. However, as Postmes (2001) argues, for the innovation purposes, the horizontal interactions might well influence the performance of a group with the same goal and focusing on solving specific problems. This influence has its manifestation in many ways, as Ashforth & Mael (1989) argues, for instance, a unit is comprised with individuals aspiring the same goal, in the eyes of an individual, colleagues belong to a similar social category and the feeling of being among equals may enhance the motivation and make individuals more comfortable to interact and share the information they possess.

Researchers such as Levine and Moreland (1990), shown that horizontal interactions within a group can be conducive to cohesion. Moreover, Bartels (2007) established that the more positively employees assess the communication climate at the work-group level, the more strongly they identify with this work group (Bartels et al., 2007). To Wallace (1995) the support of colleagues is an important antecedent of professional commitment. In order for a colleague to be properly supported, a certain intensity of intra-unit horizontal interactions between colleagues is necessary, also to bond the unit. These findings suggest that horizontal interactions have a positive influence on professional identification and knowledge sharing.

We propose the dichotomy Horizontal-Vertical interactions, at the Figure 4, as one of the important aspects to understand why certain firms are able to make the knowledge flow inside a unit and among units and therefore innovate.

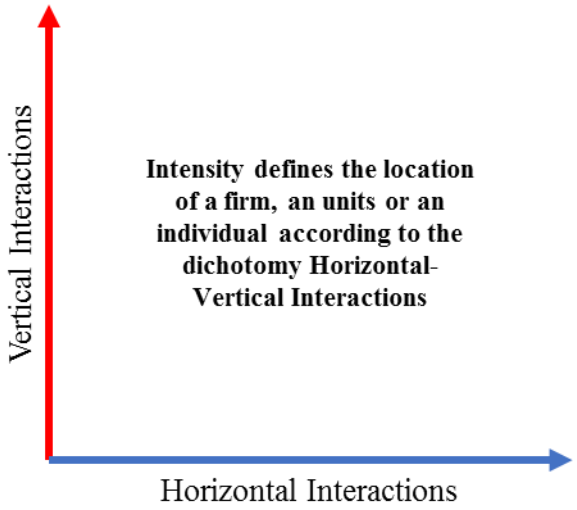

Figure 4 - Dichotomy Horizontal-Vertical Interactions
Source: Adapted from Aalbers (2015)

We also suggest the study of Horizontal and Vertical interactions to firms and researchers that want to create mechanisms to solve conflicts, create unit bond and manage projects. Yet, as Noteboom (2000) suggested, there are several alternatives that the study and management of the Horizontal and Vertical interactions can provide, as we see further in this work. But the single analysis of Vertical and Horizontal interactions does not provide a complete picture of the firm's interactions, thus, in the next subsection, we explore the reach of the interactions and how to manage it.

5.3.2. Intra-unit and Interunit Interactions: Reach

The definition of interunit and intra-unit interactions is simple. As seen in the chapter 4, interunit interactions are all the interactions that occur between units. The intra-unit or unit interactions are the interactions that occur inside a specific unit. The intra-unit and interunit interactions differs mainly in what concerns to reach and centrality. Individuals enrolled in the same unit tend to be in a common physical environment, which reduces their distance and making them more susceptible to belong to the same network of interactions. The centrality has to do with the core of the interactions, which means the density of interactions among individuals.

There are several propositions for the use of intra-unit and interunit interactions as lenses to analyze the intra-firm interactions and suggest mechanisms of coordination to manage it. For instance, we can look at a certain firm and observe that there is a knowledge flow obstacle between units that should be interacting. Also, we can observe that units that should not be interacting are, in fact, interacting, through channels that are not beneficial to the health of the knowledge flow. Yet, we can identify network centrality at the wrong units and then use the coordination to force the relocation of the centrality, or even reduce the distance among individuals from the same or different units.

The literature is vast in mechanisms that were created to manage the interactions, as we seen in the chapter 4, job rotation, downsizing and task forces are mechanisms that manage the intra-firm interactions but they are not created specially to the innovation purposes. What we propose here is to understand the dynamics of the interactions at the innovative activities. By developing an analysis of the intra-firm interactions in such context, as illustrated in the Figure 5, it would be possible to provide alternatives and mechanisms that may allow firms to optimize its knowledge flow and to innovate.

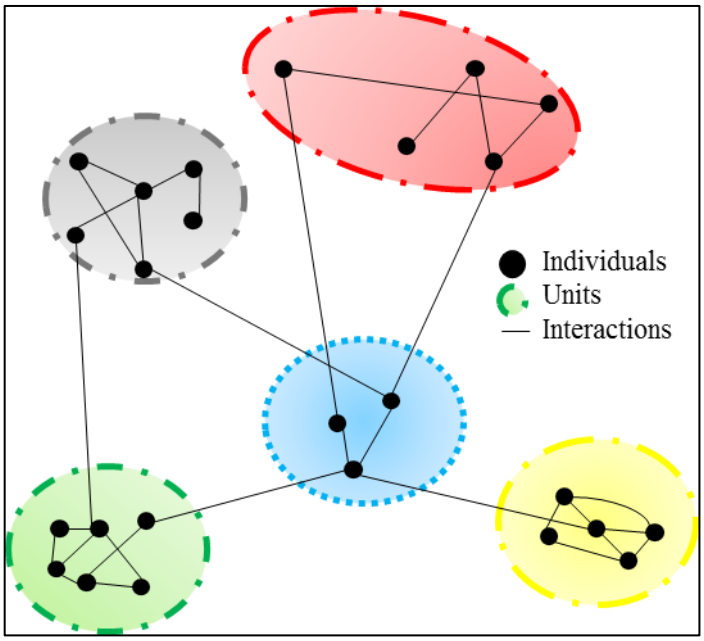

Figure 5 - Simplified Representation of Inter and Intra-firm Interactions
Source: Elaborated by the Author

5.3.3. Formal and Informal Interactions: Nature

Considering that the interactions are, according to Melo (2011), "*a relationship between two or more individuals and/or organizations in a process of exchanging information, skills, equipment, knowledge and competencies*" it is important to understand that these interactions may vary according to its nature, interactions can be Formal or Informal, regardless of intra or interunit, internal or external, horizontal or vertical.

In the recent years there has been increasing acknowledgement of the importance of socially based, informal modes of learning, the internet is spreading faster and faster and allowed informal interactions to emerge as an important way for people to learn. Sharing and learning has never been so easy. Although, at the same pace formal interactions[21] made the online interactions to growth as well. The impacts of this growth are already being seen inside the firms, startups and even big companies are already acknowledging the importance of intra-firm informal interactions and are creating proper environments that stimulate and encourage the employees to share, exchange information and enjoy these moments in order to create this culture within the individuals.

Contreras-Castillo (2004) argues that a mixed of formal and informal interactions are needed in order to manage and obtain the better absorptive capacity in each individual, which means that a firm that wants to innovate should find comfortable mechanisms and tools for coordination, mixing formal and informal interactions that allow their employees to acquire knowledge from internal or external sources and make it flow to other employees inside the firm.

The main goal of the dichotomy informal and formal interactions for the innovative process and the intra-firm coordination is to find the settings that better suit each employee and provide them a safe environment to allow the knowledge share and consequently a better performance at the overall tasks. Ideas should flow, daily tasks should be executed and each individual respond better in a particular and unique way. As Indarti (2010) argues, some individuals interact better with their superiors by informal interactions, such as a conversation or a phone call, but when interacting inside their own unit they prefer formal interactions, like email or formal reports.

[21] An example of formal interactions in online environments are the Online Training.

What we propose is the identification of the intensity of formal and informal interactions inside a company, particularly, in this study we identified the dichotomy in several highly innovative firms to understand if there is a need for firms to have predominance of informal or informal interactions. Therefore, the dynamics of formal and informal interactions combinations can be vastly explored and it may vary according to sectors, type of innovation, type of product, service or even applied to other fields like education, sports or politics.

5.3.4. Interactions Intensity: Frequency

Intensity by itself is a unit for measuring the interactions, but also the most important indicative to analyzing the firms as a whole, if there are interactions, there is an intensity as indicative. According to Indarti (2010), firms with lower general interactions[22] intensity tend to be more closed to cooperation, new projects, ideas and sharing, on the other hand firms with high intensity of general interactions are considered to be more open or inclined to cooperation and sharing of any kind. There are many reasons to believe that enhanced interactions intensity is beneficial to the firm's innovative activities, as Hansen *et al*. (2005) argues frequent and intense interactions increase the exposure to the views and skills of other units, thereby reducing negative perceptions. According to the view, Mudambi (2002) argues that rich interactions allow like face-to-face communication, and teamwork help to overcome the "transmission losses" that occur during the transfer of complex procedural knowledge.

Ghoshal & Bartlett (1988), in the light of the social interactions literature, argued that inter-unit interactions density facilitates the movement of knowledge. Gupta & Govindarajan (1994) agree and expanded the findings by adding that the use of lateral integration mechanisms (liaison personnel, temporary taskforces, and permanent teams that coordinate unit's knowledge flow) and the intensity of both corporate-units and interunit-interactions are important predictors of knowledge outflows and inflows at the firm level. The authors also argue that corporate socialization mechanisms (Such as job rotation, mentioned at the chapter 4) influence the knowledge inflows and outflows, both to/from a certain unit.

[22] General Interactions: The result of all the firms internal and external interactions, at all levels and of any kind and nature.

Intensity is what is common to all the types of interactions and we propose the intensity as the indicative used to analyze the intra-firm interactions. As Aalbers (2015) argues this indicative is not a purely quantitative measure, it is an indicative subject to interpretation and to understanding, thus, a qualitative way to evaluate the firm's interactions. Observation and documental analysis are the best way to analyze the firm's interactions. To formal interactions for instance, we can analyze the frequency of scheduled meetings in a unit, or among units. Also, we can collect and count the frequency of emails, reports and presentations shared among the employees. However, to informal interactions we can only observe the environment and make a documental analysis on the content of social media interactions, online chatting and moments of informal knowledge sharing.

5.4. The Analysis of the Intra-Firm Interactions: A Practical Approach

The use of the theory of the interactions for the analysis of the intra-firm coordination was suggested by Aalbers (2015), we added the definitions of the types of interactions, the innovation as background and the intensity as the measure variable. However, what we aim to explore and to contribute with this thesis is the analysis of the dynamics of interactions. We aim to provide an understanding on how can the firms look to its knowledge sharing processes and by the use of the concepts and definitions present in this work, reflect on its current status and manage it, by using new tools, mechanisms and process, in order to overcome barriers, obstacles and enhance its innovative activities. Understanding that innovation is a human centered process, it involves behavior, environment and social variables, that should be managed. As Tsang (2015) points out, innovation is not a merely economic process.

Our model for the analysis of the intra-firm coordination by the use of the interactions brings numerous possibilities, for institutional, firm and individual level. The focus of this work is the intra-firm analysis. To explain the model for analysis we use the example of "Firm Random". To show what is possible to assume by using this analysis, we have the Figure 06 expressing what is happening at the R&D and Marketing units of Firm Random, we use the interactions of the individual A as example:

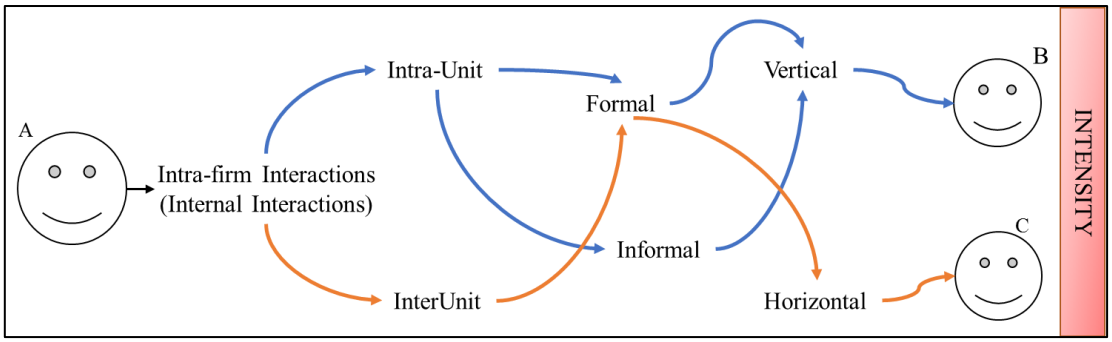

Figure 6 - Representation of the Interactions between individuals AxB and AxC
Source: Elaborated by the authors

The quantitative expression of Figure 6, according to our proposal is represented at the Table 5:

	Interactions: AxB & AxC						Intensity		
	Formal	Informal	Vertical	Horizontal	Unit	Interunit	Low	Medium	High
B	1	1	1	0	1	0	0	0	1
C	1	0	0	1	0	1	1	0	0

Table 5- Matrix of the Interactions between individuals AxB and AxC
Source: Elaborated by the authors

Practically what we have in this case is: Formal and Informal, vertical, intra-unit interactions with high intensity between individual A and B. Formal, horizontal, interunit interactions with low intensity among individual A and C. Thus, let's assume that the Individual A is working as a Researcher at a R&D department, the individual B is working at the same unit, considering that them both have intra-unit interactions, although, the individual B is not from the same hierarchical level than B, thus, we can assume that B is his superior in the organizational structure, but he could also be from a lower level, anyway, the important fact is the difference in the level. We can see that A and B have both, formal and informal interactions showing that they might have a good environment for the knowledge sharing. When we look at the interactions between A and C, we understand that C is not working in the same unit as A, we assume that C is working for the marketing unit, although they have the same hierarchical level, considering that they have only horizontal interactions among them. Although, A and C only interact by the use of formal mechanisms and with a lower intensity than A and B.

In this case, it could be an asymmetry of information and thus, knowledge between the individual A and C. A is a researcher, C a marketing manager, studies as McEvily (2014) showed us how important is to firms to align their marketing and R&D department,

therefore, in this case we found the flaw in the knowledge sharing inside the firm. The reason for this to happen can be various, but how could we address this case? What would be the managerial solutions? In this sense, the next subsection shows us alternatives to address this problem.

5.4.1. Stimulus Influence

How do firms overcome obstacles, barriers and issues when sharing knowledge? The literature up to now shows us that one of the most common ways is the use of a stimulus[23]. The definition of a stimulus come from the Psychology field, it is defined as: "*Events in the environment that influence behavior*"[24]. A single stimulus can serve many different functions. As Gescheider (1997) argues, in behavioral psychology (i.e., classical and operant conditioning), a stimulus constitutes the basis for behavior.

Thus, in the management sciences we understand stimulus, in the context of interactions, as an event that aims to change the current status of the interactions. It may or may not include change in the organizational structure, rewards, formal demands, informal attempts or similar. It is important to highlight, as Indarti (2010) points out, that the stimulus is the main way to manage and modify the firm's internal interactions. Therefore, the role of the stimulus in the intra-firm coordination for innovation purposes is to help firms rearrange its internal interactions.

The answer to the "How", although, is more complex than the understanding of what it is a stimulus. Each firm has its own way to share knowledge, which means that effectively different stimulus might be necessary and vary from case to case. At the chapter four we saw examples of mechanisms involving several different stimuli like job rotation, making the interactions centering in key employees, also task force, making a group of individuals interact with a unique goal.

[23] To Skinner (1937): An eliciting stimulus was defined as a stimulus that precedes a certain behavior and thus causes a response. A discriminative stimulus in contrast increases the probability of a response to occur, but does not necessarily elicit the response. A reinforcing stimulus usually denoted a stimulus delivered after the response has already occurred; in psychological experiments, it was often delivered on purpose to reinforce the behavior. Emotional stimuli were regarded as not eliciting a response. Instead, they were thought to modify the strength or vigor with which a behavior is carried out.
[24] https://psychology.uiowa.edu

5.4.2. The Importance of Interactions Diversity

Scholars such as Gilbert (1999), Lewis (2005), Noe (2006) and others stressed the management of communication inside the firm. An effective communication in the workplace helps employees and managers form highly innovative firms. Employees are able to trust each other and management are able to understand issues and address situations more precisely.

