DOCTORATE in BUSINESS ADMINISTRATION

Stefan Lettig

INFORMATION ACQUISITION AND KNOWLEDGE CONVERSION: TOWARDS A ROUTINIZED INNOVATION PROCESS

Date of defense: **30 September 2020**

Thesis supervised by: **Prof. Caroline Mothe**
Université Savoie Mont Blanc, Research Supervisor

Thesis jury:

Prof. Nathalie Mitev
Busines Science Institute, Assessor 1

Prof. Martin Cloutier
Université du Québec à Montréal, Assessor 2

Prof. Isabelle Walsh
Skema Business School, Jury President

Prof. Michelle Bergadaà
University of Geneva, Suffragan

DEDICATION

To my parents Meta and Luciano and my daughter Michelle

ACKNOWLEDGEMENTS

A number of people deserve a special word of thanks: Professor Caroline Mothe, Professor from the Institut de Recherche en Gestion et en Économie of the Savoie Mont Blanc University and Professor Michel Kalika President of the Business Science Institute, for providing me with one of the finest academic opportunities I could ever think of. Finally, many thanks to all respondents that took part in the study and enabled this research to be possible.

This thesis, being straight forward with appropriate logical argumentation and structure, could not have been written without the supervision, guidance and support of Professor Caroline Mothe.

As my supervisor, Professor Caroline Mothe provided me with her valuable and extraordinary academic guidance to bring this thesis to a successful viva. She was always ready to listen and advise me in my 'struggle' and broad and unstructured dilemmas. For this I am deeply grateful to her.

ABSTRACT

Innovation entails a series of complexities for both companies and customers. Companies can be unsure about the best way to develop and market innovations, while customers may be unsure if they want to accept innovative products and services, as it may mean changing their consumption patterns. The literature states that interactions with customers and employees support innovation; however, the mechanism that enables it is still not explained. This research examines the information acquisition process of customer and employee involvement, in order to better explain how it influences the development of innovation.

The primary data is collected through extended interviews with innovation managers in three case studies (two retrospective and one ongoing innovation) and nine expert information interviews. Inductive coding is the way in which this information is examined, in order to determine repeating patterns and theoretical concepts. Detailed coding of the interview data reveals a set of seven recurring activities within the information acquisition process that represent different types of customer and employee involvement. These activities are: Brainstorming, Structuring Problem, Collecting Data, Reflecting Information, Exchanging Knowledge, Filtering Knowledge and Feedback. External Benchmarking is considered as a complementary activity. The activities are then used as inputs for modelling feedback loop diagrams. In this way, an emergent theoretical model based on feedback loops is constructed. The model structure was tested through 5 final interviews: 2 professors from the field and 3 innovation practitioners.

Innovation is not considered to be something that can be achieved in a fixed number of steps. Earlier generations of innovation models have tried to illustrate this and have been called out for presenting a heavily simplified reality. Instead, this study uses feedback loops to illustrate the relation between the activities. The probability to obtain innovation is not specified, as it depends on the specific business environment and instead more general principles are presented. The contribution of this study is that it specifies the activities of customer involvement and employee involvement required to obtain information and convert it to knowledge.

The distinction between information and knowledge is also presented and used throughout the study, as information becomes knowledge only after it has been sorted and turned in a useable form by the company. The tacit knowledge of employees is a valuable resource for the company and if it is converted into explicit knowledge, it can contribute to improving the policies and procedures of the company. Customers can also have tacit knowledge, as they are looking for a very specific product or service and this can contribute to increasing the knowledge store of the company.

This study contributes with new knowledge about the information acquisition process of customer and employee involvement, hereunto the theory of innovation processes. It also has practical considerations that firms must take into account when making innovation a central aspect of their business objectives.

PREFACE

This research journey was of particular interest to me because it provided me the opportunity to conduct empirical research on the mentioned area of interest. As a senior business executive, I am equally interested because this research also provided me with relevant knowledge on how to advise firms and managers to collect and manage knowledge to be used in the development of innovations.

OUTLINE OF CHAPTERS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

This chapter contains the following sections: research area of interest, problem statement, research approach, thesis contribution and the outline of the document which concludes the section.

There is a vast amount of literature regarding the concept of innovation. The successful launch of innovation appears as a determinant for a firm to achieve high profit margins, and to gain or maintain competitive advantage (e.g., Rosted, 2005). Factors such as price competition, research, new technology and newly discovered user needs all relate to successful innovations (Rosted, 2005). Gopalakrishnan and Bierly (2001) reveal the causal relationship between organizational performance and innovation and, in line with Leifer et al. (2000), argue that innovations have the potential for "unprecedented performance" (p. 102). While innovation can lead to performance, the unknowns and difficulties of innovation impede a firm's ability to achieve it and affect its business performance (Leifer et al., 2000). The reason behind this is that innovations are often complex (Leifer et al., 2000; Morone, 1993). This confuses and unsettles firms which, in many cases, are confronted with uncertainty and evaluate possible innovations using traditional methods and criteria which is, overall, a costly process (Leifer et al., 2000). The problem is that managers do not understand how to infuse their organizations with the innovative practices of agile startups (Leifer et al., 2000). Innovative companies are those whose corporate strategies, practices and philosophies are shaped by technological opportunities (Morone, 1993). While innovators may be unsure about the performance, parameters, attributes, and features of new technologies, customers may not recognize an innovation's advantages or may lack confidence in the functionality of innovative devices. Potential customers may feel overwhelmed because innovations have no established place in their preferences, even if they claim to deliver improved quality or multiple applications of innovation. Maintaining a technological advantage thus depends on how well a firm can incorporate the customers' perspectives into its innovation development process (Zhou et al., 2005; Dutta et al., 1999).

To enhance the success of an innovation, Von Hippel (1988) suggests focusing on customer involvement. Alongside this, the literature (Kanter, 1997; McQuarrie, 1993; Souder et al., 1997) shows that acquiring customer knowledge improves or adjusts a firm's own technological knowledge, and that customer (Tajeddini, Trueman and Larsen, 2006; Herrmann, Gassmann and Eisert, 2007) and employee involvement (Ordanini and Parasuraman, 2011; Engen and Holen, 2014) improves the development of innovations.

Lynn et al. (1996) argue that "conventional market analysis" is not sufficient for the development of innovations, because there is simply no information available on the market. This is especially noticeable in the case of radical innovations, as they require a new technology or a new market strategy. Therefore, the information needs of innovators cannot be found in the market, because they cannot be expressed by customers. This missing information is referred to in the literature as an "information defect" (Spender, 1993; Mullins and Sutherland, 1998), which generates unknowns and difficulties for developing innovations.

Customer orientation is a group of actions taken by a business to make the needs and requirements of the customer their main priorities and assign its sales department and its employees to this purpose (Racela, 2014). As opposed to the concept of customer orientation, customer involvement refers to interacting with the customer to a greater extent. Customer involvement is a direct communication with customers that allows observing the problems encountered by customers when using products, services or technologies (Leonard and Rayport, 1997).

Customer collaboration is the process of creating new products and services with the support of the customers (Greer and Lei, 2012). The study chooses the term customer involvement to describe the interaction with customers. When customer involvement is set in an innovation context, it is similar to customer collaboration as defined by Greer and Lei (2012). As the topic of the study is centered on innovation, both concepts can be included.

If employees are involved in the innovation process, this can result in its improvement (Ordanini and Parasuraman, 2011). The possibility of employee idea collaboration is related, to a certain extent, to innovation (Engen and Holen, 2014). Some companies empower their employees to be product champions and create promising, complex and new products and services (Howell and Higgins, 1990). The group of employees delegated to researching innovation must accumulate knowledge, in order to understand the target phenomenon well enough to articulate and codify it (Zollo and Winter, 2002).

In order to surpass the information defect, the company must obtain the necessary missing information. An information acquisition process can to do that. The information should be collected from customers with the help of employees. The approach to include customers is customer involvement that allows direct interaction with them. The skill of the employees determines the quality of information that is obtained. The customers and employees have an approximately equal contribution to the information acquisition process.

The major focus of this research is on the information acquisition process that supports the development of technological innovations. The next section will discuss the research area of interest.

1.1 RESEARCH AREA OF INTEREST

Innovation can be examined from an innovation as output or the innovation process perspective. Innovation as an output is based on the capabilities and factors that influence the output of the company. Relevant capabilities can help a company launch a new product to market (Zander and Kogut, 1995). The capabilities can also refer to the efficiency and quality improvements that help to ensure that products respond to customer needs, while reducing development costs (Nair, 2006). Seeing innovation as an output has the drawback that it focuses on identifying antecedents of factors that allow a company to innovate. The factors or inputs that influence innovation are not outlined extensively, as firms with similar inputs can produce significantly different outputs, depending on how they are managed or organized.

Innovation as output has some drawbacks, as it is focused on identifying antecedents or factors that determine a company to excel at innovation. In this way, there is no focus on the internal processes of the company, as innovation is simply an independent variable, determined by a number of factors. Even if these factors come from the company, this remains a linear causality linkage, whereby any company that has these factors is in a position to innovate, which does simply not conform to reality. Companies with similar inputs can produce significantly different outputs, depending on how they are organized or managed.

Considering innovation as output also has the drawback that is a results-oriented approach. Studies that examine innovation will use documented innovation cases in specific companies but other companies which have the potential to innovate will be ignored. From a certain viewpoint, this is excusable, because there are a lot of methodological difficulties when studying companies with potential to obtain innovative products. One is the size argument, as a great number of innovative companies have to be included in the research. Another is the time argument, as some companies can take up to a decade before obtaining an innovative product.

The innovation as output perspective is related to variance theory which is a linear approach. A significant drawback is that variance theory does not handle nonlinear dynamics well, along with the complexities of innovation. The results are also dependent on the context from where the data were initially collected. Because of the mentioned drawbacks, we thus chose to concentrate on innovation as a process. The process perspective deals with the emergence, development and change of an innovation carried out inside the company. Innovation as a process can explain the mechanism behind innovation, considering all the stages, dynamics and actors involved.

Process theory has the advantage of considering the order in which events unfold and the influence of groups of events and contexts (Poole et al., 2000). In process theory, process means a sequence of events that is indicative of the evolution of the considered subjects (Van de Ven, 1992). Based on the chosen approach, the events can be supported by a narrative which can offer a more thorough understanding of the subject (Garud et al., 2014). The processual interpretation of innovation was considered to be a suitable approach for the study because of these advantages. Of all the studies that consider innovation as a process, none were found that identified a clear process for innovation development and management that considered information acquisition (Gupta et al., 2007).