As George (1996) argues, a firm with diverse ways to interact may offer managers alternatives to share knowledge and to make the information flow within departments and enable employees to work together harmoniously. The result of a team that works together is high productivity, integrity and responsibility. Employees know their roles on the team and know they are valued. Managers are able to correct employees' mistakes without creating a hostile work environment and thus, avoid conflict. The author still argues that a manager who openly communicates with his subordinates can foster positive relationships that benefit the company as a whole.

Quigley (2007) states that diversity of interactions is crucial to the firms that wants to innovate. The diffusion of knowledge among units may vary between formal and informal mechanisms, some individuals may absorb the information better in particular ways and in the same sense they may be willing to share the knowledge only in face-to-face interaction or only in a formal mechanism such as an email or report. The importance for this thesis is to acknowledge the importance of interactions diversity inside a firm and offer insights of mechanisms and tools that are able to provide firms different types of interactions.

5.4.3. Conflicts and the lifespan of an Interaction

Several studies approach the conflicts in the interactions context, Astebro (1995) found that emails cause conflicts inside the firm due to its intensity. Employees usually tends to stress a single tool for interactions, as Youssef (2011) argues, a single tool for the interactions have a lifespan, which means a start, a peak and a moment at which it become stable.

Colombo (2011) stats that when handling the intra-firm coordination, it is important to understand the capabilities of each mechanism and tool used to manage the

interactions. Spraggon (2012) when exanimating the intra-firm knowledge transfer processes discovered that when conflicts were taking place at the firms one of the solutions were to change the tool used for interactions, in other words, it was needed to change the type of the interaction due to the abuse of a single mechanism or tool. Thus, the lesson was that each interaction has its own lifespan and when managing the intra-firm interactions, it is needed to pay attention to the conflicts using the interactions management can cause. Reducing or enhancing intensity and diversifying interactions are extremely important aspects to firms that aim to be innovative.

5.4.4. Resistance and Control: Tools for the Intra-firm Coordination

In this chapter, we presented an example of intra-firm interactions analysis and we acknowledged the for the understanding of: Stimulus, diversity, conflicts and lifespan interactions related. Yet, there are still two aspects that must be considered to the intra-firm coordination, the first is resistance. Among the various studies of resistance in the context of intra-firm knowledge sharing, we highlight Ellen (1991), Fidler (1984) and Kor (2006), these authors argue that employees face not just technological resistance, which means resistance to new tools for interactions or tool-based mechanisms, they also face behavior resistance.

When implementing new tools or mechanisms to change the intra-firm interactions it is important to understand that firms may face resistance. Resistance can emerge from the start of the implementation or change or along the process. We see resistance as an opportunity to firms to attempt using different types of interactions to overcome barriers for the knowledge flow, as Waddel (1998) argues, resistance is a constructive tool for change management and firms should find a way to profit and to manage change by the use of interactions.

Thus, control is an important concept to the situations of resistance. First, control is important to identify from where and how the resistance emerge, second, control is important to follow the impacts after the implementation of a solution for the resistance and finally control may allow firms to identify which type of interactions suits better each unit or even employee. As Aalbers (2015) argues control is the only way firms have to verify if the changes at the interactions are effective or not, thus, firms should implement tools for the control of the interactions.

Nowadays, with the digital transformation we see several tools to control intra-firm interactions: Pipelines[25], management and team apps such as: Slack[26], Trello[27] and similar are just example of tools for informal and formal interactions that can be used to address the online interactions. As for the regular face-to-face the best tool is, yet, a psychologist or behavior specialist that can analyze reports, meetings and make observation of the firm's daily activities.

5.5. The Interaction Agents

After the definition of interactions, the types we proposed and the acknowledgement on the analysis and the aspects to be addressed, we can start looking inside the firm and recognizing how the individuals interact. The human factor of the interactions is the key to identify barriers and to solve issues at the intra-firm knowledge sharing. For that, we use the model of Brokerage, Marsden (1982) defines brokerage as a process "by which intermediary actors facilitate transactions between other actors lacking access to or trust in one another." Thus, any brokered exchange can be though to as a relation involving three actors, two of whom are the actual parties to the transaction and one of whom is the intermediary or broker.

According to Burt (1992), brokerage is a state or situation in which an actor connects otherwise unconnected actors or fills gaps or network holes in the social structure. The brokerage model was deeply worked and reviewed at the interactions context and as Aalbers (2014) argues, it suits perfectly the intra-firm coordination. At the Table 6, we can see some examples of authors that worked with the brokerage model:

[25]Pipelines are software used to manage firm's communication by email. It has several features to help firms track email correspondence, contacts and content. See: https://help.pipelines.com

[26]Slack, or "Searchable Log of All Conversation and Knowledge" is a cloud-based set of team collaboration tools and services. See: https://www.slack.com

[27]Trello is a web-based project management application. See: https://www.slack.com

Author	Year	Title
RV Gould, RM Fernandez	1989	Structures of mediation: A formal approach to brokerage in transaction networks
I Tothezan, E Athanassiou, P Alzon	1997	Enterprise modelling of information brokerage and retailer services
N Manouselis, D Sampson	2003	Learning resources brokerage systems: an agent-based virtual market model
S Papagiannidis, F Li	2005	Skills Brokerage: A New Model for Business Start-ups in the Networked Economy
L Fleming, S Mingo, D Chen	2007	Brokerage vs. cohesion and collaborative creativity: An evolutionary revolution
L Fleming, S Mingo, D Chen	2007	Collaborative brokerage, generative creativity, and creative success
L Fleming, DM Waguespack	2007	Brokerage, boundary spanning, and leadership in open innovation communities
H Oh, M Kilduff	2008	The ripple effect of personality on social structure: self-monitoring origins of network brokerage.
S Papagiannidis, F Li, H Etzkowitz	2009	Entrepreneurial networks: A Triple Helix approach for brokering human and social capital
Y Kirkels, G Duysters	2010	Brokerage in SME networks
W Stam	2010	Industry event participation and network brokerage among entrepreneurial ventures
C Penn, I Watermeyer	2012	Cultural brokerage and overcoming communication barriers
HL Aalbers, WA Dolfsma	2015	Bridging Firm-Internal Boundaries for Innovation: Directed Communication Orientation and Brokering Roles

Table 6 - Studies on the brokerage model
Source: The author

Stovel (2011) explain that the broker may connect separate areas of a unit/group/network, socially, economically, or politically, and therefore he/she is the only one to access both valued information and resources from different areas of the network. Brokerage is the only mechanism which allows isolated or unconnected actors to share information and resources and to interact economically, politically, and socially. The model of Brokering roles is being used by the scholars at the intra-firm context and to innovation ends. The debate regarding brokers and their roles, nowadays, have a deeply relation with the organizational structure the brokers have, Hargadon (1997) argues that network perspective treats network actors largely as conduits that pass along unchanged ideas and resources to others. Little attention is devoted to how or why those ideas and resources are transformed and combined into new solutions for other actors and subgroups.

In the context of SMEs, the importance of third parties in building interfaces and developing knowledge is acknowledged in innovation and SMEs literature by scholars such as Kaufmann (2002) and Sapsed (2007).

Howells (2006) argued that brokering is more than information gathering, exchange and linking function, the brokers provide a much wider, varied and holistic role for the individuals involved in the innovation process. In an example, we have the work of Snow (1992) that acknowledged the managers as architects that think each role of the firm as being critical to the success of an innovation process. Another important definition of the brokers that is important to this work the brought by Gould & Fernandez (1989), to the authors, brokerage roles express the brokerage behavior, that is the facilitation of information flows whether or not a direct reward is involved, in other words, various interests of the actors will affect the way they seize the brokerage opportunities and a lack of certain roles in a network tells us something about the flow and transformation of knowledge in the field.

The theory describes five types of brokers: Coordinator, Gatekeeper, Itinerant Broker, Liaison and the Representative, although it is important to highlight that an actor in a network can fulfill several of these roles. To better explore the brokerage roles, in the next subsection we define what a knowledge source is and then we explore each of the brokerage roles and its utility to the study of innovation.

5.5.1. Knowledge Source

The knowledge source is not a brokerage role, according to the source-receptor approach, the knowledge source is the individual that possess the information. Firms should be able to recognize its knowledge sources and create mechanisms for these individuals to interact and from them start the processes of knowledge flow among the firm units. Indarti (2010) argues that the firms should be smart enough to recognize that any employee is a knowledge source, consequently a proper environment for interactions should be built within the firm.

5.5.2. Coordinator

Kirkels (2010) argues that the coordinator enhances interaction between members of the group he belongs to. In a representation, as shown in the Figure 7, all three actors belong to the same unit and brokering happens within the group. An example of the coordination brokerage is a certain unit where one member in the office connects two other members who would, otherwise, not communicate with each other regarding topics such as how to deliver a specific service more efficiently and how to develop useful products or process to the firm. The coordinator here, use the interactions to make the information flow in an example of communication among members in the office.

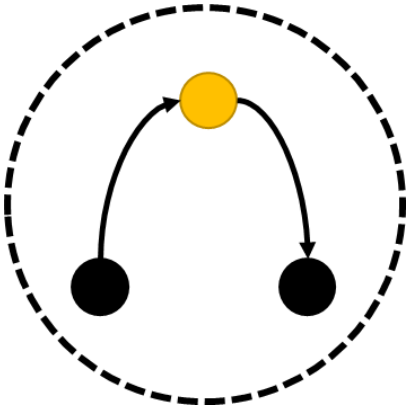

Figure 7- The Coordinator
Source: Adapted from Gould (1989) & Aalbers (2015)

5.5.3. Gatekeeper

The gatekeeper absorbs the knowledge from a certain unit/group and passes it to the unit/group he belongs to. In this brokerage type, the Gatekeeper and one of the two unconnected actors belong to one group while another unconnected actor belongs to a different unit/group. The Gatekeeper controls incoming information to his/her group and makes decisions about whether or not the unconnected actors in the group have access to information or resources.

One example of this kind of dynamic would be a manager, who may control extension sales agents access to the information regarding new products or services. The manager (Gatekeeper) and the sales agent belong to one group to which the product developer is not connected. The information flow in this brokerage example is the information about a new product or service that is yet to come.

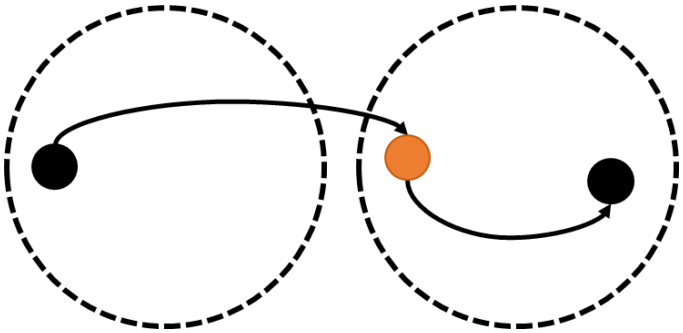

Figure 8 - The Gatekeeper
Source: Adapted from Gould (1989) & Aalbers (2015)

5.5.4. Itinerant Broker or Consultant

The itinerant broker or cosmopolitan mediates, as an outsider, the interactions between members of the same unit/group. In this dynamic two actors that are not interacting belong to one unit while the Itinerant broker belongs to a different unit.

Itinerant brokerage is also called consultant because the broker acts as a consultant to both actors of the same unit. An example of itinerant brokerage is the project manager who helps to connect a marketing unit through a development project. The information flow in this interaction example is information related to budget for advertising and package for a certain product, this information, ideas and insights is shared and managed via the itinerant broker.

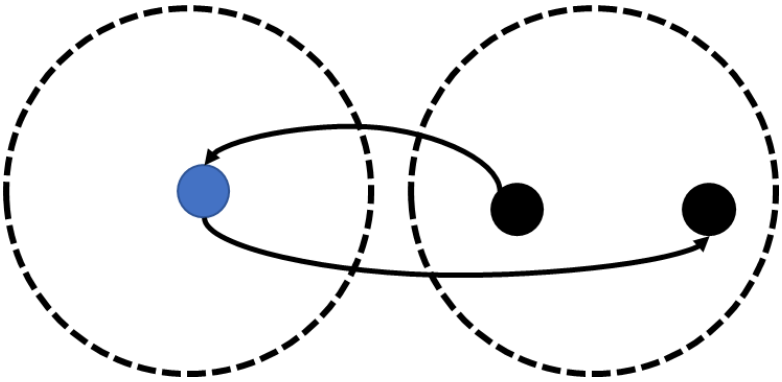

Figure 9 - The Itinerant Broker
Source: Adapted from Gould (1989) & Aalbers (2015)

5.5.5. Liaison

The liaison enhances, as an outsider, interactions between different units. In the liaison dynamic, the liaison connects two different units to which he or she does not belong. In Figure 10, the liaison connects two units but is not part of either.

One example of liaison brokerage is when a marketing manager, connects researchers from the R&D to the finance department, through the dissemination of research. The marketing manager, researchers, and the financial manager form three distinct groups, and information moves from researchers to the financial unit via the marketing manager. The information flow in this interaction is the new information discovered by researchers which in turn helps address a gap in the market.

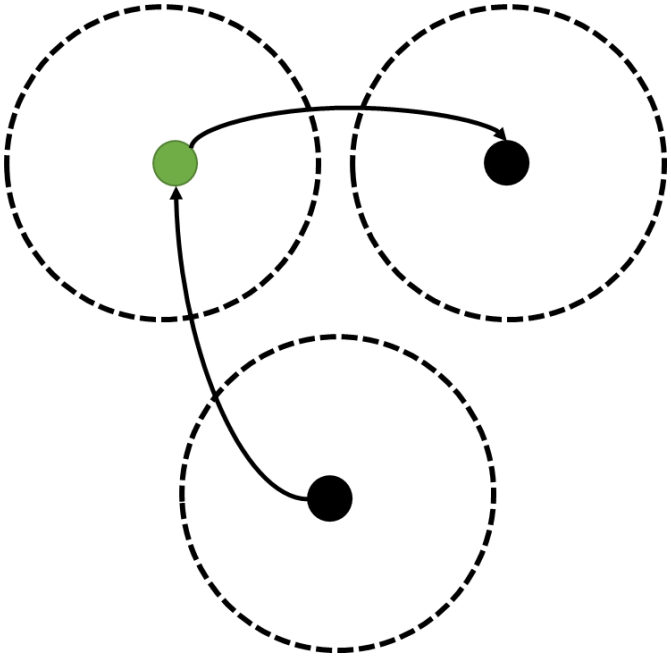

Figure 10 - The Liaison
Source: Adapted from Gould (1989) & Aalbers (2015)

5.5.6. Representative

The representative diffuses knowledge of their own unit to other units. The representative, interacts with a fellow unit member and attempts to establish interactions with an outsider. More generally, a representative role is created when one or more members of a unit delegate one of their own to communicate information to, or negotiate changes with the outsiders. The Figure 11, represents the dynamic of interactions of a representative. This type of dynamic is similar to the gatekeeper, as the broker and one

unconnected actor belong to one unit while the other unconnected actor belongs to another different group, but the direction of the flow of information or resources is different.

In this dynamic, the representative represents his/her unit for any kind of negotiations with the other unit. An example of representative dynamic would be a product development project where there is a major problem with the product design and the unit that designed the product is not aware of the problem. A unit manager in the marketing unit would act as a representative when he or she informs the development unit about the design problem and the needs of the responsible to correct it. The information flow in this interaction example is awareness of the need for a re-design and management program from development unit to better interact with the marketing unit.