Process means a sequence of events that is indicative of the evolution of the considered subjects (Van de Ven, 1992). The present research uses the same definition for process. It considers the internal processes of innovation development of the company. The innovation cycle is enabled by resource investments and the organizational structure of the company and unfolds in a setting that is shaped by internal focus and institutional rules (Van de Ven et al., 2000). A process theory uses the same definition for process to reach the precision to tell managers exactly what to do, but it can produce some principles to explain a broad class of paths and sequences that are useful to manage innovation (Van de Ven et al., 2000).

The research area of interest is to identify the mechanism of how innovation development works at the activity level which is the operational level where information from customers can be obtained. The purpose of the study is to routinize part of the innovation process that corresponds to information collection and determines the activities conducive to this purpose. The advantage of routinizing innovation is that companies already have routines in place to carry out operational activities, so it can be shown that performing the routines leads to their change and clears a path toward innovation. The study does not attempt to routinize the entire innovation process because that would be a simplistic approach to an activity that requires collaboration between customers and producers, cooperation between departments and creativity. Routines are important as they show how the first part of the innovation process is organized. The seven routines or iterative activities identified in this research are: brainstorming, structuring problem, collecting data, reflecting information, exchanging knowledge, filtering knowledge and feedback.

The concept of co-innovation is also important to consider, as this research is focused on obtaining innovation with the support of the customers. Co-innovation is a form of collaborative innovation and consists of the shared work of creating innovative design ideas conducted by customers, companies and partners (Baldwin and Von Hippel, 2011). This notion challenges the view that innovation is based on the producer and allows other possibilities and avenues of research as the interaction between the company and stakeholders can result in new outputs that can change the market structure and characteristics in a significant way.

Knowledge is central to successful innovation development (Darroch and McNaughton, 2002). Knowledge management has been recently linked with creativity, interpreted as a capability that results in new knowledge and can support the innovation process (Kazanjian and Drazin, 2012). Creative tasks encourage cooperation and require knowledge to be shared (Kazanjian, Drazin and Glynn, 2002). Although knowledge is important for the creation of innovation, it is not the first step. The initial step of the innovation process is the collection of information through various activities of the company. The activities illustrate that there are multiple ways to collect information and several routines accomplish that.

A number of other approaches can be identified that describe how knowledge can influence innovation. One is the inbound innovation approach, through which a company increases its knowledge base by incorporating outside knowledge through external relationships (Li-Ying, 2016). It has also been documented how this inbound open innovation is a driver for different typologies of environmental innovation, such as compliance versus voluntary innovation and market versus production innovations (Li-Ying, Mothe and Nguyen-Thi, 2018). This approach considers that the possibilities to innovate are placed outside the company's boundaries, as they search for new knowledge to combine with their existing technologies.

This is certainly a valid approach that is supported by a considerable stream of literature; nevertheless, this research considers innovation as something that happens inside company boundaries. The company can collect data and information from the outside, but the main aspect is to identify how a company obtains knowledge internally.

Inbound innovation is defined as “a process of acquiring or sourcing, such that the firm discovers, acquires and uses information or resources developed by external partners” (Mothe, Nguyen-Thi and Triguero, 2018). It can be classified in three separate modes of openness: acquiring, sharing and sourcing. The influence of the three categories on environmental product and process innovations has been investigated in the literature (Mothe, Nguyen-Thi and Triguero, 2018). Acquisition refers to purchasing technology or external R&D from the market, sharing consists of collaboration with other companies to gain skills or knowledge and sourcing describes the extent to which companies can use external information sources or search for freely available external ideas or knowledge.

Innovation sourcing is the category that is the closest to this research, as customers are an important market source. It can be argued that sourcing is more related to obtaining information as opposed to knowledge, because of its non-pecuniary nature. This is different to simply purchasing knowledge such as a new technology or contacting another company to conduct R&D. The customers also contribute with information as opposed to knowledge, as their feedback has a low degree of complexity and it has to be integrated by the company in order for it to be usable.

Data are collections of symbols and signs that are useful only when turned in a practical and applicable format (Rowley and Hartley, 2006). Information is the resolution of uncertainty and states what an entity is, the nature of that entity as well as the essentiality of its properties (Bateson, 1972). Knowledge is an intangible asset, has no boundaries, is context-specific and carries value only if used at the right time and place (Nonaka and Konno, 1998).

The research considers data, information and knowledge as separate concepts. Data simply describes the quantity or quality of an object or phenomenon. Information consists of organized and structured data that have been processed so it has relevance for a purpose (Rowley, 2007). Information becomes knowledge when it is connected to a specific human context (Alavi and Leidner, 1999). This research examines innovation starting with the collection of information and data and not knowledge management. The concept of knowledge management is important and is included in this research but is an intermediate step in the innovation process.

Information can be converted to knowledge by the company by assigning it to a specific context and linking it with an organizational, administrative or economic purpose. Information has to be integrated by the company and also be of some use in order to be turned into knowledge (Hayes and Walsham, 2003). In the context of innovation, knowledge management becomes the mechanism through which valuable corporate assets are created and maintained (Booker et al., 2008). Because knowledge is connected to a specific context or human experience, it has greater applicability and is easier to put into practice.

The information acquisition process that supports innovation is designed in this study to have two important components: customer involvement and employee involvement. This classification is not exhaustive, and its reasoning is found in literature. A direct interaction with customers allows identifying unanticipated or latent needs by

observing the problems encountered by customers when using existing products, services or technologies (Leonard and Rayport, 1997). Indeed, companies often involve customers in innovation development (Da Mota Pedrosa, 2012).

There are studies that state the importance of involving employees in the innovation process (Ordanini and Parasuraman, 2011). The employees that are likely to support innovation are those who interact directly with customers and know how the product and service offerings are perceived by the market. There are several ways to involve employees in the innovation process. Employee idea collaboration is related to innovation (Engen and Holen, 2014). There is also the model of Sundbo and Gallouj (2000), where innovation in services is accomplished by employees acting as corporate entrepreneurs with management supervision. The literature has examined how a skilled workforce supports innovation (Tellis, Prabhu and Chandy, 2009).

The next section will elaborate on the problems companies encounter when confronted with innovation, arguing that the information defect plays a major role for both the customer as well as the innovator.

1.2 STATEMENT OF PROBLEM

There is no innovation development model that starts from the information acquisition stage as most are centered on knowledge without detailing how it is transformed or obtained. There are studies, such as Lawer (2005), that examine how customer knowledge management influences new product development. If the innovation development process is examined from the information acquisition stage, there is the advantage of determining the activities of information collection that show how it is carried out and explain knowledge conversion.

The gap in the literature is that while there are plenty of studies that outline the benefits of involving the customer in innovation, there are only a few that state how this can be achieved, one of them being Greer and Lei (2012). Customer involvement can be simple, such as surveys or interviews, or more complex, such as including lead users with technical knowledge in product development. There is no statement of how simple activities of customer involvement can be routinized and contribute to the innovation process.

A wide variety of literature focuses on the importance of drawing in knowledge from customers, innovators and other stakeholders in order to increase the volume of depth of the input of innovation cycles (Sanchez and Mahoney, 1996; Goh, 2005). Product and organization design can benefit from customer involvement as it allows a new approach to knowledge management and organizational learning (Sanchez and Mahoney, 1996). Innovation management should introduce concepts on how to harness knowledge management practices for new product development processes (Goh, 2005). This study explains that customers, innovators and other stakeholders are sources of information and not knowledge and this information first has to be collected, stored and organized in order to ascertain its relevance.

The Nonaka model of knowledge conversion is well established, and its acceptance of dynamism is very suitable in the context of innovation (Nonaka and Takeuchi, 1995). A model of innovation could use it as a reference but also state that there are multiple sources of information feeding into the innovation cycle. The second addition would be to recognize that these sources are not only visited once but repeatedly through the development of innovation and this iterative process can be explained with activities.

Another model of knowledge conversion is represented by the continuum between tacit and explicit knowledge (Nonaka and von Krogh, 2009). Explicit knowledge is objective, rational and it does not depend on context, while tacit knowledge is subjective, experiential and depends on context. In this study, knowledge conversion refers to how information is adapted and interpreted in order to become knowledge and is concerned with the change from tacit to explicit knowledge only in the case of employees, to a lesser extent.

Tacit knowledge can be considered an important asset of the company as it takes a long time to collect it and cannot be easily converted into an explicit variant. Competitive advantage can be obtained from tacit knowledge which can be classified as: conscious, automatic and communal (Spender, 1993). The impressive returns of rapidly changing markets are counterbalanced by a significant level of risk. The involvement of prospective customers in new product development lowers this risk by uncovering consumer needs and market opportunities (Mullins and Sutherland, 1998).

Vaccaro, Veloso and Brusoni (2009) examine the organizational knowledge creation process in two virtual teams that are developing products. They use Nonaka's SECI model of knowledge creation to identify how virtual knowledge processes allow new ways of individual and organizational knowledge creation. Virtual technologies allow not only knowledge codification but also the transfer and creation of new knowledge. This study is also based on the Nonaka model; however, it simply considers it a starting point and then departs from it by including an information collection process and activities of customer and employee involvement.

There is also the question of whether knowledge influences innovation or innovation influences knowledge. It is true that knowledge influences innovation as recombining and extending existing knowledge allows companies to take advantage of opportunities in new areas, often outside their industry (Kazanjian and Drazin, 2012). Customer knowledge management also leads to increased creation value and higher innovation capabilities (Lawer, 2005). The opposite is also true that innovation influences knowledge. Knowledge is not gleaned from the customers and other sources once at the beginning of the process, as the innovation process becomes iterative and knowledge is reused (Majchrzak et al., 2003). In this way both assertions are true.

The literature has established that customer involvement supports innovation. Slater and Narver (2000) state that involving customers allows companies to identify latent needs and unserved markets and provides them with an incentive for learning and a market perspective on innovation. Coviello and Joseph (2012) argue that customer involvement has a positive contribution toward the new product development process. A growing number of research studies agree that having a customer orientation

supports innovation development with learning processes (Tajeddini et al., 2006; Herrman et al., 2007). A customer orientation has been proven to support performance and the level of innovativeness in each company (Tajeddini et al., 2006). The products that result from innovation can change the balance of power in existing markets and even create new markets (Herrman et al., 2007).

Customer involvement at the innovation development level can address the information defect. Because customers are unable to express their requirements clearly, it is difficult to obtain information about future innovations from common market data (Spender, 1993; Mullins and Sutherland, 1998). Knowing how to integrate customers into the innovation development process will allow a company to surpass the information defect by obtaining better information about latent needs, problems when using products and eventual opportunities.

Information acquisition can support customer involvement by making it possible to better communicate with them about their problems and opinions (Bilgram et al., 2008; Franke et al., 2006; von Hippel, 1988; Lilien et al., 2002). Integrating lead users is helpful for companies, as it reduces the risk of failure at the market of innovative products (Bilgram et al., 2008). Lead user theory is confirmed by examining product modification and development by users and how they can be part of an innovation (Franke et al., 2006). The view that innovations are usually developed by product manufacturers has been challenged, as the innovation process is distributed across users, manufacturers and other actors (von Hippel, 1988). Including lead users in the development process allows the company to collect information about both needs and solutions for innovation (Lilien et al., 2002).