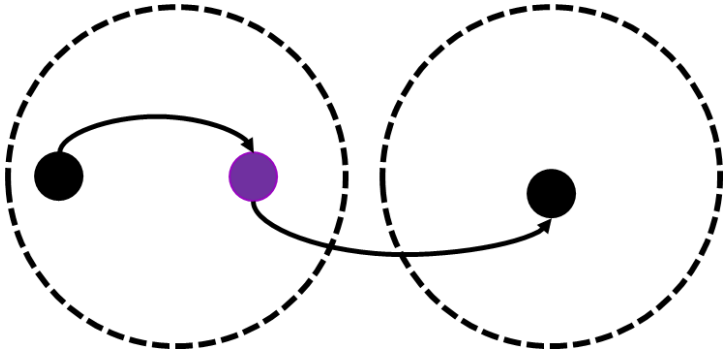

Figure 11 - The Representative
Source: Adapted from Gould (1989) & Aalbers (2015)

6. METHOD

This chapter describes how we performed an intensive fieldwork with a substantial number of observations in firms with a history of innovation. As the main objective of this study is to search for an understanding on how firms manage its intra-firm coordination in for the innovative processes. We developed a research design that could be able to uncover the possible relations of a firm's interactions and its result in the innovation field. In the next subsection, this research design is presented.

6.1. Research Design

It is important to highlight the choices that we have made regarding the methodological procedures and the approaches taken to answer our research question. Despite all the efforts to reach the answers that we seek, this study was designed embedded in our paradigms and limitations as researchers. This is exactly why the research design will expose our thoughts from the beginning.

The probability of success of a research project is greatly enhanced when the "beginning" is correctly defined as a precise statement of goals and justification. Therefore, having accomplished this are just the start necessary to write a proper design to the research that will allow us to easier gather and organize the data needed to answer the research question. The work of Crotty (1998) established the groundwork for the main framework to the research design. He suggested that in designing a research proposal, we consider four questions, regarding the inquiry:

Epistemology: The theory of knowledge embedded in the theoretical perspective.

Theoretical Perspective: Philosophical stance in which lies the methodology that will seek the answer to the research question.

Methodology: The strategy or plan of action that links methods to expected outcomes.

Method, Techniques and procedures: The tools used to gather data.

According to Creswell (2003) these four aspects show the interrelated levels of decisions that go into the process of designing research. Moreover, these are aspects that inform a choice of approach, ranging from the broad assumptions that are brought to a project to the more practical decisions made about how to collect and analyze data. With

that in mind we have to consider that the resulting design must be able to answer the initial research question, therefore, the chosen methodological approach must be able to provide proper data. This study is built within the post-positivism and pragmatism knowledge approach, uses the perspective from the Interactions Theory and it is performed by using qualitative method as strategy to address the research question, with interview script and complimentary questionnaires as tools to gather the data.

To perform a proper research design, we have to consider the aspects regarding epistemology, theoretical perspective, methodology and method in way that enable us to find the right approach to answer the research question. The Figure 12 by Creswell (2003) displays how the elements of inquiry (i.e., knowledge claims, strategies, and methods) combine to form different approaches to research.

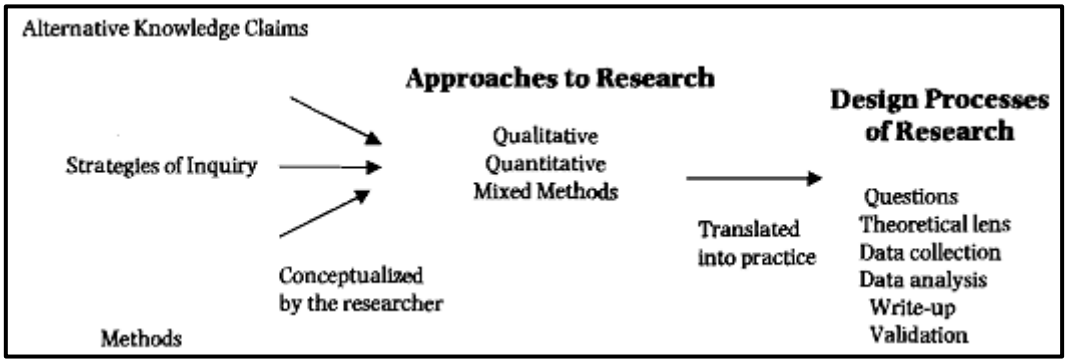

Figure 12 - Elements of Inquiry
Source: Creswell (2003)

The first step we took to draw this research was to fit this inquiry into a knowledge claim that can allow us to find the answers that we seek with that tools that we have in the present paradigm. **We lay in between the post-positivism and pragmatism**, once that Phillips & Burbules (2000) argues that post-positivism reflects a deterministic philosophy in which causes probably determine effects or outcomes. Thus, the problems studied by post-positivists reflect a need to examine causes that influence outcomes, such as issues examined in experiments. It is also reductionist, the intent is to reduce the ideas into a small, discrete set of ideas, to test, such as the dimensions that constitute our propositions and research question. The knowledge that develops through a post-positivist lens is based on careful observation and measurement of the objective reality that exists “out there" in the world. Thus, developing numeric measures of observations and studying the behavior of individuals become paramount for a post-positivist.

Besides the post-positivism approach to the research we would be naïve to ignore that our methodological procedures are in fit with the pragmatic point-of-view, according to Cherryholmes (1992). Murphy (1990) and Creswell (2003) pragmatism provides a basis for the knowledge claims such as the not commitment to any one system of philosophy and reality, and this applies to qualitative methods of research (this case) in which inquirers draw liberally from qualitative assumptions when they engage in their research. Also, individual researchers have a freedom of choice as they are "free" to choose the methods, techniques, and procedures of research that best meet their needs and purposes. The authors still argue that pragmatists do not see the world as an absolute unity, so qualitative methods look to many approaches to collect and analyze data rather than be subject to only one way.

We have to consider that when talking in the management field, truth is what works at the time; it is not based in a strict dualism between the mind and a reality completely independent of the mind. Thus, in mixed methods research, investigators use qualitative data because they work to provide the best understanding of our research problem. Pragmatist researchers look to the 'what" and "how" to research based on its intended consequence-where they want to go with it. Pragmatists agree that research always occurs in social, historical, political, and other contexts. In this way, qualitative methods studies may include a postmodern turn. A theoretical lens that is reflexive of social justice, culture and even political aims. Rossman & Wilson (1985) argues that there is a concern with applications, “what works” and solutions to problems. In addition, Patton (1990), highlight that not only the methods are important, the problem is even more important, and researchers must use all approaches to understand it (Rossman & Wilson, 1985).

Once we had our knowledge claim defined we had to address our strategies of inquiry to better answer our research question. After an extend literature analysis we found that the way that would probably provide best data to understand and describe the interactions phenomenon was to use qualitative method, mainly because the state of art on this theme does not provide a proper tool to measure and quantify interactions, as Indarti (2010) pointed out. So, the reasonable choice, before trying to measure the phenomenon, was to explore and try to investigate more aspects that could provide us better tools to seek answers. In other words, performing a qualitative study, in this case, is vital so we do not left aspects that could be important behind. The qualitative approach

could display details that we would miss with strict questions in the quantitative study, by the other hand, the qualitative study might be not enough to measure and to compare the intensity of interactions and how they increase/decrease along time. With all these aspects in mind we drew the research design, the Figure 13 shows us the path to be follow from the initial insights until the goals we seek can be achieved.

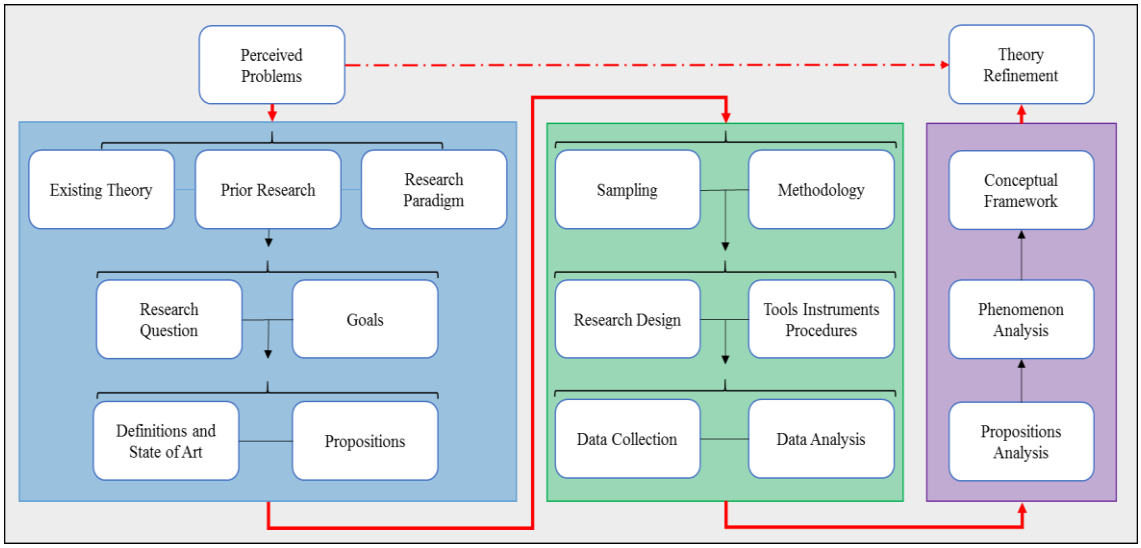

Figure 13 - Standard Research Design
Source: Elaborated by the Author

Our main goal with this study is to understand how the interactions may affect the innovative activities in a firm, the first insight to this research came from the need from the Brazilians Firms to produce not only commodities but also to innovate and fulfill a gap in the internal market that are filled mainly by international firms. From this perceived problem came this study and we aim to provide new ideas, expose relations and refine the existing Interactions Theory regarding to intra-firm interactions. To better explain the Research Design, we divided all the steps, from the perceived problems to the final Theory Refinement, into 3 phases:

- **Literature Analysis**

The transition in a study, from the initial insight to a proper research question it is not as fast as it seems, to proper address the issue we have to be careful regarding all the existing theory and perspectives on the chosen theme. The step that we called literature analysis exists so we can be sure that our proposal is adequate and it was not answered before by other researchers. Performing a literature analysis with all the studies available related to interactions of the firm and innovation process is necessary so we could identify

key items within the papers and analyze them so we acquire the knowledge on the literature stream, in other words it was basically a catch up with the current state of the art. Thereby, we focused the efforts on developing the research question and our goals, always considering the current paradigm. After working in our research question, we defined our goals and moved to the next phase. The result of this step was already exposed in the chapters 1, 2, 3, 4, and 5, and had a high impact on the choices we made for the research design.

- **Research Design**

The next procedure, once that we have our research question and goals defined, is called Research Design, this step consists in the definition of all the aspects related to the data gathering that will provide us the information needed to answer the research question and help us to meet our objectives. All concerns regarding sampling, proper chose of the methodology, tools and instruments to be used and to perform the analysis of the data are aspects developed in this step. This is one of the most important steps of the study and it will define if the research will be able to give us the answers we seek or not.

As the result of this step we got the design we used to gather and to analyze the data of the study. Essentially, we followed two guidelines to build the study design:

a. Demonstrate that different types of interactions influence the result in innovative processes, specifically in a product development.
b. Demonstrate that the interactions have a dynamic that is related to the level of the product innovation that the firms deliver.

Thus, for the sampling, to ensure that the respondents would match the objective of our study and reflect the closest reality regarding its interactions patterns, we used a **judgment sampling technique**. Judgmental sampling is a non-probability sampling technique where the researcher selects units to be sampled based on their knowledge and professional judgment as Cooper and Schindler (2008) argues. We had to choose firms that were at the same level of innovativeness, in other words, firms that worked with similar products and with product development processes within the last two years to demonstrate the similarities at their intra-firm coordination during the creation of a new product.

The only problem was that the cultural aspects would influence the outcome, this could be addressed by considering the location as an important aspect. We also wanted

to exclude most of the variables that we did not consider viable nor relevant to work with, i.e., size. Finally, we had our guidelines for sampling:

a. Firms with the same size.
b. Firms within the same industry.
c. Firms with an innovation project of product development in the last two years.

Our choice was to address the intra-firm coordination where the phenomenon is assumed to be more evident, thereby we decided to work with Highly Innovative Firms (HIF) and analyze a single project of product development. As for the firm's location, considering that this study is part of a cooperation project between Brazil and France we decided to split the sample:

I. Four HIF located in Brazil
II. Four HIF located in France

We conclude that performing a comparative study would require an extremely complex analysis of variables that are not related to the intra-firm interactions, such as history, culture, technological path of both countries and more variables that we are not able to name it. We would also need to work with different groups of firms to be the ideal solution to approach the comparison matter. Also, since we would be dealing with comparison, a qualitative study would most likely not be enough once that we could end up not finding differences between interpretation, dimension meaning and even deal with variable that we did not consider yet, so, we made the option to exclude the comparison study and perform a study of evidences from both countries. The qualitative study and its tools, procedures and data collection/analysis will be presented further.

- **Theory crafting**

The final step of this research is arguable the most critical step of it, to work with the interpretation of obtained data will define if the expected outcome, to answer the research question, will be delivered. Thus, to understand how this step works it is crucial that we define what we mean by calling this step Theory Crafting, a not much used terminology on the field of management and social applied sciences as well. Theory craft refers to the mathematical analysis of **mechanics**[28] to discover the best strategies to

[28] Mechanics: The effects of the bodies on their environment. Renn, J., Damerow, P., and McLaughlin, P. Aristotle, Archimedes, Euclid, and the Origin of Mechanics: The Perspective of Historical Epistemology. Berlin: Max Planck Institute for the History of Science, 2010, page 1-2.

maximize effectiveness. It can be performed by using tools such as statistics, simulations and in field observations.

The term was coined in the econometrics and intend to study the reactions of people in a certain environment. More precisely, it is "*the analysis of an economic phenomenon based on the concurrent development of theory and observation*."[29] The term Theory craft fits perfect to our research approach, to our willingness to refine and to contribute for the growing of the Interactions Theory in the management literature.

This step was performed after the data gathering and analysis. Once we had all the data polished we were able to start the propositions analysis. The proposition analysis is a key element on the research process, to accept or to deny any proposition may have a great impact on the current *status quo* on the phenomenon appreciation. With a deep understanding, provided by the data and the proposition analysis filled us with the knowledge that we need to develop a concept including the interactions regarding to the innovation process.

A conceptual analysis will be the closing step of this research, and it will consist in a system of concepts, assumptions, expectations, beliefs, and the theories that supports and informs all the achievements that we reached with the data we had. As Miles and Huberman (1994 p. 15) defined, a conceptual analysis can be a visual or written product, one that "*explains, either graphically or in narrative form, the main things studied, the key factors, concepts, or variables and the presumed relationships among them*".

This final result, in a wider scope, will be the sum of all the actual ideas and beliefs that we hold about the phenomenon studied and it will be our answer to the initial research question, not final, not found, but built. In the next section, the methodological procedures chosen to be the path to the answer will be unveil, starting with the motivation to perform a study in the way that the method of the study is presented itself.

6.2. Settings

After an intensive analysis of the available literature, the state of the art made us realize the need for this thesis to be an exploratory qualitative study that would allow us

[29] See: WENZ, Karin. THEORYCRAFTING: Knowledge production and surveillance. **Information, Communication & Society**, v. 16, n. 2, p. 178-193, 2013.

to identify new variables or aspects that were not covered before. According to Yin (2003) a qualitative case study design should be considered when:

a) The focus of the study is to answer "how" and "why" questions;
b) You cannot manipulate the behavior of those involved in the study
c) You want to cover contextual conditions because you believe they are relevant to the phenomenon under study
d) The boundaries are not clear between the phenomenon and context

All these assumptions fit perfectly our main goal with the qualitative study. As we chosen to work with SMEs from the food segment we chose eight units of analysis, four located in Brazil (Rio Grande do Sul) and four located in France (Picardie). We will perform what is called Qualitative non-interactive study with concept analysis and documental analysis of the units.