An additional problem occurs when customers are not automatically convinced about the merits of the new innovation. Innovations transcend buyers' routine-based decision-making (Anderson and Narus, 2003), and customers are not automatically familiarized with the new characteristics related to aspects such as function, reliability and acceptance by the public. Customers lack a frame of reference for considering the superior characteristics of the product in question in their selection. To confront the information defect discussed, the literature suggests involving the customer in the development of innovations (Atuahene-Gima et al., 2005; Lukas and Ferell, 2000; Herrmann et al., 2007; von Hippel, 2005). As a result of technological improvements, users can increasingly develop their own products and services. Innovation processes should be redesigned based on this and companies should seek out innovations developed by users (von Hippel, 2005).

Employees also have an important role to play in the development of innovations. They store, organize and interpret market data; therefore, this study is based on the proposition that without employee involvement the involvement of customers would be insignificant and not usable. Employees that have relevant skills can combine market information with technological information and build a path toward innovation.

There are departments other than R&D that can contribute to innovation, such as sales, accounting or customer support. Employees who are not usually responsible for identifying new solutions can be asked to state their opinion. A diverse base of employees working toward innovation makes it more likely to achieve it (Birkinshaw et

al., 2011). There are also studies about innovation in services, such as Sundbo and Gallouj (2015). In a number of innovation patterns employees are found to have a pivotal role. In knowledge intensive services, the main contributing factors of innovation are individual skills and competencies.

There is also the question about the best way to involve employees in the innovation process. An approach is that the organizational group that is assigned to innovation should be physically and culturally separated from the rest of the company, in order to ensure the best results (Benner and Tushman, 2003). An alternative way is to establish a separate organizational group and change the organizational structure in order to develop processes and tools that support more novel ideas (Kelley, 2009).

Routines are included in this study as they are supportive of innovation. A general definition of routines is that they are repetitive, recognizable patterns of interdependent actions, carried out by multiple actors (Feldman and Pentland, 2003). Another interpretation is that they are the best rules and procedures implemented by a company in a specific period and in a specific environment (Becker and Zirpoli, 2008). Setting up suitable routines will allow the company to be in a position to innovate, as all the operational activities will partly contribute toward this purpose (Edmondson et al., 2001). Managers are responsible to oversee the influence of routines on innovation. If they see that innovation is discouraged they can, to a certain extent, implement changes to support and promote it in the company.

A similar concept with routines consists of dynamic capabilities. They are a learned and stable pattern of collective activities that help to modify routines for improved effectiveness (Zollo and Winter, 2002). This study does not use the term dynamic capabilities as the term routine is considered to suffice. The reason is that routines are already a source of stability and change and an additional term to explain their evolution is not required, at least in this specific research project.

The potential of change is present, and this is made obvious by routines being the product of organizational learning (Argote, 1999). This process is meant to reduce variability, ensure standardization and prevent failure. Routines are a product of change and their flexibility or inflexibility in a specific period is influenced by the business environment and if there is a reason for the company to update its policies and procedures (Pentland, 1995).

Feedback loops are included to illustrate the iterative and repetitive nature of routines. The information acquisition process consists in activities of customer and employee involvement that can be represented through feedback loops and are similar to routines. A number of individuals in an organization undertake repetitive assignments that they have to complete and which are not involved directly in long development processes, so feedback loops enable their contribution toward innovation.

Feedback is defined as the amount needed to fill a gap to a reference value (Ramaprasad, 1983). A feedback loop forms a closed sequence of action and information (Richardson and Pugh, 1981). Feedback loops are applied to management systems in order to better understand their behavior.

To home in on the problem of the information acquisition process that supports innovation at the feedback loop and activity level, this research raises the following research question:

How does information acquisition support the innovation process?

In order to answer this research question, it was broken down into two supporting sub-research questions:

What are the routines associated with customer and employee involvement in the information acquisition process?

How is the information collected from customers and employees converted into knowledge?

A research objective is to construct a model that is applicable for a number of industries, hence the reason for qualitative rather than quantitative data. There is no clear focus on one industry in particular, so there is no detailed technical examination. Another research objective is to find and illustrate the underlying principles of customer involvement, employee involvement and knowledge collection that can be applied to a wide range of companies. Every company has skilled individuals, but rather than the study being centered on how they work, it is based on how their work is organized and on what they work toward. Customer involvement can identify a clear target that the company can put resources in to reaching. Once the target is identified, the company must rely on its employees to develop solutions that can attain it.

The following section discusses the scope of this research and the intended contribution to the scholarly literature in the field.

1.3 RESEARCH APPROACH

The research approach depends on the chosen subject to be examined and there is always more than one way of constructing a methodology to address the research questions at hand. The important element is to ensure that the approach ultimately taken is carefully justified and represents the best means of combining intellectual rigor with that of meeting the research objectives. In the case of this research project, to an extent, the research aims to guide the selection of the methodology. The overall aim of this project is to provide a model of innovation management that can be deployed in commercial organizations; a model that outlines general issues will be adaptable enough to be used consistently over time in different settings.

This project deploys a qualitative data collection process. When constructing a model, it is often easy to be too descriptive, to simply provide a set of instructions that produce an output, but not to explain how and why those instructions do what they do, and why that is better than other options. It is not possible within the space of a single thesis to make such an attempt with the scientific method, so this project will use qualitative data that will illuminate and endow the model with explanatory power as well as practical value, not least because this assists with the academic quality of the thesis, in terms of being able to locate the model generated, here, among a wider

canon of work on innovation and, therefore, to very carefully describe the unique contribution that this thesis will make.

Moreover, there are some questions with regard to the nature of the research environment that need to be addressed at this juncture. The literature review noted that one of the difficulties with innovation is that the objects of analysis are not necessarily clear; there is a substantial level of debate as to what the factors of innovation actually are. Therefore, this research methodology needs to take a two-phase approach to developing the model of innovation that is one of the key research outputs.

The data collected are mostly qualitative because when studying innovation, the objects of analysis are not necessarily clear and quantifiable. For example, customer involvement cannot be quantified because the quality of knowledge obtained is more important than the number of individuals interviewed. Finding the right methods to involve customers will result in valuable knowledge that can be used to modify the processes and policies of the company. Qualitative data are important for this study in order to find the best way to illustrate the information acquisition process of customer involvement.

1.4 THESIS CONTRIBUTION

The study examines the innovation process starting with information acquisition. It is agreed in the literature that knowledge supports innovation (Kazanjian and Drazin, 2012). Starting with information acquisition results in a longer process which can be researched in more detail and more extensively.

The research is not concerned only with a change in terminology by replacing knowledge with information and stating that a new model is obtained. Choosing the term information has a series of advantages. One is that it allows examining the activities of information acquisition that are identified with routines. Another is that a greater number of departments and individuals are included in the study as they are likely to contribute to the innovation process.

The innovation process examined in this study contains two segments. One starts with information collection and ends with converting it to knowledge. The other starts with knowledge and concludes with obtaining innovation. The first segment is composed of simple activities that are operational, most of which can be routinized. The second segment is composed of complex activities that are technical, creative or specialized and can be routinized to a lesser extent. The first segment is less examined in the literature but is supportive of innovation. Innovation is not usually considered as something that can be routinized as it is a complex process. Performing a routine or following a set number of steps does not guarantee innovation. This study shows that at least part of the innovation process can be routinized, and this results in obtaining knowledge. The next part is combining and extending this knowledge in creative ways in order to achieve innovation. Not all companies can afford to involve the customer directly in their internal processes. The advantage is that even companies that only use simple activities to include the customer such as interviews and surveys can be in a position to innovate.

The problem of examining the innovation process starting with knowledge and not with information is that what it is based on is not clear. Companies can collect knowledge in several ways and from a lot of sources, but it is also a question of what activities are best for this purpose. By starting with information, the knowledge creation process can also be considered as companies are choosing what is relevant from what is not, what is useful from what is not and what is applicable from what is not. It is also shown that organizational responsibilities support creative ones that search for innovation. This is accomplished by collecting, organizing and sorting information so it can be converted to knowledge and can support innovation.

Extensive research supports customer involvement in the processes of innovation (Atuahene-Gima et al., 2005; Lukas and Ferell, 2000; Herrmann et al., 2007). The contribution of this study is that it examines ways in which customers can be involved in order to obtain information from them and convert it to knowledge with the support of employees. Customers are usually involved early or late in the development process, rather than in between (Olson and Blake, 2001). Common activities of interaction include exchanging information, group problem solving and testing (Laage-Hellman et al., 2014). Involving customers and learning from them allows the company to obtain detailed information structures, causal linkages between different elements and capabilities for complex decision making (Cohen and Levinthal, 1990).

Employees can be involved in several ways in the innovation process. One is by composing an organizational group responsible for achieving innovation that is separate from the rest of the company (Benner and Tushman, 2003). Another approach is to change the organizational structure in order to develop processes and tools to support more novel ideas (Kelley, 2009). Having a base of employees actively contributing to innovation makes it more likely to achieve it and create value outside the usual areas (Birkinshaw et al., 2011). The capabilities and skills of the employees will determine the quality of customer involvement. Customers will then influence the amount and quality of information obtained by the company in order to achieve innovation.

This research analyzes and elaborates on innovations using case studies from information technology, biotechnology, the banking industry and expert interviews from the information technology, telecommunications and the chemical industry. It analyzes mechanisms that regulate customer involvement in order to enhance current understanding on innovations and to further help in ameliorating the information acquisition process. Its contribution to theory is in the form of feedback loop models as they apply to the non-linearity of innovation (Kline and Rosenberg, 1986). It contributes to the stream of innovation as a process, illustrating with feedback loops the routines of the information acquisition process at the activity or operational level explaining “how a sequence of events unfolds over time” (Van de Ven and Poole, 2005, p. 1382). Its contribution to practice consists of providing organizations with a framework for managing innovation development through customer involvement and employee involvement.

The practical advantages of the study are that it provides companies with a clear distinction between the stages of collecting information and helps managers to incrementally work and verify each stage, before continuing to the next. Thus, errors and

redundant work can be avoided which, in turn, increases overall efficiency. The increase in efficiency, entailed by individual innovations, means that a firm can better allocate and manage its resources, such as labor, capital and infrastructure, and therefore, increase its capacity to develop further innovations.

This study uses feedback loops and considers them as an optimal way to explain the process of innovation, because they allow identification of the relations between steps while, at the same time, illustrating interdependencies and non-linear characteristics. The interaction between innovations and the market led to the idea of this study, to use feedback loops in order to explain the activities related to customer and employee involvement. This research contributes to the literature by studying the feedback loops and activities of agent involvement.

This study also focuses on the information acquisition process that supports knowledge management. Information is collected from customers, as they are the best source, and their feedback illustrates their preferences. The information acquisition process is examined in detail as customer involvement and employee involvement are classified into seven activities that have the objective of collecting information, structuring it or converting it to knowledge.

1.5 OUTLINE OF THE DOCUMENT

This study continues in the six remaining chapters. Chapter 2 elaborates and investigates the problem of the information acquisition process that supports innovation and establishes the foundations of the investigation. It provides the definition of innovation that will be used throughout the study. It examines innovation and routines in order to determine if there is a relation of causality and how it can be described in the most precise way. Chapter 2 reviews the literature in order to identify theories that function as the body of concepts to find answers for the development of innovation. Chapter 2 also reviews prior research and identifies gaps that must be filled, in order to answer this study's research question.

At the end of chapter 2, in section 2.5, the conceptual framework presents the concepts this study will use in order to answer the research question. These are innovation, the information acquisition process, knowledge management, routines and feedback loops. The section links between concepts, states how these notions relate and the influences some have on others in order to create a model that will incorporate them in the correct way.

Chapter 3 discusses the study's methodology, research design, and research method. It explains why the investigation combines a case study approach with modelling causal loop diagrams. It describes data sources, collection and analysis. It establishes the validity of this research by demonstrating that its data is pertinent and its findings replicable.

Chapter 4 presents a case-based analysis of customer involvement and employee involvement and develops an empirical model. Sub-codes are identified from the interviews, evaluated for similarities in their patterns and contribute to finding the seven recurring activities or main codes that are used to construct the models.

Chapter 5 discusses the study's qualitative results and shows that they answer the research questions raised. It discusses how these results affect theory-building in the relevant research area and translates its findings into strategic insights for decision-makers to put into practice.

Chapter 6 concludes and presents the contribution, the limitations and the directions for future research of this study.

2 THEORETICAL BACKGROUND

This chapter focuses on the presentation of the problem statement: the information acquisition process that is required for the development of innovations and their study, as well as the role played by customers, employees and companies in that same development. The chapter is divided into four main sections that introduce the study of innovation (section 2.1), the information acquisition process (section 2.2), innovation and routines (section 2.3) and knowledge management (section 2.4).

The chapter begins by presenting the concept of innovation and stating why it is important by associating it to company performance (Greenacre et al., 2012). The term of co-innovation is also described, and the corresponding literature is illustrated because it is relevant when including and relying on the customer in the innovation activity. Given the variety of approaches to innovation, this study focuses on innovation as a process.

The study discusses the information acquisition process of the company by separating it into customer involvement and employee involvement. One of the main interests of the literature discussed in these sections it to analyze the important role of customer involvement in the development of innovations, noting the learning opportunities that arise from customer-supplier interactions. The section outlines relevant patterns and mechanisms of interaction, providing arguments from previous literature endorsing the potential for customer interactions to support innovations. The information defect, a term introduced by Spender (1993), is also presented as it illustrates a knowledge gap that has to be closed in order for innovation development to be carried out suitably. In addition, the role of employee involvement in the development of innovation is presented. Employees are a source of technical and market knowledge and that is why the information acquisition process should also be targeted at them, to some extent. Employees can produce innovative ideas and improve the processes of the company if the opportunity is presented to them and if the company finds new ways to involve them in the new product development process and obtain knowledge from them.

The literature on innovation and routines is presented next, as routines are the organizational knowledge store of the company. Their change represents new processes and new products and services. Those products and services can present improvement and innovation. Routines are especially important as they represent the bridge between the information acquisition process and knowledge. Improving routines leads to organizational change and an increased potential for learning (Feldman, 2000). A learning organization can have new information from transforming data and new knowledge from transforming information that can be a competitive advantage (Kim, 1993). The reasons for considering routines are provided in the next chapters.

Section 2.4 ‘Knowledge management’ examines in detail knowledge acquisition, sharing and improvement. Special attention is given to knowledge management, because the creation and management of knowledge differs from the management of other firm assets, such as financial or human resources. The section pays special attention to Nonaka (1991) and Nonaka and Konno (1998), in order to describe the kinds of

knowledge that firms must acquire, communicate and improve. The distinction between tacit and explicit knowledge is presented. The knowledge conversion model of Nonaka and Konno (1998) and the I-space model of Boisot (1998) are explained. A more recent model of innovation examined is that of Nonaka and von Krogh (2009) which studies knowledge conversion and states that tacit and explicit knowledge are in a continuum that enables this transfer to take place. The section ends with a presentation of knowledge management in the context of innovation development, to determine the specifications and components a model should have in order to suitably illustrate how knowledge supports innovation.

The chapter ends with the conceptual structure which presents, once again, the main concepts of this research and how they can be linked in a concept map that illustrates the road toward innovation and the best direction to proceed.

2.1 INNOVATION

Innovation can be approached and analyzed from different analytical levels. To narrow the scope of this study's analysis, the following section provides a short recap on the most relevant approaches to the study of innovations.

Innovation can be described as a disruptive change introduced by a company. This can be explained as follows. Economic theory argues that in a competitive market all firms will face the same production costs in the long run, which means their costs of production and the quality of their products is virtually the same for all firms (Varian, 2010). A disruptive change will mean benefits for the company in the short term, before equilibrium is reached and all firms have the same costs. It is this disruptive change (disruptive because it departs from established production processes) that is referred to as an innovation (Varian, 2010; Acemoglu et al., 2006). The economic approach, therefore, focuses mainly on innovation, as a technological change whose most important effects go beyond the firm as a unit of analysis. It is also helpful to identify the processes and actions associated with innovation. In other words, organizational processes become the object of analysis. Innovation becomes a central factor for organizations to determine their output and becomes less determined by environmental changes within their market.

The importance of innovation is best described by presenting its relation to company performance. An increasing body of research explores innovation from the perspective of company performance (Sorescu and Spanjol, 2008; Tellis et al., 2009). In an analysis of 30 academic articles on the innovation-performance relationship (between 1981 and 2003), Walker (2005) reveals that "in a majority of cases innovation works and is a route to higher levels of organizational performance" (p. 2). Rosted (2005) argues "In the global knowledge economy innovation is becoming an increasingly important competitive factor" (p. 90). This is supported by empirical studies (Mansfield, 1968; Audretsch, 1995; Cefis and Marsili, 2003), which reveal firms that innovate successfully have a higher probability to thrive in the market.

The link between innovation and performance is directly related to Schumpeter's (1942) theory of profit product of innovation, where competitive advantages depend

almost by necessity on innovation development, where firms are able to gain "a temporary quasi-monopolistic position, which enables them to extract rents" (Rubera and Kirca, 2012, p. 131). Such superior rents can vanish once imitation from competitor's sets in, transforming a competitive advantage into an established industry standard. A firm can naturally maintain its competitive advantage, its superior performance, and the ongoing temporary gains through continuous innovation and by periodically launching new products to the market (Sharma and Lacey, 2004). Marketing research suggests, for instance, that innovativeness positively affects various performance measures, such as market position, brand equity and stock market value (Sorescu and Spanjol, 2008; Srinivasan et al., 2009).

As a research theme, innovation is studied by an array of disciplines, from business to economics and sociology. The contribution of research and development (R&D) in the process of innovation has, for instance, been seen as fundamental to the commercialization of innovations (Huang et al., 2015; Greenacre et al., 2012; Deeds, 2001; Cohen and Levinthal, 1989). Innovations are developed by organizations through specialized business units and R&D. Along these lines, new developments become localized and may arise, in principle, from any business unit although, in practice organizations interested in innovation development set up teams and establish processes whose aim is to specialize on innovation development (Eveleens, 2010).

Early models of innovation were linear in nature and did not consider the possibility of feedback loops and dynamic relations between business units and between the company and the market. Criticism has, thus, asked for increased attention to be paid to institutions (economic, political, social, etc.), while others suggest that the linear approach needs to be revised, in favor of nonlinear models that are able to capture different potential sources of innovation (Kline and Rosenberg, 1986).

Eveleens (2010) argues that, in consequence, the management models of innovation have become more elaborate, making way for more interdisciplinary approaches, where there is a patent interest in integrating the firm to its environment, to other firms, to their consumers and to neighboring markets. Recent studies on innovation have focused on the role played by knowledge management and organizational performance (Di Stefano et al., 2012). This focus has allowed for the study of innovation to turn towards the processes involved in the development of outputs (products, services, but also knowledge, new technologies, new organizational structures) within organizations (Teece et al., 1997). In this way, company outputs have become more intangible, especially in the case of knowledge and organizational structures, so quantitative methods do not work well in order to study them. The new trends in the literature of innovation have not focused on simply the output, but on the entire process that comes before it. This process unfolds according to a series of factors and contexts, pertaining to diverse fields of study, such as business, economics and sociology. The question changes from "What measurable characteristics do these companies that have achieved innovation have in common?" to "What are the everyday practices and routines of companies that strive towards innovation?" This is a more comprehensive approach that, even if it does not reach generality so cleanly and neatly, can provide more applicable and valuable answers.

In this way, this interpretation examined innovation as appearing through carrying out the operational activities of the company and not because there is a deliberate plan to innovate. The change in products, services and processes appears naturally as the company adapts to the environment and tries to stay ahead of the competition. The concept of innovation is simply related to the process of change and this results from an evolution of organizational routines. Innovating and creating new products and services can result in a competitive advantage and a better market position (Cooper, 2001). Products can be constructed from different modules and components (Henderson & Clark, 1990). This allows to categorize innovation as: incremental, modular, architectural and radical.

The literature sees change in products and services and innovation as closely related. However, this relation is not so close and simplifies reality greatly. Many of companies change their products and services in order to stay ahead of the competition. In contrast, there are fewer companies that innovate. Products and services have a lot of features that can be improved, and this can be done without innovating. An innovation is an invention that is accepted by the market. This implies that customers must also give their opinion in the development process of an innovation. This is why the study examines employees and customers as an influence of innovation separately.

2.1.1 Innovation and co-innovation

In this research, innovation is obtained with the help of customers, therefore, the concept of co-innovation is important to consider. This term consists in collaborating with other actors to achieve innovation as opposed to simply delivering it to customers once it is completed (Rothwell and Dodgson, 1991; Berthon et al., 1999). Studies such as these accept that innovation includes external participants such as universities, research institutes or customers. The nature of innovation changes from relying on the role of the producer to being directed to participatory forms with customers and other stakeholders (Baldwin and Von Hippel, 2011). Consequently, co-innovation requires significant attention as it can become highly disadvantageous for the company to ignore (Shih et al, 2008). This notion challenges the view that innovation is based on the producer and allows new possibilities as the interaction between the company and stakeholders can achieve not only profits but also help the greater good in society.