The research instrument is based on the dimensions proposed by Indarti (2010) and Aalbers (2015) with some specific additions regarding innovation, intra-firm interactions and the brokerage roles. The semi-structured instrument can be found at the Appendix A and the complimentary questionnaires at the Appendix B and C. The interviews were performed in French, English and Portuguese, the content was recorded, translated to English, validated by the reversal translation method and by specialists. Finally, the interviews were analyzed by using the software N-vivo and the content analysis method.

Cole (1988) argues that the content analysis is a method of analyzing written, verbal or visual communication messages. As Harwood & Garry (2003) argues, it was first used as a method for analyzing hymns, newspaper, magazine articles, advertisements and political speeches in the 19th century. Nowadays, according to Neundorf (2002) content analysis has a long history of use in communication, journalism, sociology, psychology and business, and during the last few decades its use has shown steady growth.

We chose to use content analysis because as a method it has systematic and objective means of describing and quantifying a phenomenon (Krippendorff 1980, Downe-Wamboldt 1992, Sandelowski 1995). It is also known as a method of analyzing documents. **Content analysis allows the researcher to test theoretical issues to enhance understanding of the data.**

By using the content analysis, we are able to distil words into fewer content related categories, such as interactions, innovation strategy and product development process. Cavanagh (1997) assumed that when classified into the same categories, words, phrases and the like share the same meaning. With the outcome of the qualitative study we expect to be able to refine and improve our understanding of the intra-firm interactions at the product development project and demonstrate how interactions are enrolled in the process of innovation at the Brazilians and French firms from the food industry.

To understand how the firms, innovate and create new products in the lens of the dynamic of interactions we had several tasks to be done:

a. Understand intra-firm interactions, at the individual level of interactions.
b. Understand intra-firm coordination mechanisms for the innovative activities.

As the Rogin (1987) stated social science methodology does not concern mere technique; it concerns the relationship between thinking and researching. The key concern here is the impact of the organization of the investigation and the structure of the data analysis on how the investigator thinks about the subject. We strongly argue that to understand how the interactions work we should use a study with different realities. The different factors could be used to expose cultural, legal and other aspects can influence the interactions and the same patterns can be used to discuss what the nature of the interactions are. In the next subsection, we present our sampling method.

6.3. Units of analysis

As for the sampling method, we used the multistage sampling, derived from the cluster sampling method and judgment sampling technique as previously stated. A sample is, according to Field (2005) "*a smaller collection of units from a population used to determine truths about that population*". In cluster sampling, the cluster, i.e., a group of population elements, constitutes the sampling unit, instead of a single element of the population. The complex form of cluster sampling in which two or more levels of units are embedded one in the other is called multistage sampling.

Multistage sampling refers to sampling plans where the sampling is carried out in stages using smaller and smaller sampling units at each stage. Multistage samples are used primarily for cost or feasibility reasons. To select an SME of the food industry in Brazil according to its products positioning, would be extremely difficult because no

clearly list of all those firms exists. However, we could proceed in stages: Firms from Rio Grande do Sul and France from specific regions, and finally firms that have innovative products released within the last two years.

Our first clusters are SMEs, second cluster is the food industry, third Brazilian and French firms from the food industry, fourth firms from the regions of Rio Grande do Sul and Picardie and fifth Highly innovative firms, which means firms that released at least 1 product new to the market in the last two years. From this point, we mapped out the firms and we intentionally selected 8 firms to compose our sample.

The eight firms we selected had unique products developed, the products were awarded in recognized fairs in Brazil and France. We focused our interviews in each process of product development, its general context, interactions, main units involved and the responsible for the ideas and to lead the project. Table 7 describes the sector, country, number of units, the presence or not of a R&D department and the size of each firm, as well as the code we use do refer to each firm, from A to H.

Firm	Country	Sector	Units	R&D	Size
A	France	Vegetables	9	Yes	Medium
B	France	Organic Products	6	Yes	Small
C	France	Organic Products	7	Yes	Small
D	France	Fruits	7	Yes	Small
E	Brazil	Animal Origin Products	8	Yes	Medium
F	Brazil	Dairy Products	8	Yes	Medium
G	Brazil	Dairy Products	8	No	Medium
H	Brazil	Grains	6	No	Medium

Table 7 - Firms analyzed in the study
Source: The authors

The Table 8 shows the details on the individuals interviewed in each firm. The interviews lasted from 3 hours to 4 hours. We highlight the high level of education of the professionals interviewed, as well as the high position at the firms.

Firm	Interviewed Position	Age	Education	Previous R&D Experience
A	R&D Manager	46	Master	Yes
B	CEO	53	PhD	Yes
C	CMO	44	PhD	Yes
D	Head of R&D	35	Master	Yes
E	R&D Manager	40	Bachelor	Yes
F	Head of Marketing	32	Master	No
G	R&D Manager	40	Master	Yes
H	CEO	38	Master	No

Table 8 - Individuals participants in the study
Source: Elaborated by the authors

In the next subsections, we describe the particularities of the locations, our categories of analysis and the procedures for the data gathering and the data analysis.

6.4. Location

The description of the location in which the study was performed is important due to the tradition of the regions in the food industry. First, we briefly describe Rio Grande do Sul, located in Brazil and then we describe the region of Picardie[30],

- *Rio Grande do Sul - Brazil*

Rio Grande do Sul is a region on the extreme South of Brazil, see Figure 14, its food industry has a strong role in its economy and it is spread all along the state. According to the CNAE (National Economic Activities Classification) the state count with 81 activities related to the food sector, which goes from slaughtering activities, rice growing to the production of "ready-to-eat" products. The agriculture is the basis of the state's economy and the state produces a large variety of products such as soybean, rice, wheat, corn, barley, bean, grapes and apples. Considered the second largest grain producer in Brazil, the Rio Grande do Sul State produces 18.6 million of tons, equivalent to the fourth part of the country's entire grain production. Rio Grande do Sul also stands out for its animal production, which includes the cattle, swine and poultry, responding for 20% of national GDP.

[30] Picardie is now part of the Hauts-de-France region.

Figure 14 - Location of Rio Grande do Sul
Source: Google Maps (maps.google.com)

As Brazil's southernmost state and bordering with Argentina and Uruguay by an extensive frontier, Rio Grande do Sul has a peculiar culture, characterized by the Gaucho's image and defined by the ethnic diversity. Rio Grande do Sul's quality of life, human resources and its infrastructure distinguish this state from the remaining Brazilian states. The State's industrial matrix is modern, diversified and integrated. In 2010, the industry was the segment that presented the highest development rate compared to other Brazilian states, reaching 8.8%. The most important complexes are the leather-footwear, agro-industrial, and metal-mechanic, chemical-plastics, besides the furniture, textile and information technology sectors. (WEISS, 2015)

The State Government adopts a development strategy that aims at strengthening the existing economic matrix and encouraging the installation of productive sectors considered equally strategic to complement the economic matrix, solve technological problems and generate jobs and income. Rio Grande do Sul is the second larger exporting state and the fourth greatest economy in Brazil. According to the Brazilian Institute of geography and Statistics (IBGE, 2013), the state is the second largest rural producer; it has the second largest industrial park and the second trade center in Brazil. Responsible for almost 8% of the national production, it also has a GDP of US$ 46.5 billion. Rio Grande do Sul average per capita income – U$S 24.417,4 – is one of the highest in the country and Latin America. - Foreign Trade In the first half of 2005, the Rio Grande do Sul State became the largest exporting state in Brazil, presenting a commercial surplus of US$ 1.1 billion, from January to June. The United States, Argentina and China are the state's main markets.

Other important segments are textile and furniture industries. Many of those complexes became in Local Production System (LPS) or clusters, as they are also known. An example of that are the leather-footwear, furniture, car-manufactures, auto parts, machinery, agricultural implementations and preserve industrial complexes.

All these characteristics make the food sector of Rio Grande do Sul an important line in this work. The region of Picardie has even more tradition in the food sector as it will be presented next.

- *Picardie*

A known gastronomic country "*par excellence*", France is a rich country regarding to its regional specialties that are part of its global products reputation. The second place chosen was the region of **Picardie** located at the extreme north of the France, see Figure 15. Picardie is an ideally located region with many assets, including an efficient agriculture and a dynamic economy on a European scale, due to its strategic position. Its natural riches also make it region of traditional, authentic gastronomy and top-quality products. (LANDO, 2008)

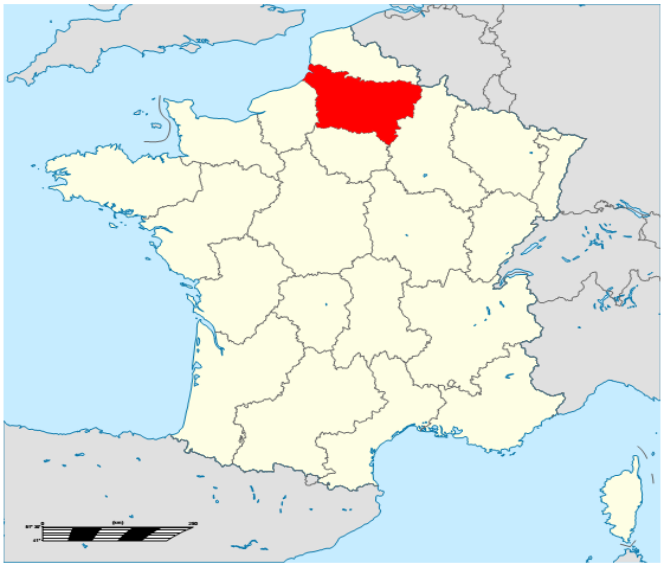

Figure 15 - Location of Picardie
Source: Google Maps (maps.google.com)

According to Lami (1998), thanks to its temperate climate and fertile soils, Picardie has been a farming region for a long time. The utilized agricultural area covers 1.32 million hectares, or 70% of the regional territory. Picardie agriculture is dominated by large-scale farming on cereal crops and oil-producing crops. The surface areas devoted to sugar beet, the region is the leader in the French market with a production of 10.7

million tons, or over one third of domestic output. Picardie ranks first for potatoes used in the potato flour industry and second for potatoes for consumption with.

Also, Picardie ranks very high in endives, beans, garden peas and spinach. The marshlands used for vegetable farming around Amiens[31] supply vegetables. Besides the centuries-old production of pears and apples, Picardie also cultivates red berries (strawberries, raspberries, red currants, blackcurrants) mainly in the Noyon area[32].

Picardie agriculture has turned toward new non-food outlets (ethanol, biodiesel, fibres, biopolymers, etc.). It has also pioneered the implementation of alternative production methods like reasoned agriculture and integrated production. Picardie has also turned to organic agriculture, which is a highlight aspect to our project. The largest vegetable crops are forage, cereals, grasslands and high-protein crops. According to the "*Picardie: L'ambition de l'excellence*" the animal husbandry, in Picardie, concerns poultry (71 000 hens, 1 400 chicken) and dairy and beef cattle (1 300 head). In addition to large-scale crops, Picardie is also an animal husbandry region. In 2009, the cattle population totaled 543 800 head, with 128 620 dairy cows and 76 900 nursing cows, for a milk production of 10.5 million hectoliters, or 3.9% of domestic production. The pig population totaled 174 120 head, with 63 540 fattening pigs and 17 690 sows (50 kg and over). The sheep population is roughly 96 500 head, with 66 300 ewes. As for poultry, the total comes to just over 5 million fowl.

This would be already considered as enough to choose Picardie to a comparative study but in addition, Picardie gastronomy is simple and traditional, similar characteristics if we compare to Rio Grande do Sul. It is inspired by the region's local lands and traditions. Champagne Picard (AOC) is a first-class wine produced in the south of Aisne department with the "*Pinot Meunier*" grape variety.

Finally, with 40 km of coastline, rivers, marshes and ponds and lakes, Picardie has exceptional fishing resources where numerous species are present. The saltwater species include herring, sole, bass, whiting, mullet, plaice and shrimp and the freshwater species include eel, pike, pikeperch, carp and trout. Shellfish are also common (cockles, mussels, Saint-Jacques scallops, etc.).

[31] Amiens is a city and commune in northern France, 120 km north of Paris
[32] A part of which is used in the food industry.

Picardie has a strong history related to the food sector and lots of firms that, as large part of French firms, innovate in its products. With these aspects in mind, Picardie allowed us to have a relevant sample to perform our study.

6.5. Categories

The knowledge exchange between individuals working in a firm, across and even within divisions, does not occur automatically (Szulanski 1996). It is not obvious that people exchange ideas, point one another towards useful information or give feedback, even in the absence of any motives for not cooperating in such a manner. However, as a firm's competitive advantage is closely related to its innovative capacity, which is largely based on how it uses knowledge that is already available, the questions that arise are: how does knowledge flow inside a firm? What can be done to stimulate or re-arrange the knowledge flow in a firm?

Tsai (2001) argues that while it is highly useful to examine the direct effects on knowledge sharing behaviors and ultimately organizational outcomes of organizational mechanisms, it should also be recognized that there may be various kinds of interaction effects between mechanisms on knowledge sharing. Some organizational mechanisms may complement each other with respect to the impact on knowledge sharing behaviors, while other mechanisms may be substitutes.

A deeply understanding on how the knowledge is shared inside high innovative firms may open space to new ways combinations of organizational mechanisms to improve and enhance competitiveness within an entire industry. These new ways of organizational bonding may impact knowledge sharing in very different ways. Only very little of this has been explored in the literature. What is necessary therefore is an "X-ray" from the inside of the firms.

Several authors, like Grandori and Furnari (2008), identified relevant organizational mechanisms/variables, and hypothesizes how various combinations of these may impact knowledge sharing. Based on the exposed at the chapter 4 and 5 and the literature analysis[33] our proposal of analysis consists in four main types of classification for interactions:

[33] See: Santos, De Barcellos & Sauvée (2016)

- **Hierarchy: Horizontal or Vertical Interactions**
- **Reach: Unit or Cross-unit Interaction**
- **Nature/Mechanism: Formal or Informal Interactions**
- **Intensity: Frequency in which the Interactions occur**

Regarding the Hierarchy, several authors discuss its influence on what is called *Relational/Structural Embeddedness*[34]. It is argued that there are several advantages conferred by a structural embeddedness, provided most of the time for organizations with a strong hierarchy established, by manipulating the configuration of an actor's network of contacts. Among these advantages, those that come from having contacts who are more or less connected to each other have received perhaps the most attention. With this type of structure, the instrumental value to managers of having such sparse social networks accrues largely from privileged access to information and greater control over its use. These advantages should also enable mangers to create more value for their firm.

Moreover, a more horizontal and open hierarchy is related to *relational embeddedness*, one that establishes how much of the firm's potential will be realized. In other words, the quality of social interactions influences which of those resources that are within reach will be accessed, and to what extent. Although an actor may have access to several people who are potentially critical sources of information, personal experience and the quality of past interactions will often influence whom he or she is likely to approach and engage. In this sense, a firm with more soft hierarchy may enhance its interactions disregarding the difference among position levels, making possible that solutions emerge as results of free interactions within the firm.

Regarding the mechanism or nature of the interactions, the relation of formal and informal knowledge sharing might be exemplified, for instance, a strong corporate culture that stresses general sharing behavior (e.g. in the form of organizational behavior) may *substitute* (within certain ranges) for explicit incentive pay (formal incentive, formal interaction) for knowledge sharing. Formal organizational arrangements and informal organizational practices may be *complementary* to each other with respect to their impact on knowledge sharing.

[34] See MORAN, Peter. Structural vs. relational embeddedness: Social capital and managerial performance. **Strategic management journal**, v. 26, n. 12, p. 1129-1151, 2005.