Co-innovation is a type of collaboration and this is how it should be understood. Open and collaborative innovation is a way to conduct innovation collectively with actors such as companies, users and partners (Baldwin and Von Hippel, 2011). This idea removes borders and boundaries that would have prohibited companies from collecting new insights and opinions from customers once they use a product. This idea allows companies to produce something new after integrating and benefiting from the available information.

As a result of studies such as this, innovation started to shift from a unidirectional view centered on the company to a more open and collaborative form. This challenged the interpretation of innovation held by Teece (1996) that assumed that innovation must be concerned with the producer's role to outperform competitors and should be kept secret in order to surprise the market. This is a philosophy that is no longer relevant, as globalization changed the market to include information societies. Marketing has

also started to consider the customers as a higher priority than the companies and innovation should follow this approach (Chesbrough and Appleyard, 2007).

Studies such as Bossink (2002) and Lee et al. (2012) have stated the meaning and philosophical implications of co-innovation. Some cases of successful collaborative innovation in a business setting have been identified, such as the rapport between Nike and Apple (Ramaswamy, 2008) and Lego (Greer and Lei, 2012). Several other studies have focused on co-innovation in companies such as IBM and Lake Nona (Shih et al., 2008; Teixeira and Caverly, 2012).

Customers now have more bargaining power than suppliers because they have access to more information and can quickly find innovative companies. Activities such as co-creation and coproduction have become relevant in creating value for companies. Collaboration has become the center of business activities (Caruso et al., 2009; Vercesi et al., 2014). Companies see collaboration as important because it allows integrating the customer into the organizational processes in order to improve innovation activities and the market acceptance of products and services.

The process of co-innovation has been identified in both product and service industries. A list of industries that have some co-innovation patterns of innovation has been provided by Bossink (2002). The activity of co-innovation in the automotive industry has been researched by Maniak and Midler (2008).

Some researchers have also investigated the phenomenon of co-innovation in service industries. Parmentier and Mangematin (2011) have studied how co-innovation can be applied in creative industires by considering four companies: Trackmania, Propellerhead, Freebox and MySQL. The results show that innovation can be found in communities of customers and these have to be recognized by companies in these industries and included as an important factor in the innovation process.

Innovation is a process that is influenced by creativity as new ideas are used to obtain a service or process that fulfils a need. Innovation can have a wide spectrum of interpretations, from scientific breakthroughs to adjustments in the supply chain that create value. Lee et al. (2012) state that several important stages of innovation in business can be classified as: closed innovation, collaborative innovation, open innovation and co-innovation. In this interpretation, co-innovation is a more recent stage than open innovation.

The reason for implementing co-innovation is that organizations are no longer local. Global businesses are part of a new ecosystem, where individuals, organizations, governments and economies are networked and independent and this requires a new innovation approach. Lee et al. (2012) define co-innovation as a framework where a number of ideas can be united and applied to create something that can be of value to the organization.

The key advantage of innovation is to provide a compelling impression with network effects for value creation. The concept of co-innovation can be considered as a platform where new ideas from internal or external sources can be applied to create value for all those involved, including customers (Von Hippel et al., 2011). This research considers customers as the main external stakeholders and employees as main internal

stakeholders that contribute with ideas in the context of co-innovation in order to make innovation a real possibility.

The concept of co-innovation is included because it illustrates customer involvement and how it is carried out. This research is focused on individual customer involvement as opposed to groups or communities as this allows a more direct communication with the customers. The other advantage is that the customer is included in the organizational processes of the company and can contribute to the design, development or marketing activities as opposed to simply giving feedback to finished outputs.

The term innovation can lead to ambiguity given the equivocal usage it is given, referring at times to processes, at other times to products and still other times to technologies (Slade and Bauen, 2009). This research considers the innovation process and the reason for this choice together with the corresponding literature is presented next.

2.1.2 The innovation process

Innovation can be studied as either an output or process. The approach of innovation as output is based on the capabilities of factors that influence the end result of the organization. This type of research is centered on the concrete role that organizational capabilities play in product innovations (Hoonsopon and Ruenrom, 2012). Organizational capabilities are included in the antecedents of factors that the output approach considers to be the key determinants and reasons why the company obtains innovation.

This research is not based on innovation as an output. The reason is that simply identifying the factors that support innovation is not sufficient to describe such a complex activity. Concepts such as an active management, routines and the work done by individuals and teams are also required to understand how innovation is obtained and an innovation process approach that includes them is better suited for this task.

Process theory has the advantage of considering the order in which events unfold and the influence of groups of events and contexts (Poole et al., 2000). In variance theory, which is similar to innovation as output, process can mean causality between independent and dependent variables but, in process theory, process means a sequence of events that is indicative of the evolution of the considered subjects (Van de Ven, 1992). This study will use the term process as it is described in process theory. Several theoretical approaches are part of process theory, such as practice theories, complexity theories, change and organizational dynamics, the narrative perspective and routines. A short presentation will be given in order to illustrate how the innovation process can be placed, understood and studied.

Practice theory provides a clear relation between instances of actions to the contexts where they are performed, leading to an improved way in which to study innovation. According to practice theory, practice is what practitioners know about innovation and praxis is the specific actions they take (Seidl and Whittington, 2014). Practice theory has been used to study multiple organizational phenomena, such as routines (Feldman and Pentland, 2003) and innovation (Dougherty, 2008).

Product innovation contains several dualities of concepts, such as that between social constraint and social action (Dougherty, 2008). There is also a duality between formalization and collaboration (Ramus et al., 2015). The former is a sequence of implemented rules, instructions and procedures that state and clarify how a task should be accomplished. The latter consists of cooperative actions that aim to provide solutions to relevant and complex problems.

Complexity theories help innovators and organizations to understand the logic and characteristics of non-linear processes (McCarthy et al., 2006). The complexity theories show how systems evolve through the interaction of multiple systems in multiple ways (Frenken, 2006). Systems that change are far from equilibrium and are determined by differences and imbalances. The branch of complexity theory that relates more closely to this study is the theory of complex adaptive systems (Kauffman, 1993) because it is centered on the agency of individuals and is a bottom-up approach (Stacey, 1995). Change and organizational dynamics state that organizations must be aware of the complexities entailed by change (Burnes, 2005). Organizations are not prompted by stability or instability to change, but they are in a zone at the edge of chaos (Stacey, 1995). This means that they are constantly facing instability and adaptation is the mechanism through which they can surpass it.

The narrative perspective is a more descriptive style of elaborating theory that supplements variables and constructs with narratives (Garud and Van de Ven, 1992). Examining how innovators, designers and programmers interact and shape technological innovation can offer a more thorough understanding of the process, especially if it is described with a narrative (Garud et al., 2014). The narrative is described as a set of events and the contextual details surrounding their occurrence (Bartel and Garud, 2009). Using the narrative perspective can better highlight the innovation journey, which is based on organizational design or on processes that allow productive social interactions.

Routines can also be theorized as practices (Feldman and Orlikowski, 2011). This means that they are created through action, do not exist without action and the development of the routine happens through its enactment. The perspective on routines as processes states that they have an internal dynamic influencing the actions taken by individuals and the ideas and plans related to those actions. Pentland and Rueter (1994) introduce the term effortful accomplishment in routines, meaning that individuals repair the cycle if required, so that it continues to produce outcomes that are similar to those previously obtained.

This study is based on process theory, as it considers the order in which events unfold, such as the activities of customer and employee involvement, in line with Poole el al. (2000). The sequence of events is indicative of the evolution of the considered subjects, which are knowledge management and innovation, according to Van de Ven (1992). When studying the innovation process it is important to identify the relevant events and order them. The information acquisition process is an event that can be placed at the start of the innovation process. This event involves multiple actors and describing how innovators, programmers and designers interact can be useful to illustrate its development, especially when supplemented by a narrative (Garud et al., 2014).

Information acquisition can also be interpreted as a process that contains several events or activities. These are the activities of information acquisition and it will be shown how these are carried out, the relations between them and their characteristics. It can be demonstrated that the information acquisition process is the first part of the innovation process because information allows innovators to identify how the market looks like, what has been done before, what do the customers want and how can the company address this need through its new offerings.

The activities of customer and employee involvement can be conceptualized as routines. A narrative perspective can better outline the road to innovation which is based on organizational design, such as innovation groups and processes such as routines that support interactions between departments and individuals.

2.2 THE INFORMATION ACQUISITION PROCESS

Information acquisition is the ability to collect information from internal and external sources (Brown and Eisenhardt, 1995). It is sometimes linked to organizational learning. Information acquisition allows the company to adapt to environmental uncertainties (Gnyawali and Stewart, 2003). The literature highlights that companies with high performance tend to be involved in more information acquisition and processing than other companies (Daft, Sormunen and Parks, 1998). New information usually determines a better performance of product innovation (Brockman and Morgan, 2003).

Information acquisition can determine an improved capacity for learning and innovation performance (Jones and Craven, 2001). An information acquisition process can lead to a better recognition of opportunities that reside in new markets, products and services (Shane and Venkataraan, 2000). Social networks have been identified as having a positive influence on entrepreneurial opportunity recognition (Ardichvili et al., 2003). Social networks allow individuals to access possible information resources. People who use social networks are exposed to more opportunities and recognize them quicker. Ozgen (2003) states that the information flow supports entrepreneurial opportunity recognition through learning. The concept of information flow is similar to the definition of information acquisition.

Information acquisition is often presented in literature to be a component of learning. Learning is assumed to have two components: creation and transformation of schemas as well as acquisition of information (Vosniadou and Brewer, 1997). There is also the view of Huber (1991) who states that organizations learn by acquiring, transferring and making sense of information. This is an informational mode of learning. A mode of learning is a systematic organizational process through which shared understanding is enhanced in organizations. Conversely, von Krogh et al. (1994) argue that organizations learn as they communicate and create some generally accepted understandings. This is an interactive mode of learning. The majority of the learning interpretations, such as vicarious learning, which is the acquisition of the information of other companies through corporate intelligence (Huber, 1991), learning through imitation (Levitt and March, 1988), congenital learning, which is information acquired before the birth of the organization, and learning by actively searching the environment and noticing the actions of other competitors (Garvin, 1993) are based on information.

The information acquisition process outlined in this study has two components: customer involvement and employee involvement. Collecting the right information from customers is the first step toward innovation and it will be further shown that customer involvement can be carried out through different activities. Obtaining information from employees is also important, as they have tacit knowledge and the potential for great creativity, even if they are not specifically responsible for the design of new products. Evaluating the best ways of involving them in innovation development is a solid consideration.