For example, the effect of explicit incentives on knowledge sharing may be increased by the presence of a culture that accepts substantial pay differences across employees. On the other hand, studies have documented that formal organizational mechanisms (introducing extrinsic rewards in terms of payment) may act against existing informal patterns and practices (intrinsically motivated organizational members) and such a combination may destroy knowledge sharing behavior and cause irreversible, long-term negative effects on organizational behavior (OSTERLOH and FREY, 2000; ROBERTSON and SWAN, 2003).

As for the intensity, Indarti (2010) points out that the frequency of interactions might be a good indicative on how much innovative a firm can be. Although it is important to highlight that it is possible that the effectiveness of interaction have a decay level, which means that along the time if repeatedly without any space of a time the knowledge sharing might be compromised and give space to meaningless interactions with lack of information exchange. The same applies at intra-unit interactions, once that the knowledge inside the unit are easily spread, due to closeness it is safe to assume that a balance between cross-unit interactions and intra-unit might be necessary. We can also speculate that the use of instrumental-formal and expressive-informal communication to stimulate interactions can be explored as option to reach this desired balance.

We analyzed these dimensions in an Innovation process, a product development in each firm, we followed the suggestions of Tsai (2001), Singh (2004), Aalbers (2015) and Tsang (2015) as taking it a new product introduced to the market, and explore the whole development. To summarize, as for the intra-firm interactions, the dimensions are in the Table 9:

Dynamics of Intra-firm Interactions			
Type of Interaction (hierarchy)	Interaction Reach	Interaction Mechanism	Interaction Intensity
Horizontal	Unit	Formal	Frequency
Vertical	Cross-unit	Informal	

Table 9 - Dimensions of the Intra-firm Interactions
Source: Elaborated by the authors

We also established propositions for the intra-firm coordination according to each dimension of the interactions.

Type of Interaction: The type of interaction is important to verify how the coordination intra-firm is influenced by the hierarchy structure, it might be:

Horizontal - Same hierarchical level) or Vertical - Different hierarchical level

P1: Vertical Interactions plays a central role at the product development of HIF

Interaction Reach: According to Tsang (2015) the reach of interactions may define the knowledge flow along the units, it is divided as:

Unit - Interactions at the same Unit, or *Cross-unit* - Interactions between different units.

P2: Interunit interactions have a dominance in the product development of HIF

Interaction Mechanism: The Interactions may occur through two mechanisms:

Formal - By schedule and contracts or *Informal* - With no obligations

P3: Formal interactions are dominant on the product development of HIF

Interactions Intensity:

Frequency – Quantity of Interactions along time

The horizontal and vertical interactions are important to verify how the coordination intra-firm works along the hierarchy structure. As the reach of the interactions, Tsang (2015) argues that cross-unit interactions are important to guarantee the knowledge flow and access to all units, and in times this flow occur in an informal way by a single agent. To verify the existent mechanisms could help us to understand what a firm can make to assure that the knowledge will be available to all units. Finally, the interactions intensity will help us to verify how far the influence of these interactions goes to the innovative process of the agri-food SMEs.

We used the Brokerage roles presented at the chapter 5 to identify the interactions agents in each firm. Our main goal was to identify how particular mechanisms could influence the intra-firm coordination in firms that have innovation as its core, we expect that identifying these situations can help other firms and scholars to replicate it and enhance the innovative activities of other firms. In the next section, we explain the process of data gathering

6.6. Data Gathering

In this section, we present our methodological procedures for the data gathering. The data was collected along the year of 2015 and 2016, physically, in Brazil and France.

6.6.1. Instrument

We developed an interview script, semi-structured, based on the work of Tsai (2001), Indarti (2010), Aalbers (2015) and Tsang (2015). The result was the instrument with 24 questions related to the general characteristics, intra-firm interactions, the product development project and innovation. The instrument is presented at the Appendix I and two more complementary questionnaires at the Appendix II and II. First, we selected one of the firms to perform a pilot test with the Head of R&D, then we adapted our instrument and we were able to correct language, adapt the script and add two more complimentary questionnaires to properly collect all data need it. The Table 10 show the categories and the questions for the semi-structured script.

CATEGORY	QUESTIONS
Firm's characteristics	Questions 1 to 9 Example: Number of Employees, Units and Interviewed details
Innovation	Questions 10. to 10.5 Example: In the last two years, does your firm launched a new product or improvements to the existing ones? Describe.
Intra-firm Coordination	Questions 11. to 11.4 Example: Do all the units have knowledge about new products and improvements to products that the firm are working on it?
R&D	Questions 12 and 13 Example: How much does your firm spend in R&D?
External Interactions	Questions 14 to 20 Example: Does your firm cooperate/interact with other Firms?
Intra-firm Interactions	Question 21 Example: Would you describe information exchange among units in your firm as?
Innovation (Product Development)	Questions 22 to 22.3 Example: The general outline of the development project.
Interunit and Intra-Unit Interactions	Question 22.3 to 22.7 and 24 Example: How the information about the product development were passed to the firm's units?
Mechanisms for Intra-firm Coordination	Questions 22.8 to 22.11 Example: Have you used any specific tools for communication during the project?
Brokerage Roles	Question 23 Example: Can you describe the role of the main employees involved in the project?

Table 10 - Categories of the Interview Script
Source: Adapted from Indarti (2010), Aalbers (2015) & Tsang (2015)

6.6.2. Procedures

In this subsection, we describe all the procedures we used to perform our study. First, we describe our primary data, the observations, secondary data source, complementary questionnaires and finally the data analysis procedures.

6.6.2.1. Primary Data

The data was collect with the use of the semi-structured instrument presented at the section 6.6.1. The interviews were conducted in a safe environment, in loco, with the Head of the product development process from each firm. These interviews were recorded, translated and analyzed.

6.6.2.2. Observations

We performed observation in loco of the firms in this study, this was important for us to understand the mindset of the employees and to evaluate the products and firm's environment. In addition, during the period of the data gathering and data analysis, twelve months more or less, we followed the firms' reports, new products and activities in an online environment.

6.6.2.3. Secondary Data

As we analyzed the firm in a single specific project of product development, fortunately we were able to use documental analysis of the records done before, during and after the project. Some of the product development won awards and others were part of bigger research project, we used all the available data to better address our propositions and identify interactions agents. There were also video interviews about the product development processes. These interviews were also included at the analysis.

6.6.2.4. Complementary Questionnaires

As we felt the need for more data about the firms, we used the questionnaires that can be viewed at the Appendix B and C. These complimentary questionnaires, adapted

from the work of Indarti (2010) contain questions related to the interactions and knowledge flow during the daily activities of the firm and they content data important to support our analysis of their innovative processes and the product development.

6.7. Data Analysis

The data analysis in this thesis was performed by using content analysis and documental analysis. To treat the data, we used the software Nvivo 11 for windows. We used the technique of focus prompt to adapt the research question and In vivo auto coding[35] to analyze the nodes and find the categories. According to Bazeley & Jackson (2013) In vivo coding is the practice of assigning a label to a section of data, such as an interview transcript, using a word or short phrase taken from that section of the data.

Thus, for the results we used the case nodes and we linked them with our node classification, see Figure 16, to confront the results with our previously defined categories.

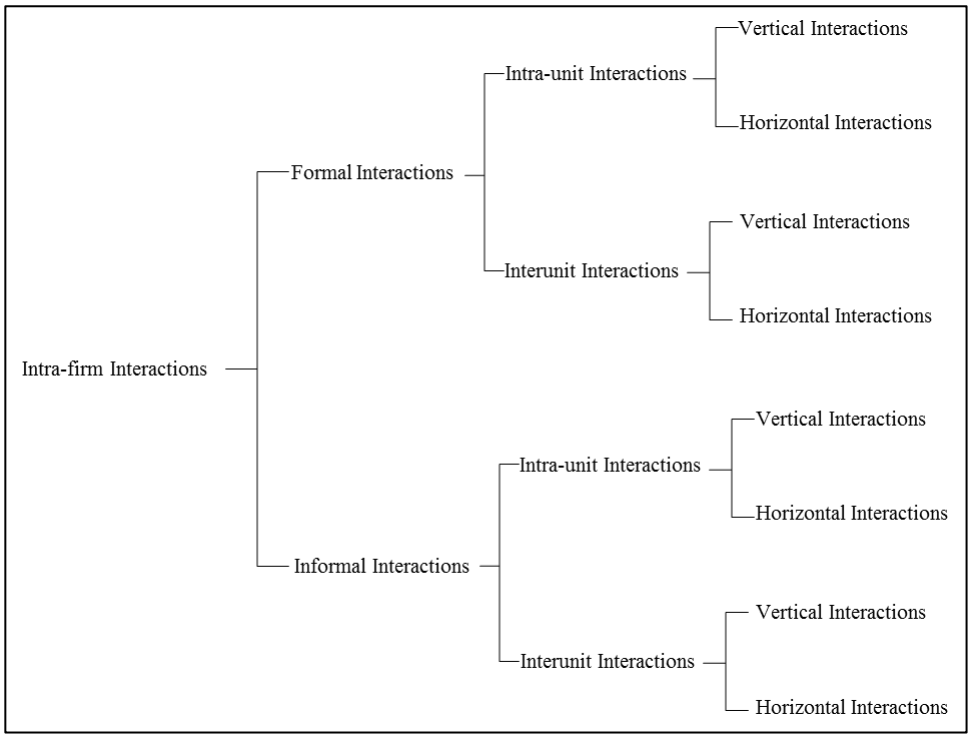

Figure 16 - Parent Node, Child Node and Categories.
Source: The author

[35] Automatically assigning relevant information to specified nodes. It is a way of reorganizing data for further analysis.

6.7.1. Content Analysis

The Content analysis is the process of organizing information into categories related to the questions of the research. Silverman (2000) argue that it facilitates the interpretive processes that turn talk into text. Research experts argue that these documents include more than transcriptions of interviews and other forms of talk. We performed the following procedures for the content analysis:

- Interviews
- Transcription
- Translation
- Validation by Reversal Translation
- Validation by Specialists
- Node analysis with Nvivo 11 software
- Sentences selection to present the results
- Proposition analysis

The result of the procedures is shown at the chapter seven. In the next subsection, we present how we performed the documental analysis.

6.7.2. Documental Analysis

As Yin (1994) and Stake (1995) argues document analysis is a method particularly applicable to qualitative case studies, intensive studies producing rich descriptions of a single phenomenon, event, organization, or program (Stake, 1995; Yin, 1994). We include here, Non-technical literature, such as reports and internal correspondence, as a potential source of empirical data for case studies as the case of this thesis. We sustain the use of documents and records in this study as Merriam (1988 p. 38) states that "*Documents of all types can help the researcher uncover meaning, develop understanding, and discover insights relevant to the research problem*"

We performed a systematic procedure of reviewing and evaluating documents—both firm reports and online documentation on the project (computer-based and Internet-transmitted) material. As an analytical method, as Strauss (2008) suggests, we examined and interpreted the data in order to elicit meaning, gain understanding, and develop empirical knowledge.

As we used two more complimentary questionnaires, the supplementary analysis, a more in-depth analysis of the firm's general interactions was only partially addressed in this study, thus, we considered as an undertaken material used for us to better understand each firm's characteristics.

6.8. Ethical Issues

As this thesis is the result of a cooperation between Brazil and France the data used here is available to the government of both countries. Although, the identity of the firms analyzed as well as the names and positions of the interviewed employees in both countries are confidential and subject to a Non-Disclosure Agreement (NDA), signed and valid in both countries.

7. RESULTS

Organization structures or mechanisms such as “total quality management”, “task forces” or even the new so called “reinvention” are considered at the mainstream as the holy grail to innovation. It appears that in the popular business world too much hopes are being placed in these mechanisms to the firms increase the performance and to succeed.

There is a perception that innovation come only from a single inventor or with single roots, As Penn (1999) argues the trend is for ‘Managers’ being replaced by ‘facilitators’, and staff are being trained in “self-management”. What we present as results, in this section, is a statement to firms support the idea of the development of corporate culture, conducive to the aims of an organization, rather than on enforcing firms through a hierarchy oriented management and formal mechanisms of interactions.

Although we use the traditional organization matrix to look at the firms and understand how they interact to generate innovation, it is important to understand that our results support a low-hierarchy intra-firm coordination form. Due to the online mechanisms, the intra-firm interactions are “virtual” oriented, we were able to clearly see the use of the new communications technologies to allow rapid response to a innovative business environment. Thus, each of the mechanisms and forms of intra-firm coordination we present here propose an isolation from the particular nature of traditional way that firms organize its work processes. The borders of the spatial organization of the tasks, and the workplace design are giving space to a much more flexible environment. Yet, it seems that the realization of new intra-firm coordination that gives the structure its forms, and in particular the interactions arrangements is being driven by practice and by need rather than the formal structures given by the theory.

In the next subsections, we present the characteristics of the firms and the product development project we used to perform the study and identify the intra-firm coordination mechanisms in the light of the theory of the interactions.

7.1. Context and the Product Development Projects

The Table 12 show the basic information on our sample. We call the firms A, B, C, D, E, F, G and H due to the confidentiality. The product development time duration varies

from 3 to 24 months and the unit involved in the projects vary from 1 to 6. Some firms used external partners and others developed the project all by themselves.

Firm	Country	New Product	Product Development Duration	Units Involved	External Partners
A	France	New Variation of Dry Mushrooms	18 months	4	No
B	France	Gluten Free Pasta	6 months	3	Yes
C	France	Crystallized Organic Sugar Cane	7 months	6	No
D	France	Fruits Reduction	12 months	2	No
E	Brazil	Pasteurized Whole Egg	6 months	3	Yes
F	Brazil	Lactose Free Milk	6 months	1	No
G	Brazil	Vitamin/Collagen	24 months	3	No
H	Brazil	Champagne Biscuit	3 months	3	No

Table 11 - Product Development Basic Information
Source: Elaborated by the authors

It is also important to mention that all the firms in this study export their products and invest at least 2% of their revenue in R&D projects. In the next subsections, we explore more characteristics of the firms and their innovative activities.

7.1.1. Firm A

The firm A was founded in 1853, the business encompasses activities regarding canned and frozen vegetables in Europe as well as with brands for the retail and food service circuits. The firm have a strong history of innovation. Although, only recently started participating in fairs, expositions and similar at a global level. Other interesting fact is that the firm is a multinational company but it does not have product development with units from other countries. Each firm from each country acts as if it was a different company.

7.1.1.1. Product Development Project – Firm A

Due to the problem with weather and transportation the firm A developed a project with a PhD candidate to develop a new variation of mushroom that could be dried and handle the transportation and packaging for enough time to be commercialized. The project lasted for 18 months and involved the units of R&D, Marketing, Logistics and General Management.

Along the entire project the information was centralized by the Head of the R&D unit and all the units had to present reports on the project status. Important information about the project:

- The Project had a clear structure: New Idea and Concept, Product Development, Packaging Development, Industrialization, Tests and Commercialization.
- Formal Interactions were dominant during the entire project.
- The idea and concept of the product was a result of informal interactions.
- The Head of R&D had more than 20 years of experience with innovative products and project development.
- The final product was a success and won two different awards, for packaging and innovation.

7.1.2. Firm B

The firm B was founded in 2010 due to lack of products for people with food restrictions. The firm produces gluten free and organic products, is composed by six units but the development of the product was entirely conducted by the R&D department and extremely centralized.

7.1.2.1. Product Development Project – Firm B

Due to an increasing demand for products that supply the customers with food restriction the firm B developed a gluten free pasta, unique for its proprieties a nutrition value. The project lasted for six months as an old product was used as reference to the new one. The project was conduct by the Head of R&D and involved only the R&D unit. The particularity was that an external researcher was hired specifically to this project, due to his unique capabilities. Important information about the project:

- The project had no clear structure as it was conducted by a single unit.
- The idea and concept of the product was a result of external interactions.
- The Head of the R&D launched more than 5 new products in the last year.
- An external researcher made his transition to the firm during the project.
- Formal interactions were used to help in the research transition.

7.1.3. Firm C

The firm C was founded in 1998 and at start was a firm developing Research and Development to big firms. After some years, in 2005, the result of the product development starts to directly reach the market, without other brands involved. The firm always worked in the "edge of the science" with state of the art equipment and researchers. The CEO of the firm is a Researcher himself but he moved to business position in the past five years, although he closely follow the process of the development of the new products.

7.1.3.1. Product Development Project – Firm C

In 2014 the firm C needed to import sugar cane to develop a new product. Although, raw sugar cane was costly to transport and it took much more time. It was verified that other firms from the same sector had the same issue, thus, the firm C decided to develop a crystalized sugar cane, that would serve for the purposes needed by them and for the other firms. The project development lasted for seven months once that the firm had previous know-how from past projects, however it was a big project it what concerns to budget and validation of the product. The CEO of the firm was directly involved and although he was not the main researcher he leaded the development. Important information about the project:

- The project followed the same structure as previous project.
- The idea and concept came from interunit interactions.
- The project leader had a low hierarchy level.
- Mostly the interactions were formal.
- Due to the deadlines stablished at the start of the project, six units were involved.

7.1.4. Firm D

For more than 25 years, founded in 1990, the firm D has been committed to provide the highest quality fruits, engaging in innovative activities at every stage of the production process until the deliver to the customers. With more than 40 new products launched in these 25 years the firm D have a collection of awards and news about its innovative activities and has a strong presence in the European market.

7.1.4.1. Product Development Project – Firm D

In this product development project, the Firm D enhanced its interunit interactions, both formal and informal, vertical and horizontal, in order to develop an innovative product not yet seen in the global market. The crystallized fruits were developed in twelve months and different from regular ones in the market the sugar added derived from raw fruit and no flavor, colorants nor thickeners or preservatives were added in the whole process. Also, more than 30 flavors, include exclusive ones were developed along the project. The project was leaded by two people and there was a unique hierarchical structure developed exclusively for the project. Both units worked in an innovative environment, created for the project, and as they were relocated during the whole period of the project, the interactions were coordinated by a designated supervisor that was not directly involved in the project processes. Important information about the project:

- A new temporary unit was created mixing two different units.
- The Head of R&D recognized interactions needed to be addressed.
- The project was initially an 8 months project but it was extended.
- CRM software used as tool to share the knowledge.
- The product received an award.
- A person was designated exclusively to coordinate the interactions.
- After the project two employees changed units, due to the good fit.
- The co-lead was stated as a success.

7.1.5. Firm E

After more than 40 years and through several investments, the Firm E built an ample and modern structure and became one of the biggest egg exporters in South America. In 2007, increasing its actuation at the market, invested on installing an industry of pasteurized eggs, with a modern project and quality control in full time. This is the result of high investments in technology, infrastructure and human resources, which are the recognize characteristics of Firm E. Nowadays, the company exports to more than 30 countries from Africa and Middle East, being the biggest producer of eggs from South of Brazil.

7.1.5.1. Product Development Project – Firm E

In 2016, the Firm E started the product development for a range of powder eggs, which uses the technology Box Dryer, creating a final product with the same properties as the “in natura” egg. After the development analysis, the Firm E stablished a separate unit from the other units exclusively to the development, creating an environment “innovation oriented”, and focusing on the interactions among the developers. The unit was settled in a technological park and the Head of R&D carried the project during its 6 months. Although, the other units of the firm were able to contribute for the development at any time by the use of a specific tool, a CRM software. Important information about the project:

- Hierarchy developed for the project.
- Cohesion at the intra-firm coordination.
- Product Development was broadly discussed inside the firm.
- Formal mechanisms used to share the information.
- The structure used for the project remains to new projects.

7.1.6. Firm F

Founded in 1967 the Firm F was created by the union of several producers that wanted to hold control of the industrialization of their products. The firm started as a cooperation of the Brazilian and the German government that invested to develop the know-how and allow the Firm F to succeed. As the opposite of the previous firms described here in this study the firm F has never engaged at innovative activities before the year of 2013 and only after that year they started the development of several products and this lead the firm to be awarded and launch four new products in the last 3 years.

7.1.6.1. Product Development Project – Firm F

In 2016 there was a growth in the Lactose free milk packaging and processes development in the Firm F. Due to the success of the lactose free products the firm decided to invest in the development of a lactose free milk with vitamin addition and in a special package. The project took six months to be developed and there was only a single unit involved in the process. Although the intra-firm coordination based on informal interactions allow the development to be a success. Important information about the project:

- Product development was faster than predicts, from 10 to 6 months.
- A single unit was developing the product.
- Informal intra-unit and interunit interactions were the core of the coordination.
- The centrality was the key during the whole development and allowed the firm to make use of the informal interactions.

7.1.7. Firm G

The firm G was founded in 1985 and it was initially a brand for natural products. Nowadays they produce and have a network of retailers offering products for different kinds of diets. The products developed by the company includes gluten free, lactose free, functional food, organic and the procedures for producing these products.

7.1.7.1. Product Development Project – Firm G

The firm G developed a vitamin based on collagen, gluten free, lactose free, sugar free with the objective of helping the strength of the muscles and the relaxing after gym. The product development was complex and involved 3 units during 24 months. The head of the project development was also the head of R&D and she used several tools to enhance the interactions during the whole project. Important information about the project:

- Highly complex product development project.
- Several tools used for the intra-firm coordination.
- Multiple mechanisms both to formal and informal interactions.
- Low influence of the hierarchy during the project.

7.1.8. Firm H

The firm H started its business in 2006 after one year of research to allow them to provide the best low fat and sodium products. Nowadays, the firm H produces more than

50 gluten free products and 40 lactose free. The company has in its core the constant search for innovation as it launches usually two or three new products per year.

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7.1.8.1. Product Development Project – Firm H

The product development started in 2015 and it took only 3 months to be completed. The firm H has an interesting system that rewards employees of any unit if they have an idea for a new product or to improve the processes, this mechanism was seen before in software companies such as Google, Apple or Microsoft and it is becoming a common practice. The product idea, Champagne biscuit proper for people with celiac disease came from an intern and its development was conduct by himself has his Bachelor project. There was 3 units involved in the project, Marketing, R&D and Sales. The intra-firm interactions were fully coordinated by the project lead (the intern) and the firm provide him with all assets needed to develop it.

- Independent centralized management of the interactions.
- Low relevance of the hierarchy
- Freedom for the Innovation
- The product received an award
- The development was planned for 6 months and finished in 3.

7.2. Types of Intra-firm Coordination

In the 7.1 subsection we presented the firms, the product development overview and basic characteristics on each project. In this section, we present what we found with our analysis. The nodes and categories revealed 3 types of intra-firm coordination for the innovative activities and 1 specific mechanism of intra-firm interactions used by mostly of the firms from our sample to enhance its interactions.

The first form of Intra-firm coordination was the Hierarchy Oriented Coordination, as the name says in this type of coordination the firms focus on the hierarchy to assure the product development project to be performed. The second is Interactions Oriented Coordination, firms here focus on the importance of interactions rather than the hierarchy, the individuals have a role that may vary according to their relevance in the project instead

of the position they occupy. The third for is called the Knowledge Flux coordination, it is a form of intra-firm coordination in which the firms organize a new structure to the development of the innovation, they settle the employees in the most comfortable position in order for them to interact and make the knowledge flow. It differs from the interactions oriented coordination because there is a change in the structure and in the positions occupied by the employees, rather than just ignoring it.

Finally, we present a mechanism seen in six out of the eight firms we analyzed. We suggest the name of the Gatekeeper Artificial Flow. Gatekeeper, because the role of the central individual in the mechanism is the Gatekeeper as pointed out in the brokerage roles, presented here in the chapter 5. Artificial, because it was not a natural movement but something planned and exclusively made to manage the intra-firm interaction and the flow is to characterized the "rotation" in the interactions caused by his or her actions. In the next subsections, we present the types of intra-firm coordination we found and the mechanisms.

7.2.1. The Hierarchy Oriented Coordination

In firm D and E, we found an extremely a similar type of intra-firm coordination, the pattern of interactions had the hierarchy as basis to the organizational structure used in the project. The top management had direct contact with the Researchers and the interactions jumped levels to centralized the knowledge at the upper hierarchical levels and the interactions happened mainly as formal interactions. Reports, meetings and emails were broadly used the head of R&D and the Head of the project. The Figure 17 shows the example of intra-unit and interunit interactions found in this coordination.

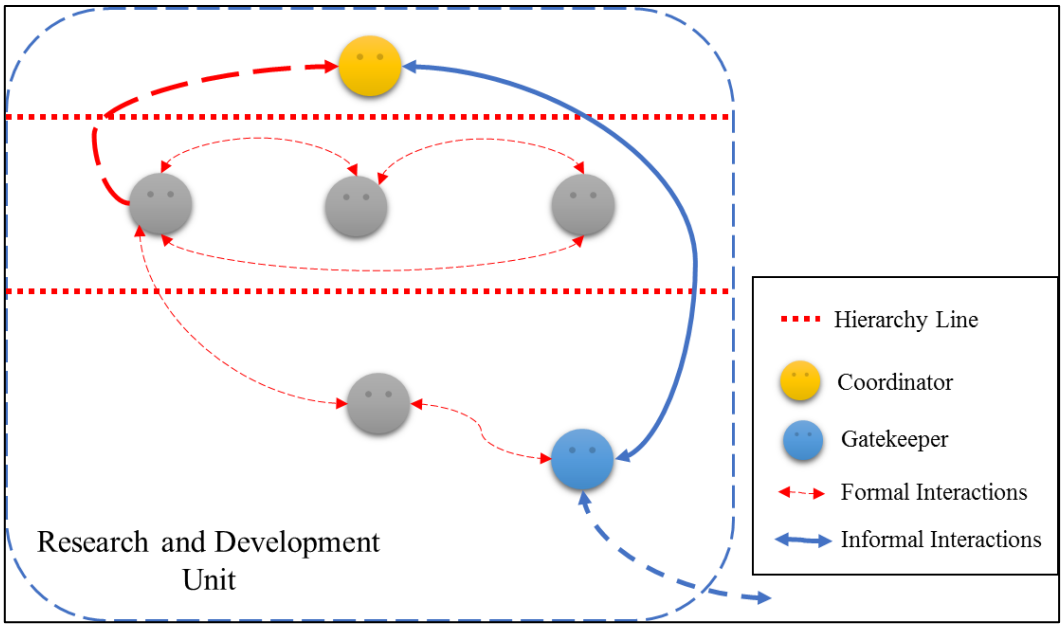

Figure 17 - The Hierarchy Oriented Coordination
Source: Elaborated by the authors

In addition, this scheme for interactions was found in four firms, but highlighted and stronger at firm D and E, that centralized the control of interactions to the Head of the Unit. Both companies were also the ones that exists only for innovating, since they were created as result of an innovative product. The literature of leadership and Entrepreneurism support this finding once the figure here, called the Coordinator (Aalbers, 2015) assume the leadership paper at the unit. The Gatekeeper was the lowest level position at both cases.

Firm	Responses
D	*"I am aware of our research development, as it is my job. I follow the researchers from close and I report the results and problems to the others in the unit, personally I ask them for feedback and suggestions, mostly by email, but we have a meeting (...) like, once per month to brainstorm and discuss issues"* *"(...) we learnt with the time that if we do not delegate someone to involve the right people to create for us the product is never finish, for that we always gather all the people involved and we talk to them for them to understand how we will proceed to proper develop the product (...) We always have all recorded so if something happen we know how to act"*
E	*"I controlled our product development from the start and I had to make reports to the board so I usually go direct in the source, ask everything and then I send the reports with copy to everyone, ideas are always welcome"* *"Even if I trust the people in the units and I do, when we have big project I believe I have to be more present and allow people to innovate, we never know from where the new big idea we will come from so if we have all the information about our project in ways that everyone can see it is better"*

Table 12 - Perceptions of the Project Leader on the interactions
Source: Elaborated by the authors

With this analysis, we bring back two of our propositions:

P1: Vertical Interactions plays a central role at the product development of HIF

P3: Formal interactions are dominant on the product development of HIF

As we seen in four of our sample firms' and highlighted by using D and E example, it is likely that formal and vertical interactions play a central role at the innovation, here represented by a product development project, in Highly Innovative Firms. The head of the R&D and the project in both firms admitted to use the same intra-firm coordination to all the products developed by the firms and considering the high success we found strong reasons to support both proposition 1 and 3. In addition we confirm that highly innovative firms have proper mechanisms for vertical interactions (among different hierarchical levels) and this results in an enhanced innovative process.

7.2.2. The Interactions Oriented Coordination

In this form of intra-firm coordination, the individuals with high hierarchical position were aware of the importance of the knowledge flow for the innovative processes. Thus, they proposed a similar intra-firm coordination model, in the cases of firms A, B and C. The interactions were centralized and then decentralized, in a movement bottom-up then up-bottom. Vertical formal interunit interactions were used to centralized the information and then vertical informal interunit interactions were used to decentralized the knowledge created. As for the intra-unit interactions, the firms had mainly informal interactions (vertical and horizontal) as they had no formal tools to manage the interactions at the intra-unit level. We can see an expression of this intra-firm coordination at the Figure 18:

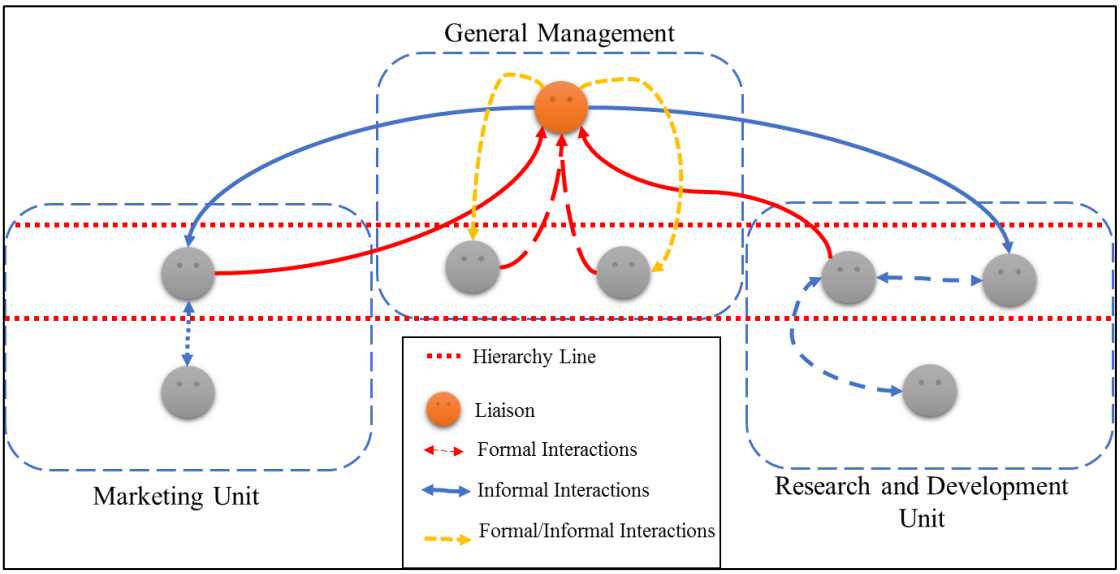

Figure 18 - The Interaction Oriented Coordination
Source: Elaborated by the Authors

We suggest that this type of intra-firm coordination emerged due to the fact that the firms A, B and C were aware they were having problems related to interacting. They all argued that they had the human asset but they were facing difficulties and not sharing among units. Formal mechanisms were stablished to solve the problem. Company B and C used reports and company A used round of emails and forum discussions at their software. We have here a Liaison acting to the management of the interactions. At the firm A, people knew they could use the software to provide insights on the product

development and were encouraged to do so but they only started using after it was imposed by the managers. A positive result was achieved but resistance to vertical interactions were faced. The Table 13 show us the analysis:

Firm	Responses
A	*"We realized we had a problem during the product development, we have a software where we put the updates on the new products and people can send suggestions, but they never used it, then we stablished that everyone should send their ideas and what they think it should be better, once each two weeks at least, then we start to having a dialog with people that were not used to work together but some complaint"*
B	*"(...) At some point, I started to ask all the people involved in the project to send me emails reporting how it was the development, it was funny because I had my box filled with crazy ideas and comments, which it was good, although it was too much things for me to put in a report or document/record in a cleaner way then I just went to talk with the people if I think something they sent me is interesting or valid to our scientists"*
C	"(…) I had to act during the development because some people were not talking to others, I don't know why, but the point is that I needed to go to them ask them questions and ask them to report things, then I call our researchers and set up a coffee to gather and discuss what it was sent to me, but it was a natural thing I guess, not everyone likes everyone"

Table 13 - Perceptions of the Project Leaders on the interactions
Source: Elaborated by the authors

With this analysis, we bring back the proposition 2:

P2: Interunit interactions have a dominance in the product development of HIF

The firms A, B and C showed us an intra-firm coordination oriented to the interactions. This form of coordination, however, was built due to problems in their interunit interactions. We found the same characteristic in six out of the eight firms we analyzed but the data is not clear in this sense, thus, with the evidence we possess it is not possible to confirm or deny the proposition two. Although, what we observed in all the firms of our sample is that firms use the formal vertical interunit interactions as the tie to enhance the innovative process.