Information acquisition supports the innovation process as it is an initial step toward this objective. The information acquisition process can result in a better innovation performance (Brockman and Morgan, 2003). To determine this process, it is required to identify the sources of information most relevant to the company. Information can be obtained from several sources, such as suppliers, competitors, supervising authorities and business partners. However, the most relevant information for the company is that of customers and employees. Customers are a source of market knowledge and can specify the problems that appear when using products and services and how an innovation will be received by the market after launch. Employees are a source of technological knowledge and are responsible for the ideation, design, testing and implementation of new products and services. Skilled employees can also improve the routines of the company. The most relevant and valuable information can be obtained from these two types of individuals, hence the reason for including them in this research.

The literature of information acquisition in the context of innovation is rather scarce as knowledge acquisition is considered to play a key role. Open innovation functions on the assumption that external knowledge can be identified and collected from outside the company to support innovation (Chesbrough, 2003). The difficulty is that this external knowledge can't be easily assimilated by the organization.

Knowledge integration is required so that the company can assimilate it to support its innovation performance. Knowledge processes associated with the communication, sharing and integration of acquired knowledge are considered to be at the center of knowledge creation (Liu and Liu, 2008). It is also important to note that knowledge integration is sometimes defined as collecting information and transforming it to knowledge (Grant, 1996; Moreno-Luzon and Lloria, 2008) thus supporting the view stated in this research that information acquisition is also significant for innovation as it allows the creation of new knowledge.

The knowledge acquisition and customer involvement in product development are mediated by the company's absorptive capacity, thus showing the difficulty of working with outside knowledge (Dahiyat and Al-Zu'bi, 2012). The existing literature states that the processes used in knowledge management are very interlinked and have an overall influence on innovation. However, evidence on this subject is still developing and an amount of discrepancy and lack of consensus exists concerning the relations between knowledge management and innovation (Subramaniam and Youndt, 2005; Andreeva and Kianto, 2011). This is why recommendations concerning which knowledge practices significantly contribute to innovation should be made with caution.

To sum up this duality between information acquisition and knowledge acquisition, it should be stated that knowledge can be created by acquiring it through boundary spanning activities (Nonaka et al., 2000) or converted from information. Knowledge acquisition is also a complex process, as companies need to internalize it by combining it with their existing knowledge base, but new knowledge obtained from information can be a better approach. The argument for this is twofold. Firstly, in the context of customer involvement and innovation, the feedback obtained from customers is certainly information and not knowledge, as it has to go through a long process for this. Secondly, creating new knowledge proves that the company has potential for creativity and can develop something unique, which are qualities that are required for innovation. It is also natural that the literature on information acquisition for innovation is lacking, because placing information acquisition into the innovation process begins to fill that gap and is a contribution of this research.

In order to properly understand the information acquisition process, it is important not to confuse information with data or knowledge. The difference between these concepts allows determining where information acquisition fits in the innovation process. This distinction will be presented in the next section.

2.2.1 The distinction between data, information and knowledge

Data, information and knowledge are concepts that have some similarities, but each has its own meaning and role. Data only describes the quantity or quality of an object or phenomenon. It can be measured, collected, reported and then visualized using graphs or images. Data is a way to represent or code information and knowledge in a form that is better suited for processing. Data becomes information that is useful for making decisions once it has been interpreted in some way. Knowledge is the process of understanding obtained by significant experience with information on a subject.

The concepts of data, information and wisdom are the building blocks of library and information science. The first to put these concepts in a single formula is Ackoff (1989). This consisted of a hierarchy with wisdom on top, followed by knowledge, information and data. The model could be viewed as a pyramid and has been likened to one since then (Rowley, 2007). The definitions of data, information and knowledge by Ackoff (1989) are considered to be amongst the most precise and will be presented next. Data, in his interpretation, is the product of observation and it has no value if it is not processed and transformed into information to become usable. Information is represented by answers to questions. Knowledge further refines information by converting it to instructions.

The DIKW pyramid that contains data, information, knowledge and wisdom refers to a class of models that represent the structural and functional relations between these concepts. As stated by Rowley (2007), there is little reference to wisdom on articles on this topic and she does not include wisdom in her own definitions on this subject. The research of Zins (2007) on the conceptualizations of data, information and knowledge makes no explicit commentary on wisdom. In this research wisdom is only acknowledged to be a part of the DIKW pyramid but is not a main subject and will not be described or interpreted further in order to concentrate on the other concepts.

Data are composed of symbols and signs that are useful only if they are turned in an applicable and understandable format (Rowley and Hartley, 2006). The classification of Zins (2007) contains universal data that are the symbols and subjective data that are the signals and stimuli corresponding to the symbols or how they are interpreted. Data are some facts and observations that are unorganized and not useful until they are contextualized or interpreted. According to Henry (1974) data are simply raw facts but can also be defined as facts about the state of the world (Gamble and Blackwell, 2002) that is a more recent interpretation.

Information consists in sorted or interpreted data that is now useful. It is possible to obtain information from data by asking interrogative questions, such as who, where, when and what, thus making it useful for decisions or action (Liew, 2007). Information is organized or structured data that have been processed in such a way that it has relevance for a specific purpose or context and, consequently, is meaningful, valuable and useful (Rowley, 2007). This definition contrasts with that of Ackoff (1989) wherein the difference between data and information is structural, not functional.

Knowledge can be defined as information that has been processed or organized in some way or it has been applied and put into action. A definition that is frequently quoted is that of Wallace (2007): knowledge is a combination of contextual information, framed experience, values and intuition that allows to evaluate and assimilate new experiences and information. In companies it is possible to find it in organizational routines, processes and practices (Davenport and Prusack, 1998). Knowledge allows the individual to bring forth from his background a coherent and consistent set of actions (Zeleny, 1987). It can be considered as information combined with understanding and capability. Knowledge is not only descriptive as Zeleny (1987) states that it is action and not simply a description of action.

This hierarchy allows data, information and knowledge to be ordered according to their usefulness and relevance. Knowledge is the most important concept for innovation but the way to obtain it resides in data and information and from there this research will try to determine it. Information results from interpreting data and creating knowledge is the process of accumulating information or learning in order to know how to carry out specific actions that are important to an individual or company.

One purpose of this research is to determine how information can be converted to knowledge that is useful for supporting and obtaining innovation. This information is considered to originate from customers and employees and can be collected through their involvement. This involvement will be presented next.

2.2.2 Customer involvement

As indicated in section 2 (page 23), innovation can be directly related to firm performance. When setting out to conduct innovation, companies find that information about customer requirements and their latent needs is vague, difficult to interpret and confusing. Customers lack the prior knowledge needed to be capable of expressing problem statements or stating the new characteristics an innovation must have (Cohen and Levinthal, 1990). Since prior knowledge is crucial for improvements in learning performance, that is, effective knowledge transfer (Ellis, 1965; Estes, 1970), the

lack of availability of prior knowledge makes it impossible for customers to capture problem statements and generate solutions accordingly (answering the problem statement).

The first question to ask is therefore: Why is customer involvement important in innovation development? Customers are an important source of information as they can provide insights about the market that the company can use to better position its products and services. Being able to improve the quality of products and services is a great motivator for customers and can make the information acquisition run smoother (Svendsen et al. 2011; Laage-Hellman et al., 2014).

Vercauteren and Vanhaverbeke's (2007) findings provide indications on the way customer involvement helps suppliers learn about the limitation of an established technology (Huber, 1991; Slater and Narver, 2000), and then use this knowledge to design a solution. Learning opportunities that arise from these inter-firm interactions, between customers and suppliers, during the development of an innovation, supports information acquisition because customers can stimulate suppliers in the development or co-development of required solutions (Hakansson and Snehota, 1989; Huber, 1991; Slater and Narver, 2000).

It makes sense to integrate the customer into innovation, in order to acquire the necessary information on latent needs from the customer to confront the "information defect" (Spender, 1993; Mullins and Sutherland, 1998). The information defect is the difference between the amount of information necessary to perform a specific task and the information already available to the company. Mullins and Sutherland (1998) base their research on a telecommunications company and state that the information gap happens because of not knowing the needs of the customers, the characteristics of new technologies and the optimal resource allocations that are required in an industry. Their study finds that the company examined by them improves information acquisition by using prototyping earlier in the production process and by relying on qualitative research methods to discover new product ideas and to use prototypes to reach those products.

Since knowledge is key to customer involvement and collaboration or co-development, knowledge management plays an important role in the generation, acquisition, and transition of knowledge within the "information acquisition process" (Greer and Lei, 2012, p.74) of the collaboration between the supplier and customer.

Knowledge offers the company a way to engage in complex decision making. If a company is in a position to use external knowledge, its innovation capabilities increase (Cohen and Levinthal, 1990). This is realized through learning because learning allows a task to be experienced and understood. The more tasks performed by an employee or organization, the more their capabilities improve and the potential for innovation increases.

There is another way in which these concepts can be linked. By innovating and creating a new product or service, a company receives feedback from the market. By listening to the requirements of their customers, companies can respond with new products that meet or even surpass their needs (Thomke and von Hippel, 2002). In this way,

innovation creates a dialogue between company and consumer that allows the creation of new knowledge. In cases of innovation, this knowledge is valuable as it is not known by competitors, being related to the new product launched by the company; therefore, the high degree of specialization of this knowledge allows the company to continue innovating.

The information defect can be surpassed by identifying latent needs or unserved markets. Leonard and Rayport (1997) argue that direct interaction with customers allows for the identification of unanticipated or latent needs, through observation of the current problems encountered by customers, when using existing products, services or technologies. Da Mota Pedrosa (2012) reviews a considerable number of articles in the field of innovation, showing that companies often involve customers in innovation development.

Slater and Narver (2000) argue that involving customers enables firms to discover latent needs and unserved markets and provides them with an incentive to remain committed to a continuous learning process, thereby giving them a market-focused perspective on innovation. Customers who are active or passive sources of new innovative developments can motivate manufacturers to develop or co-develop solutions for specified needs, while lead manufacturers with specific and suitable technologies and competencies can be detected by customers (Lettl, Herstatt and Gemünden, 2006). From this follows that suppliers can design innovations, by acquiring information from the environment (market/customer) and by observing customer behavior, preferences, and needs (Greer and Lei, 2012). Involving customers successfully is a type of capability that allows the company to understand and bring external stimuli to improve organizational orientation (Tidd, 2001).

It is difficult for suppliers to assess customers' latent needs, and customers have difficulty recognizing the new beneficial characteristics of innovations (the exploitation of phenomena). Moreover, marketing activity is challenging and complex (Davidow 1986, Shanklin and Ryans 1987, Mohr 2001) because neither the product nor the market is developed: Ignorance about the kind, and magnitude, of customers' need for a new innovation means that customers cannot explain their needs and solutions to their problems (as mentioned above), because they assume these are either latent or simply cannot to be answered by the supplier (Leonard and Rayport, 1997). Relevant market information is not found in the form of customer needs identified through market research and it is precisely this challenge that characterizes the uncertainty posed by the information defect discussed, such as understanding markets that may not exist or that can be transformed (Leifer et al., 2000; Spender, 1993; Mullins and Sutherland, 1998).