7.2.3. The Knowledge Flux Coordination

The Knowledge Flux Coordination was found only in Firms D and G. This type of intra-firm coordination followed a sequence of interunit and intra-unit horizontal informal interactions to gather the information and formal vertical interunit interactions to spread the information. However, the firms adopted a unique new approach for their innovative activities, assigning a designated person to report the activities to the high managers in a formal interaction but gathering information by using tools for informal interactions. The Coordinator was a dedicated function and had a balance in interunit formal/informal interactions, the Gatekeeper was present in a key unit (marketing). It was present in both companies a figure called Itinerant broker, that worked floating between two units. The Figure 19 represent this dynamic.

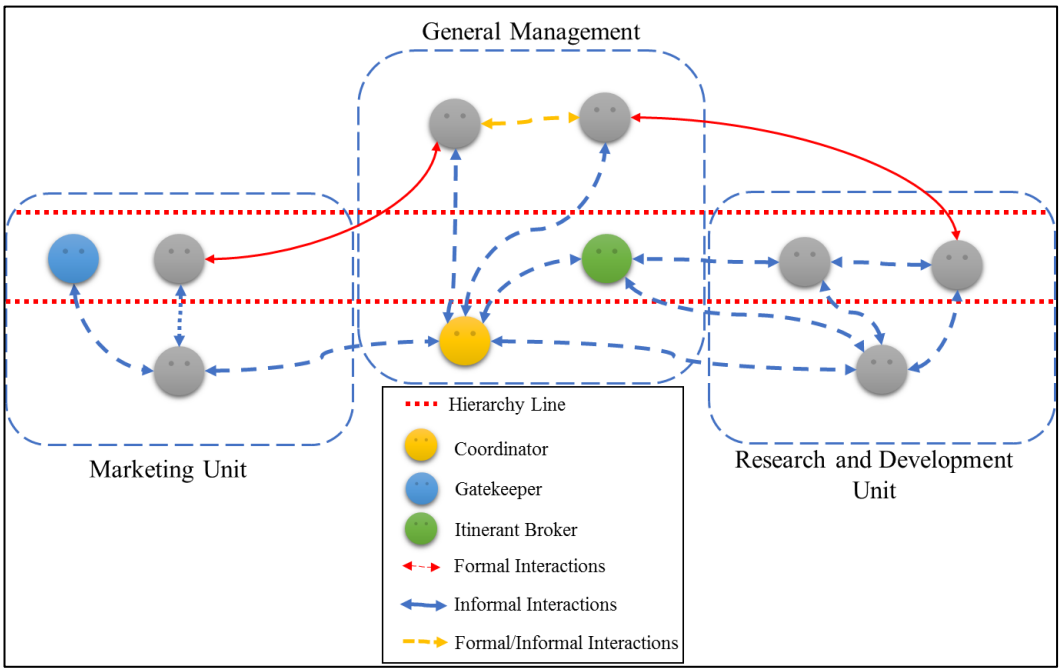

Figure 19 - The Knowledge Flux Coordination
Source: Elaborated by the authors

Intra-unit formal interactions were stated as not used, for both firms. Vertical informal interactions occurred with more intensity than formal. An interesting aspect was that firm G used tools for interactions that were not recognized by the firms as actual tools for intra-firm coordination, such as *WhatsApp* [36] and *Facebook*[37] groups. The units had

[36] See web.whatsapp.com
[37] See www.facebook.com

chat groups in both applications and used it every day during the product development in order to share the knowledge and general information concerning to the product and to related technologies. Here lies the insight for the study of Shadow IT[38] in the innovation context, many firms use these tools for interactions without proper acknowledgement and firm support, we suggest that future studies address this issue and that firms start to thinking new ways to incorporate these technologies. The table 14 shows the analysis, in the first sentences the Firm D shows us the Itinerant broker and the Coordinator. At the firm G analysis, we see mechanisms for interunit informal interactions (vertical and horizontal) and the tools they used to enhance their innovative activities.

Firm	Responses
D	*"We have a supervisor that is in charge of controlling the development, he follows the daily activities and report to us, our marketing delivers the tests with clients and I am always talking during coffee with members of R&D and other managers"* *"Particularly in this project we had an intern that was doing his management master thesis about the project, thus we used him to be like a "mailman" delivering the notes, information and following the project, it was really useful as it was easy for us to keep track of everything, he kind of act like the assistant manager for the project and it was working directly with all the units"*
G	*"We have the coffee together with others every Friday, our general manager is always telling us about the new products and works closely to the marketing as well"* *"(...) Ah, we have our whatsapp group for the company and also facebook groups, we know it maybe something that has nothing to do with the project but we use it to share news about technology, new discovers and regular daily stuff, sometimes business opportunities and new ideas come from the group and for sure makes our employees to think more because they love the group. There is the facebook group also, but they use more for each unit and they don't cheap chat, it is just people posting news and asking questions regarding work, our researchers sometimes run some pools to know people opinion"*

Table 14 - Perceptions of the Project Leaders on the Intra-firm Coordination
Source: Elaborated by the authors

With the analysis highlighted by using the case of firm D and G we can make a case for the use of specific tools for the intra-firm coordination. New technologies in the field of Information Technology emerge every day and firms that wants to innovate should understand the benefits they can have by using these tools. A proper intra-firm

[38] Shadow IT is a term often used to describe information-technology systems and solutions built and used inside organizations without explicit organizational approval. It is also used, along with the term "Stealth IT", to describe solutions specified and deployed by departments other than the IT department.
See: Silic, M., & Back, A. (2014). Shadow IT–A view from behind the curtain. Computers & Security, 45, 274-283.

coordination requires established mechanisms and mechanisms requires tools, finally tools require capable individuals to understand how to benefit from it.

7.3. The Gatekeeper artificial flow

The Gatekeeper Artificial Flow is a mechanism found in the firms H, B, G, and F. It consists in a mechanism that emerges when a gap or flaw in the intra-firm interactions is seen by the firm, causing the knowledge to not flow among certain units that are working together. This flow or gap can happen due to various reasons, thus, instead of rearranging the structure, changing the hierarchical positions of the workers, the firm designate a single individual to act as a Gatekeeper and address the gap. It is not a tool nor a type of intra-firm coordination, it is simply a mechanism used by firms to manage the interactions in specific situations.

It is considered to be artificial because as the Oxford dictionary defines, it is "*Made or produced by human beings rather than occurring naturally, especially as a copy of something natural*", and it is exactly what the Gatekeeper Artificial Flow is, a copy, adapted and enhanced of the natural role of a Gatekeeper, that is located among units by a manager, in order to overcome a certain interactions obstacle.

In the Gatekeeper Artificial Flow, the Gatekeeper have hierarchical freedom, he or she acts as an independent and chose his methods to solve the interactions gap. Here we saw examples of the use of an online informal tool (WhatsApp) and also formal ones like report, emails or meetings, it is the job of the Gatekeeper to understand the type of interactions that suits better the firm and that can solve the problem. It is important to highlight that all the individuals that were acting in this mechanism were individuals with high education level and with history in leadership positions.

We stand for the idea that the Gatekeeper should not necessarily have the role of conflict solving or mediator but rather the role of a facilitator an interactions agent that have as his only goal to make the knowledge flow. Thereby, it is important to notice as there is a behaviorist nature for the Gatekeeper role, that not all the firms have the human assets that fits perfectly the role of a Gatekeeper and individuals outside the firm probably do not possess the knowledge needed to develop the role. Thus, firms have to understand the role of the Gatekeeper, evaluate the individuals available to the role and verify if they

fit to the task, otherwise the whole concept of the Gatekeeper Artificial Flow will fail in what concerns to efficacy.

8. DISCUSSION

The dynamics of interactions had relevant changes at the analyzed firms. The scheme for interactions, although the departmental structure was basically the same, had several variations according to the human material available and to the way that managers thought the information would better flow. The model for the interactions used at mostly firms (six out of eight) were not planned, not designed and not implemented, was natural, it simply emerged and most of the times the firms were even not aware that they were managing interactions.

Recognizing the nature of the interactions and how to manage it may directly influence in the way the firms perform. All the interviews pointed out knowledge flow and communication as a problem, barrier and issue that should be addressed, some even mentioned attempts to do so. It is undeniable that managing the interactions requires a certain skillset. As showed, individuals with leadership skills tend to be able to spot the knowledge and make it flow by forcing it. We called this phenomenon here: The Gatekeeper Artificial Flow

Due to the artificial aspect, the Gatekeeper artificial flow may have a limited impact, if he or she is using formal horizontal interactions, people can start ignoring or not able to absorb or share the knowledge. In a practical example, too many emails a day may not be effective. A simple conversation addressing the pin points might have the same impact. The balance of formal and informal interactions is something that firms should be able to recognize and address it.

It was not found a single unit based only on informal interactions, as the management literature argues, since the work of Weber (1979)[39], it is not possible in the paradigm we live in. But since we can see a limit for both informal and formal interactions, firms should benefit if balance it and increasing both together. This should make the process natural for people.

It was possible to visualize some particular characteristics that varied according to the countries. The French HIF (Highly innovative firms) were able to acknowledge and address the interactions for intra-firm coordination in a natural way. We observed that the units in the French companies have informal interactions with more intensity during the

[39] See: DU GAY, Paul. In praise of bureaucracy: Weber-organization-ethics. Sage, 2000.

projects and the ideas were more valued that in the Brazilians. However, the Brazilian companies value the product development more, providing the units more assets after the idea and concept of the product is already conceived.

As stressed during this entire thesis, the hierarchy plays a central role in the interactions, but due to the characteristics of HIF it was not possible to visualize and exploit the results. The literature points in the direction that hierarchy may interfere negatively in the process, which means it can shrink the frequency and reach of interactions. As for what we seen in the firms from our sample, the formal interactions seem to have a peak, and after this peak it loses its value and does not add knowledge. Informal interactions seem to make it possible to surpass particular obstacles, and may come in hand at special situations.

8.1. The role of management sciences in the Innovative Process

Gloet & Terziovski (2004) describe knowledge management as the formalization of and access to experience, knowledge, and expertise that create new capabilities, enable superior performance, encourage innovation, and enhance customer value. The authors also describe knowledge management as an umbrella term for a variety of interlocking terms, such as knowledge creation, knowledge valuation and metrics, knowledge mapping and indexing, knowledge transport, storage and distribution and knowledge sharing.

Darroch & McNaughton (2002) indicate that knowledge management is a management function that creates or locates knowledge, manages the flow of knowledge and ensures that knowledge is used effectively and efficiently for the long-term benefit of the organization. In the authors' opinion, an organization that demonstrates competence in knowledge

A smart firm will enhance its innovative activities if they manage to provide a proper structure and tools to the right individuals and the brokerage roles, adapted and called here Interaction Agents are the perfect definition for firms to understand who are those individuals. The same goes to the typology of interactions we presented here. The firms that will mostly benefit from it are the one in which the top managers understand how to look to the individuals and identify the type of interaction needed for them the share their knowledge.

8.2. The Coordinator Role

As we mentioned before being a Gatekeeper is not appealing to everyone, and this goes for all the other roles of the interactions agents. Whether or not people emerge naturally and will perform as an interaction agent seems to depend on the characteristics of people and the context in which they work.

This thesis focused on the unit affiliation, types of interactions and the way that firms share its knowledge. The unit from which the person belong can affect its interests and considering that it is in the nature of the Gatekeeper, Itinerant Broker to filter the information before sharing it we argue that the Coordinator plays a central in this situation. It is his job to make sure the information reaches the desired destination.

Thus, it would be interesting to investigate whether individuals in the roles of Gatekeeper, Itinerant Broker and similar retain information and what could the Coordinator do to manage such type of situation.

8.3. Creating the environmental conditions

In all the cases, we studied there was a constant concern of the firms to create the ideal environmental conditions for the employees to innovate. In what concerns to the theory of interactions and the intra-firm coordination for several reasons understanding the importance of the environment is crucial. As Rice (1993) argues informal interactions such as face-to-face is important when tacit, non-codified knowledge needs to be transferred. As Nadler (2003) argues employees engage in inter-unit interactions, more frequently the more time they spent in inter-unit committees, teams, taskforces, meetings, conferences, and at world headquarters.

Our study converges with the findings of Ghoshal et al. (1994), the author found that interpersonal relationships, informal interactions, are developed through lateral networking mechanisms such as task forces and informal meetings, having in this sense, a positive effect on the knowledge flow. In the same line Bresman et al. (1999) argues that protracted modes of interaction such as technical meetings, are extremely important for the transfer of knowledge among units.

In the chapter five we mentioned the relevance of centrality and distance in what concerns to the interactions. In this sense, Plaskoff (2003) defends the importance of closeness at the knowledge share as the author stats that knowledge "*is socially constructed through collaborative efforts with common objectives or by dialectically opposing different perspectives in dialogic interaction*". Thus, extending the author's statement we argue that knowledge is indeed socially constructed, but the study of the interactions should be seen not primarily as the simple means for transferring existing knowledge, but rather as a necessary condition for the social production of new, unique knowledge, needed for the firms to innovate.

However, our results go against Adenfelt (2006), the authors state that "there will be no knowledge to transfer if there is no social interaction", for us this shows a fault line cause by the sender-receiver approach and social learning theory as the model is incapable of predict the central role given to the formal interactions, to keep track and records of the knowledge previously established so others can access without any need for social interactions.

Finally, we have to consider the development of new interactions technologies, with the concept of home office taking place and new ways to interact it would not be a surprise if firms find a way to reduce the importance of the workplace, even if dealing with high profile innovation projects.

8.4. The role of the artificial stimulus

Another aspect that we demonstrate with the firms from our sample was all the efforts the firms do to maintain their status as innovative firms; our findings clearly show that these firms focus to increase the number of innovation ideas created by their employees and they consider the possibility of interacting with other people a key factor that it should be supported and facilitated.

One way to enhance the chances of individuals increasing their interactions could be creating special spaces, meeting points where knowledge could be change regardless its nature. Innovation hubs are already a reality among entrepreneurs but a distant dream for most of the firms. The artificial stimulus plays a central role at the interactions as humans are not always willing to share their thoughts. Using idea generation techniques in projects and other groups, creating tools for formal interactions between individuals

from different units, and improving sharing of information and knowledge by other available means, such as online tools (WhatsApp, Facebook and others as we seen here) is something simple and that can provide the firms good results.