If not yet in the market, where and how can knowledge on latent needs be found? How can the gap of information defect be closed? Several studies state that this can be accomplished through customer involvement during innovation development (Gruner and Homburg 2000). Most studies of customer involvement in innovation development, while generalist (Montoya-Weiss and Calantone, 1994; Lilien and Yoon, 1989; Cooper and Kleinschmidt, 1986; Calantone and Cooper, 1981), do agree on the interaction with customers being determinant of new product success, yet, given their approach, provide little to no detail about the type of interactions needed throughout

the product development process. These authors note there are profound development differences between consumer and industrial products (Gruner and Homburg, 2000; Biemans, 1991).

Once the reasons explaining the needs for customer involvement are understood, an equally important question follows: When in the development process of innovations should customers be involved? The study of Gruner and Homburg (2000) examines the machinery industry in Germany and reports that high levels of customer interaction are positively correlated with successful innovation development in the prototype testing and market launch stages. Prototype testing, furthermore, is reported as the most significant stage in terms of customer involvement. What makes customer involvement especially valuable at this stage is having the possibility to continue adapting the design and customers providing information about the prototype. The product launch stage revealed more typical methods of customer involvement, such as insights into the market positioning of the new product. The interaction with lead users has a positive impact on innovation performance, yet it is important to distinguish between lead users and technically attractive customers. The latter are actually reported to have a negative impact on innovation performance. Such customers can mislead the firm, because they are customers that have specific needs with respect to those found in the market and, additionally, their involvement is most often seen when firms have technical issues that they seem unable to resolve on their own (Gruner and Homburg, 2000).

Similar studies argue for customer involvement early in the conceptualization phase (Kaulio, 1998; Neale and Corkindale, 1998), while still others suggest it is better throughout the whole development process (Ritter and Gemuenden, 2003; Lagrosen, 2005; Brockhoff, 2003; Lin and Huang, 2013). Empirical evidence suggests that it is more common for customers to be involved early or late in the development process, rather than in the intermediary or design phase (Olson and Blake, 2001). This research is interested, in likewise manner, in contributing to the question of when in the development of innovations is best for customers to be involved or for the interaction with customers to take place.

Alongside the question of when, there is also the question of what: What are the types of interactions or activities that should be pursued through customer involvement? Common activities of interaction include exchanging information, group problem solving and testing (Laage-Hellman, Lind and Perna, 2014). Given the learning aspect entailed, Ritter and Gemuenden (2003), Lagrosen (2005), Brockhoff (2003), and Lin and Huang (2013) highlight the importance of establishing relationships as a precondition of effective customer involvement. High levels of trust are, in turn, reported as a precondition of fruitful customer involvement. An open and effective interaction process requires both tight and loose customer relationships, which Coviello and Joseph (2012) argue have a positive impact on the NPD process in industrial manufacturers. The activities chosen, and the interactions pursued require, in addition, that firms have or acquire capabilities that allow them to gather relevant information. Knowledge management is a central concept, as companies need to be able to integrate and configure internal and external competencies, in order to be able to transform customer involvement into a higher rate of successful NPD.

The intense development process includes activities such as prototyping, testing, designing and redesigning, which show different degrees of potential for successful customer involvement. Innovation development begins at the drawing board. Large-scale production systems allow for a new technology to be scaled and for it to produce steady results. Such endeavors are, however, in many cases unpredictable and tailored solutions do not exist.

Continuous interaction between customer and supplier entails, therefore, a learning process that allows for customers and suppliers to define new functionalities and their technological specifications, that is, for firms to understand the contribution that customer involvement may have, depending on the distinct stages of development. Prototyping provides firms with access to customer environments and infrastructures by experimenting in the real world. Lynn, Morone and Paulson (1996) study four companies (General Electric, Motorola, NutraSweet and Monsanto) and report on the introduction of prototypes in assorted market segments. These firms experiment with the sequential introduction of their product to potential markets in a probing fashion that entails repeated learning stages. These initial stages do not end in the introduction of the product but, rather, that introducing the product is a first step, aimed at learning and gathering new information that can be used in subsequent stages of development (Lettl, Herstatt and Gemünden, 2006).

Learning from customers provides companies with detailed information structures and causal linkages between different elements that provide them with the capabilities for complex decision making. Learning is an ability on its own which can be seen as a skill contributing to a firm's absorptive capabilities. The transfer of such "learning skills across bodies of knowledge" (Cohen and Levinthal, 1990, p. 130) affects the way a task is experienced and understood which, in turn, impacts the performance of that same task; with time, tasks may become defined or established, yet there is still a progression involved, a learning curve that has to be travelled in order to achieve an optimal state: an optimal set of capabilities (Ellis, 1965; Estes, 1970).

An advantage of customer involvement is that it can improve the development process, by eliminating redundancies, decreasing development costs and increasing the knowledge store of the company (Brown and Eisenhardt 1995; Callahan and Lasry 2004; Feng, Sun and Zhang 2010; Laage-Hellman, Lind and Perna, 2014). The literature most relevant to this research is that which specifically associates customer involvement with obtaining innovation. Creating an innovation in order to satisfy the needs of customers is a difficult task because, at the early stages of the development process, the firm may not even know which customers they are aiming for with their product (Deszca at al., 1999). Even if that information is available, customers may not be able to formulate the characteristics new products and services should have. A solution to this problem may consist of proactivity, in order to anticipate, and even influence, the role of customers and to build better links between the innovation and the market (Sandberg, 2008).

The study of Sandberg (2008) is closely related to the present one, because it examines customer involvement in developing innovations, the difference is that it uses proactivity as a way to create and support this involvement. Proactive behavior allows com-

panies to anticipate changes and even alter their environment, in order to have sustainable growth and benefit from the changes in the business landscape. Proactivity is not necessarily better than reactiveness, as there are situations where reactiveness brings better results. However, proactivity may allow the company to be in a better position to attain innovation (Kaplan, 1999). Even if companies are proactive in developing an innovative product, the relation with the customers can still be conventional, limited to marketing and selling the product to an existing segment of customers. In this way, the companies can be proactive in technical product development, but at the same time be reactive towards the customers.

To make a connection with customer involvement, customer-related proactivity is either acting on information about customers before they have made a purchase decision or intentionally influencing and creating changes in their behavior. The relation between proactive behavior and customer needs has been illustrated in a two-by-two matrix by Hamel and Prahalad (1994). The needs of the customers are presented as unarticulated and articulated, the latter consisting in general and specific needs. Proactive behavior allows the company to meet the unarticulated and general needs, while reactive behavior allows the company to meet the specific needs. This applies to both existing and new customers.

Customer resistance is one of the most important barriers in innovation, which is often caused by the lack of experience of similar products (Sandberg and Aarikka-Stenroos, 2014); it influences all innovative activities, from idea generation to development and commercialization and proactive and reactive approaches are needed in order to surpass it. Companies in B2C markets may find it more difficult to innovate because of the distance between them and their numerous customers, so more effort is required in order to discover opportunities and evaluate the market suitably. The external barriers to innovation depend on the size of the company, target market and activities of the innovation process. The competence barriers depend on the closeness of customer.

There has been a growing interest in the nature of customer involvement in a range of management activities. Techniques such as ‘Agile Management’ in product design and project management, particularly in terms of software and services, have introduced two key ideas about the value of customer involvement. The first is that customer involvement is a necessary thing; in order to build something that a customer wants it is sensible to ask their opinion. However, the big departure of approaches like Agile is that customer involvement is something that should be iterative; it is not something that is done at the start of the process, such as with market research; customers should be involved through every stage of the process in as small iterations as are possible. Theoretically, this should result in a substantially better end product.

While not exactly the same, there is a lot that a model of innovation can take from this. Innovation, however conceptualized, is not something that can be divorced from customers. For innovations to be commercially viable they can be both driven by and accepted by customers. However, much of the literature on innovation has left customer involvement under-theorized; thus, this section expands on what exactly a customer might be in the context of innovation, and how their involvement can be made central to a model of innovation. In line with literature (Dosi, 1982; Lundvall, 1992;

Anderson et al., 1994; Dutta et al., 1999; Lukas & Ferell, 2000; Callahan and Lasry, 2004; Hult, Hurley, and Knight's, 2004; Atuahene-Gima et al., 2005; Zhou et al., 2005; Tajeddini, Trueman, and Larsen, 2006; Herrmann et al., 2007) this study assumes that customer involvement can support innovation development.

Lettl (2007) notes that users have an active role in the innovation process by contributing to the invention and development processes. Instances include scientific instruments (Riggs and Von Hippel, 1994), CAD software (Urban and Von Hippel, 1988), pipe hanger hardware (Herstatt and Von Hippel, 1992), medical surgery equipment (Luethje, 2003), and sporting equipment (Luethje et al., 2005; Franke et al., 2006). Information and communication technology, in particular, offer new opportunities and means of acquiring information about users and engaging them in innovations. A user-driven innovation strategy seeks to demonstrate the market's awareness of innovations and accompanying product enhancements. This explains why, as Von Hippel (1998, 2005) argues, users have been the major source of innovations.

Lettl's arguments emphasize the success found in companies where customers worked actively with inventors and co-developers, integrating their ideas and requirements (Lettl, 2007). The firms gathered ideas for innovation and gained a competitive advantage through customer contribution in the development phase. Their participation reduced development time and cost and enhanced product quality (Lettl, 2007). Expertise was acquired by testing customer activities which, in turn, increased the usability of innovations. Delivering a product that maintained user-friendliness increased its acceptance and determined its market success. Furthermore, customer involvement improved firms' decisions and led to more appropriate selection of prototyping and the establishment of appropriate priorities. Lettl's (2007) findings focus on showing the implications that leveraging customer involvement can have in the innovation processes. Nonetheless, user involvement in innovations differs significantly from conventional marketing research. Therefore, innovations such as these require a different marketing strategy (Lynn et al., 1996; O'Connor, 1998).

Innovation design is another area in which customer involvement appears at first glance as counterproductive or irrelevant, but which Menguc and Yannopoulos (2014) argue can contribute to product innovation. For these researchers, the relevance of customer involvement in product design is a matter of capabilities (i.e., the ability of firms to deploy resources effectively, transforming inputs into desirable outcomes), explaining, thus, why two firms can use customer-related information in entirely different manners; similar resources are able to obtain substantially different levels of performance. Their perspective stems from the resource-based-view, which explains performance heterogeneity by means of giving more attention to capabilities rather than to the existence of resources *per se* (De Sarbo et al., 2007; Newbert, 2007; Menguc & Yannopoulos, 2014).