It is undeniable that, in order to increase innovation capabilities, managers need to provide the individuals and units the means to interact among them and with other units. The knowledge sharing should always be promoted but without destroying the innovation focus. However, whether it is more fruitful to formalize the interactions for ideation work or to try to use informal interactions in a subtler manner is a question that each firm should answer. We hope that our study provides firms insights in this matter, defining the interactions was a first step and showcasing the intra-firm coordination, at an innovation development, might help the firms to understand the power that the interactions have to manage the knowledge sharing processes.

9. FINAL REMARKS

There are several different approaches emerging around the themes intra-firm interactions and innovation, but the basis for the studies have in common studies such as Tsai (1998) and Tsai et al (1998). New possibilities as sociological applications and psychological, behaviorist point of view is also starting to be explored by the researchers. The entrepreneurial behavior and the intra-firm approaches are not commonly found. The use of the interactions in this thesis and the studies such as Aalbers (2015) with the social network analysis and Tsang (2015) with the brokerage roles show us that the scholars are searching for new ways to understand the intra-firm coordination for the innovation purposes.

Laukkanen (2015) highlight that the intra-firm coordination can be understood as a catalyst for the innovative activities inside the firm. The main concern is related to how to manage the intra-firm coordination for a better knowledge flow. The interactions shine in this sense, understanding how the dynamics of changing the way that the employees interact may make them more inclined to share their knowledge may be the solution innumerous firms were looking for. This thesis showed us that an important aspect of intrafirm coordination is to retain the knowledge flowing inside the firm by the use of key "interaction agents" like the coordinator and the gatekeeper. In this sense, what we called the "Gatekeeper Artificial Flow" (GAF) can contribute to firms overcome barriers in the intra-firm inter-unit interactions, making the units, in fact, interact and address the issues along the product development or innovative activity.

This thesis brings a few contributions on the matter of Innovation, Interactions and Intra-firm Coordination. First, showing the growth of interest in the subjects, in the last few years. This aspect is important mainly because the knowledge transfer within the organization were, as Carlile et al. (2003) pointed out as a "very much black box". Thus, the new trend may show us that this may change in the next few years, once that there are many new papers and the researchers are starting to look more into the organizations in an attempt to explain the innovation process.

The second is the review and the application of the theory of interactions to the management sciences and in an innovation context. The theory of interactions was drafted by Becker (1974) and vastly used at the sociology, economy and even psychology field but only recently it dragged attention to the management science, our review linked the

interactions to a part of the social network analysis by using the brokerage roles to classify individuals with a certain "pattern" of interactions. It is important to understand, as Gould (1989) points out, that the brokerage role, in this thesis, is not simply an inert epiphenomenon or artifact of social interaction, we used these roles to explore the relationship of the position of an individual and the knowledge flow he or she can provide. This relationship can be influenced by power, collective behavior and cultural aspects. So, the brokerage roles here are not just an explanatory variable but also a phenomenon to be studied and explained in its own right, thus, that is why we call it the "interaction agents".

The third and main contribution is the study performed. Highly innovative firms are not easy to be addressed by scholars, even more if we consider that these firms belong to the food industry. All the firms in this study had more than two products, new to the market, launched in the last two years, products that had a long time of research and development efforts involved in its conception. Unveiling what these firms do, regarding its intra-firm coordination, in order to interact and make the knowledge flow inside and among its units is something unique and we hope that the discussion in this thesis open the debate on the intra-firm interactions management and that, not just more studies emerge from it but also more firms can find its path to the innovation.

It is important to add that culture, institutions, social aspects and country of origin might have a high influence in the intrafirm innovation process, although, considering that in this thesis we worked with firms that were already established as highly innovative firms, it would be reckless from us to make any kind of assumption.

As for the particular challenges for the food sector, all the companies, from both countries mentioned that regulations are an obstacle for innovation, and the same goes for the government and associations, that were even characterized, by our sample, as institutions that most of the time "lack the vision" aside from really particular initiatives.

9.1. Study Limitations and Future Research

Contributions aside, this thesis have several limitations but also open doors to possibilities to future research. Here we discuss the main limitations and we point out some possibilities for future research.

9.1.1. Definitions

One of the limitations of this study is regarding the complex entangled definitions we work with. The concepts we worked come from different fields, therefore, have different definitions by different authors. We attempted to cover the most important authors and its definitions to all the concepts we used, however we recognized that some concepts are almost impossible to find a unique sense, considering that there is not a convergence in the ideas of the main authors. This was the case for the interactions, communication and knowledge flow, these concepts were broadly used in several fields and most of the time misconceptions were found within the literature.

9.1.2. Quantitative Approach

The second study limitation is regarding to the methodological approach. The qualitative methods allow us to deeply understand to phenomenon of intra-firm coordination and observe how our sample behaved during the development of the product, in the innovation context. However, the assumption, propositions and insights from our study apply only to similar cases, it is not possible for us to exploit the result to firms from other sectors and with different context, at different innovative levels. This is the main reason why we chosen to perform the study with highly innovative firms, we believe that the study of these cases makes possible for us to assume that the mechanisms and tools for the intra-firm coordination used by these firms might be an example that can be aimed for other firms that are not yet at the same level regarding innovation.

Although, a quantitative longitudinal study with a larger sample would allow the analysis of different hypothesis such as the influence of culture in the intra-firm coordination, the relation innovativeness x informal interactions or even aspects that we did not consider in this study. Thus, we suggest that the future research address the topic with different methodological approaches.

9.1.3. Absorptive Capacity

The absorptive capacity may be one of the most interesting aspects to be studied together with the interactions. Firms can have the perfect set up of intra-firm coordination but the absorptive capacity plays a central role in order to knowledge, in fact, be shared. Again, this was an aspect that made us chose our sample in cases that the innovation succeeded, but in firms where the product development or any other innovation related activity does not go well because of the knowledge flow, absorptive capacity might be

the reason along with the interactions. Studies exploring more this assumption could help us to better understand the intra-firm coordination.

9.1.4.Future Research

As for the future research we suggest, first, studies involving a broader sampling and more diversity of methods. Second, we expect firms to incorporate the mechanisms and tools cited in this thesis and be aware that intra-firm coordination can lead to innovation and to the solution of several daily problems.

Also, it would be beneficial to the theory crafting a proper systematic review on the themes here studied. There is a lack of a guide or map of the references on the literature of intra-firm coordination, the definitions are still unclear and the possibilities to new approaches shrink due to the lack of convergence by the authors.

One of the topics that recently gained strength in the field of innovation is the study of the innovation capabilities. In this sense, we suggest two paths to be followed. The first, the incorporation of the behavior approach to the innovation capabilities, interactions could be considered a matter of capability, thus, we suggest it as an aspect to be analyzed. The second is that each firm's capability could need a specific type of interaction to be developed, studies in this sense could help firms to understand better the relation interactions x innovation.

Finally, we suggest the use of social network analysis to address the topics, but not solely Social Network Analysis, since we consider it to be a tool of analysis and not a proper solution to the innovativeness of the firm, we suggest the social network analysis to support machine learning systems such as (Convolutional Neural Network) to completely scan the intra-firm interactions and come up with models to better manage it and suggest the application of mechanisms or tools for interactions when needed.

10. FINANCIAL SUPPORT ACKNOWLEDGEMENT

The financial support for the PhD candidate during the PhD and the support for the data collection was divided by the two countries that participated in the project.

- **Brazil**

This study was co-funded by CAPES (Higher Education Personnel Improvement Coordination) and the PDSE Program (Programa Doutorado Sanduiche no Exterior). Supported by the Innovation Research Center, NITEC and the Universidade Federal do Rio Grande do Sul in Brazil.

CAPES: http://www.capes.gov.br

UFRGS: http://www.ufrgs.br

NITEC: http://nitec.co

BRAZIL: http://www.brasil.gov.br

- **France**

This study was co-funded by UniLaSalle – Beauvais, former Institut Polytechnique Lasalle Beauvais and supported by the INTERACT research Unit. The French government provided all the legal structure for the work to be developed at the European territory.

UniLaSalle: https://www.unilasalle.fr

FRANCE: http://www.gouvernement.fr

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APPENDIX A

Interview Script – Part I

Date of Interview: ____ / ____ / ____

1. Firm`s name: _____
2. Country: _____
3. City: _____
4. Interviewed: _____
5. Position: _____
6. Unit: _____
7. Number of Employees: _____
8. Number of Units:
   8.1. ( )Marketing. ( ) R&D. ( ) Production. ( ) Human Resources. ( ) Finances. ( ) General Management. ( ) Logistics. ( ) IT ( ) Public Relations. ( ) Others _____

9. Does your firm export?
   9.1. If yes, what the % of exports: _____

10. In the last two years, does your firm launched a new product or improvements to the existing ones? Describe.

    10.1. If yes, these innovations were new for the market or only for the firm?
    10.2. If yes, these innovations were developed by the firm alone?
    10.3. If no, who were the partners?
    10.4. What units of your firm participate on these innovations?
    10.5. If more than one unit, how do they exchange information? And how frequent?

    Email, Formal Meetings, Informal Meetings, Software, Phone, Informal Meetings.

    Other? _____

11. Do all the units have knowledge about new products and improvements to products that the firm are working on it?

    11.1. If yes, how do they get to know about it?
    11.2. If yes, all the workers from the units have knowledge about it or only key personal?
    11.3. If no, could you point main reasons for this to happen?
    11.4. If no, could point barriers for this to happen?

12. How much does your firm spend in R&D?
13. How much does your firm spend in acquisition of new equipment/machines/software?

14. Does your firm have cooperation/interaction with Educational Institutions?

14.1. If yes, at what level? ( ) Local ( ) National ( ) Global
14.2. If yes, what is the role of your firm at this cooperation?

15. Does your firm cooperate/interact with Government Agencies?
15.1. If yes, what is the role of the firm in the cooperation?

16. Does your firm cooperate/interact with other Firms?
16.1. If yes, at what level? ( ) Local ( ) National ( ) Global

17. Does your firm externalize functions or units?
18. Does your firm utilize outsourcing?
19. The activities of R&D are developed inside or outside the firm?
20. Comparing with competitors how would rate your firm`s level of innovativeness?

21. Would you describe information exchange among units in your firm as?
(Use 1 to 6 to grade from the best fit to the worse fit)
( ) Natural. ( ) Frequent. ( ) Formal. ( ) Informal. ( ) Restricted. ( ) Non-existent.
( ) Other: _____

22. About the product development we are discussing, at your firm, please describe:
22.1. The general outline of the development project.
22.2. How the main idea emerged?
22.3. From the original concept, who were in charge of carrying the development?
22.4. Which units were involved at the product development?
22.5. How did you record the development of the product?
22.6. How the information about the product development were passed to the firm's units?
22.7. Do all the units knew about the product development?
22.8. Did you use any specific tools for communication during the project?
22.9. What were the main barriers?
22.10. What the firm learnt with this product development?
22.11. Do the interactions were a problem during the development?
23. How was the communication in each unit that participate at the product development?
23.1. Can you describe the role of the main employees involved in the project?
24. How is the communication among these units? Please describe.

APPENDIX B

Questionnaire – Part I

To help us understand how the interactions are being held inside your company, please mark the options that better describe the frequency and type of interactions in your firm. Use the scale:

Never	Annually	Monthly	Weekly	Daily

1) Does your company usually interact by these ways?
    a. Separate meetings for each unit?

Never	Annually	Monthly	Weekly	Daily

    b. Meetings with two or more different units?

Never	Annually	Monthly	Weekly	Daily

    c. Coffee Break with employees of the same unit?

Never	Annually	Monthly	Weekly	Daily

    d. Coffee Break with employees of different units?

Never	Annually	Monthly	Weekly	Daily

    e. Any other formal mechanism for interactions?

Never	Annually	Monthly	Weekly	Daily

    f. Any other informal mechanism for interactions?

Never	Annually	Monthly	Weekly	Daily

2) How does your firm usually interact with, mark more than one option if needed?

a) **Inside the same unit**?

Phone	Email	Software (BM, ERP)	Formal Meetings
Informal Meetings	Formal Reports	Internet (Website, Forum)	Other (Specify)

Other: _____

b) **Among different units**?

Phone	Email	Software (BM, ERP)	Formal Meetings
Informal Meetings	Formal Reports	Internet (Website, Forum)	Other (Specify)

Other: _____

c) **High executives and their units**?

Phone	Email	Software (BM, ERP)	Formal Meetings
Informal Meetings	Formal Reports	Internet (Website, Forum)	Other (Specify)

Other: _____

d) **High executives and other units**?

Phone	Email	Software (BM, ERP)	Formal Meetings
Informal Meetings	Formal Reports	Internet (Website, Forum)	Other (Specify)

Other: _____

e) **Executives and the board or shareholders**?

f) Phone	Email	Software (BM, ERP)	Formal Meetings
Informal Meetings	Formal Reports	Internet (Website, Forum)	Other (Specify)

Other: _____

g) **Is there an open way to interact common to all the employees**?

h) Phone	Email	Software (BM, ERP)	Formal Meetings
Informal Meetings	Formal Reports	Internet (Website, Forum)	Other (Specify)

Other: _____

APPENDIX C

Interview Script – Part II

To help us understand how the interactions are being held within your company, please mark the options that better describe the frequency and type of interactions with stakeholders in your firm. Use the scale:

Never	Annually	Monthly	Weekly	Daily

3) Does your company usually acquire information with?

a. Buyers?

Never	Annually	Monthly	Weekly	Daily

b. Suppliers?

Never	Annually	Monthly	Weekly	Daily

c. Competitors?

Never	Annually	Monthly	Weekly	Daily

d. Consultants?

Never	Annually	Monthly	Weekly	Daily

e. Government offices and agencies?

Never	Annually	Monthly	Weekly	Daily

f. Industry Associations?

Never	Annually	Monthly	Weekly	Daily

g. Religious Affiliations?

Never	Annually	Monthly	Weekly	Daily

h. Research Institutions?

Never	Annually	Monthly	Weekly	Daily

i. Exhibitions?

Never	Annually	Monthly	Weekly	Daily

j. Magazines/Newspaper?

Never	Annually	Monthly	Weekly	Daily

k. Television?

Never	Annually	Monthly	Weekly	Daily

l. Radio?

Never	Annually	Monthly	Weekly	Daily

m. Internet?

Never	Annually	Monthly	Weekly	Daily

4) How does your firm usually interact with, mark more than one option if needed?

i) **Customers**?

Phone	Email	Software (BM, ERP)	Formal Meetings
Informal Meetings	Formal Reports	Internet (Website, Forum)	Other (Specify)

Other: _____

j) **Suppliers**?

k) Phone	Email	Software (BM, ERP)	Formal Meetings
Informal Meetings	Formal Reports	Internet (Website, Forum)	Other (Specify)

Other: _____

l) **Competitors**?

m) Phone	Email	Software (BM, ERP)	Formal Meetings
Informal Meetings	Formal Reports	Internet (Website, Forum)	Other (Specify)

Other: _____

n) **Consultants**?

o) Phone	Email	Software (BM, ERP)	Formal Meetings
Informal Meetings	Formal Reports	Internet (Website, Forum)	Other (Specify)

Other: _____

p) **Government**?

q) Phone	Email	Software (BM, ERP)	Formal Meetings
Informal Meetings	Formal Reports	Internet (Website, Forum)	Other (Specify)

Other: _____

r) **Industry associations**?

s) Phone	Email	Software (BM, ERP)	Formal Meetings
Informal Meetings	Formal Reports	Internet (Website, Forum)	Other (Specify)

Other: _____

t) **Research Institutions**?

u) Phone	Email	Software (BM, ERP)	Formal Meetings
Informal Meetings	Formal Reports	Internet (Website, Forum)	Other (Specify)

Other: _____