The key to customer involvement, in conclusion, lies in the type of involvement (type of activities and interactions) and the frequency and timing of such involvement (i.e., where and how often in the development stage it takes place). While companies prefer early and later stages, there seems to be a variety of potential opportunities for involvement, such as co-design opportunities and greater interaction with lead users that can support companies with information useful to the innovation process.

As shown, many studies state the importance of customer involvement in the innovation process and this is only a part of the framework this study uses to describe the information acquisition process. Employee involvement is also a valuable source of information that is more exact and applicable when compared to that from customers but is centered more on the means than the ends. The literature concerning this topic is not so vast, but the relevant studies will be presented and interpreted below.

2.2.3 Employee involvement

In order for an innovation to go from idea generation to development and then to implementation, many factors are required. Sundbo and Gallouj (2000) state that innovation is an interactive process, with a number of external and internal factors. The most important external factor is customer involvement, followed by suppliers and competitors. Customer involvement has already been presented; however, internal factors also have a great influence on innovation. These internal factors are employees, managers and R&D departments. In order for the study to include the most relevant aspects and literature, employee involvement, an important internal factor, will also be considered.

It is true that all companies have employees in order to carry out their activity. However, simply the presence of employees does not guarantee that they will contribute toward innovation. They can have responsibilities that do not include innovation, they can lack motivation, or the company can lack organizational structures for innovation. In order for employees to participate in the innovation process the company has to support them for this purpose.

The company can empower them to be product champions (Howell and Higgins, 1990), create an innovation group that is separate from the rest of the company (Benner and Tushman, 2003) or develop processes and tools to support more novel ideas (Kelley, 2009). Regardless of the chosen method, employees should be incentivized to produce ideas and discuss them with the relevant parties. The contribution of employees is valuable for innovation, but the company must decide the best way to involve them in this complex process.

Employees specify how something can be done, while customers, directly though their statements or indirectly through their purchase behaviour, specify what should be done. Even if customers are involved during the production process and come with ideas regarding the present and future solutions offered by the company, the feedback presented by them will consist of what should be done, even if it is a detailed set of information that includes each step to be taken. Employees offer technical knowledge, while customers offer market knowledge or, more precisely, their opinions and preferences are part of the market knowledge. Innovation is a process that balances the contributions of these two types of actors. Employees are not limited to technical knowledge because some departments are more technical than others and because they can accumulate a quantity of market knowledge by interacting with customers. In a similar way, customers can also offer technical knowledge if they are lead users or interested in a specific product from a technological standpoint.

In this way, the framework presented here, based on customers and employees, is more accurate than the third generation of innovation models because the focus is not only on technology and market, it goes into more detail about the people corresponding to each category. The human element is examined more thoroughly. Technology is a lesser issue than the people responsible for using and implementing it, the employees, while following the policies and procedures of the company. The issue is not what is technologically achievable, but what can be technologically implemented by employees, in order to achieve innovation because innovation can be achieved with existing technology, if it is implemented in a different way in order to suit the needs of the customers better.

Employee involvement plays a central role in the information acquisition process, together with customer involvement, as it is the means through which the company collects the information needed to close the information defect and to achieve innovation.

The employees considered for developing innovation are those who have stayed in the company for a longer period of time and who have accumulated tacit knowledge. New employees are less likely to contribute to innovation because of knowledge and organizational factors: they are expected to conform more closely to the rules of the company and are assigned to tasks that do not necessarily involve creativity. More experienced employees can have more leeway when approaching a problem, if management considers that their knowledge justifies giving them a greater degree of independence. The contribution of managers is also important, as they need to balance and lead the processes, while ensuring that the company is on the right track by fitting innovations with the chosen strategy.

A model that showcases the importance of employees is that of Sundbo and Gallouj (2000), where innovation in services is a result of employees acting as corporate entrepreneurs who are overseen by managers in order to control the entrepreneurial process. In this way, the focus shifts from traditional R&D departments to individual initiative, but in a corporate environment.

There are also other studies that state the importance of involving employees in the innovation process (de Brentani, 2001; Ordanini and Parasuraman, 2011). This is especially important for employees who interact directly with customers and know exactly how the offerings of the company are perceived by the market as a whole. Employees have the capacity to continuously adapt and customize the services offered, achieving innovation eventually through an evolutionary process of change. They may develop creative ideas that are important for organizational innovation (Zhou and Woodward, 2003). It is important for the knowledge and ideas of employees to be allowed to circulate through the organization, which is why meetings between different departments are useful.

Engen and Holen (2014) reach the conclusion that employee idea collaboration is related, to a reduced extent, to innovation. However, their limitation is that they are centered on the service industry in big companies. Also, their methodology is based on questionnaires, rather than a detailed longitudinal case study. The concept of employee idea collaboration also needs to be further defined, as it can mean informal

communication or organized meetings with management supervision. The contribution of employees in achieving innovation needs to be further researched from multiple viewpoints.

The literature of employee involvement in innovation presents them with more discretion and initiative than is usually the case in most companies. Some companies empower them to be product champions, with additional resources to explore, study and create promising, and complex, products and services by using future technologies (Howell and Higgins, 1990). This empowerment is a way to let loose the enterprising spirit of the employees in a similar way to that of the established managers who brought the company its initial success. The incentives offered by the company are not only for the senior management, but for all employees who identify and follow through new enterprises. In order for the employees to contribute to innovation in this way, the company must maintain the internal markets, composed of internal autonomy and internal competition (Chandy and Tellis, 1998). Internal autonomy is the autonomy granted to division managers when compared to the corporate office. Internal competition is a possibility for employees and departments to compete with themselves in identifying new technologies and achieving innovations in a fair environment. In this way, employees will feel challenged and also motivated to do quality work, knowing that their achievements are recognized and implemented by the company.

In the literature, the way in which skilled labor influences innovation is examined (Tellis, Prabhu and Chandy, 2009). The term labor is used with the meaning of a skilled workforce at the firm and at a national level. That study examines, among other variables, how an educated and skilled workforce in technical areas determines new products. The level of national labor is examined as a sum of factors: scientists, research institutions, education budgets and the quality of management schools. The results of the study show that national labor has a reduced influence on innovation, as opposed to firm labor, which is described as the percentage of R&D employees within the company. Differences in the structure of employees between companies are more important than those same differences between countries when pursuing innovation.

It is agreed that there are several paths toward innovation (O'Connor and DeMartino, 2006). One is by obtaining new capabilities by new technologies and by acquiring new companies that have them. Another approach is through organic growth through new lines of business that are identified and developed within the organization by groups of employees. Incumbent companies have difficulties in obtaining and commercializing products based on innovation. New companies have the opportunity to sell innovative technology at the expense of incumbents (Utterback, 1994), which is why the second path towards innovation, the organic one, is the most worthwhile even if it is more difficult to pursue.

The reason companies have difficulties with obtaining innovation is that they see it as an outcome instead of a process. They are too focused on efficiencies of scale and scope and on core competency areas that, in time, become core rigidities or even core incompetencies (Dougherty, 1995). They are used to a quick conversion of time and resources into profits; however, innovation can require several years, even a decade, until the financial returns are noticeable. The factors that contribute the most to the

success of innovations are senior managers, product champions and employees (Howell and Higgins, 1990).

Building an innovation capability or putting together a team of employees with that purpose is a difficult process for a company. This capability is something foreign to the usual processes of the company, focused toward operationalization and efficiency. A clear set of roles and responsibilities must be implemented in order to make the process achievable and sustainable. The group of employees delegated to researching innovation must accumulate experience, in order to understand the target phenomenon well enough to articulate and codify it (Zollo and Winter, 2002). The dedicated group will accumulate more complex experiences than in the case when routines are simple, and the process structures are rudimentary.

Large, incumbent, companies have one advantage over start-ups: they have more room to learn and experiment with new routines if they direct resources toward this purpose. Start-ups are propelled by a newly discovered process or technology, but incumbents can use more resources in obtaining the same result, even if they spend them less efficiently. Because incumbent companies usually do not make good use of their employees and do not implement the organizational resources necessary for obtaining innovation, they are surpassed by new entrant companies, which develop suitable processes.

The literature is divided on the topic of the ability of incumbent companies to obtain innovation. Jelinek and Schoonhoven (1993) argue that innovative companies have the mechanisms required for major innovations. They state that clear reporting relationships and a separate organizational group are required, in order to ensure that there is both creativity and discipline throughout the company. As opposed to this view, most of the literature states that separate organizational structures for achieving innovation are, in most cases, something that should be implemented, as they are not already in place. These should be implemented in order to arrive at professional business models and processes that are required to achieve rapid growth, with enough capabilities that they are not required to conform to the existing mainstream operating models (Rice, Leifer and O'Connor, 2002).

The organizational group responsible for achieving innovation should be physically and culturally separated from the rest of the company, in order to ensure the best results (Benner and Tushman, 2003). However, this separation has to be at the product level rather than system level, to make the innovation easier to implement throughout the company. The reason behind the separation is that employees in the innovation group should not be pressured to obtain the same results with the same efficiency as the other departments. Consequent to the nature of the task being different, the evaluation criteria should also be different. The separation should create a different working environment, but should not hinder communication, as it is especially important for leveraging and stretching current competencies, while building new ones.

An alternative approach to establishing a separate organizational group and changing the organizational structure is to develop processes and tools in order to support more

novel ideas (Kelley, 2009). These processes and tools can be designed as communication vehicles between people pursuing an innovation activity and the rest. In contrast to creating a separate group of employees, this approach aims to achieve innovation by involving a greater number of people in the process.

There are also examples of companies involving employees in innovation and the richest in information and the most illustrative are those in the technology industry. In the case of Google, several innovation practices went beyond investing in advanced technology. The company had an extensive number of means to involve employees that were experimental in nature. Some involved setting up meetings about technology, cultural events, designing the offices to enhance communication, supporting employees and providing a new set of performance metrics and requirements. These experimental methods made it clear that the company had a fearless attitude toward failure and chaos; hence, the company had an extensive and developed information acquisition process and was in an enhanced position to achieve innovation.

The role of managers in innovation, also, cannot be understated, as they are in a position to enable, support and implement it. They can also oversee the interaction between organizational members and external partners. Managers can aid in the creation of a learning environment for employees that can be conducive to innovation (Damanpour, 1991), as well as establish a climate of acceptance and tolerance towards diversity within the group. A supportive culture towards innovation and an organizational design that can be easily adapted allow managers and employees to pursue creative work. The enhanced communication can permit employees to engage in debates and have divergent ideas. This degree of autonomy is translated into a greater amount of empowerment that allows employees to pursue ideas as if they are independent entrepreneurs with access to funding and a team of dedicated individuals.

The steps and activities that are required to lead the innovation group remain unknown; consequently, managers have a difficult task ahead. There is no consensus on the degree of formalization, as in some studies it supports radical innovation (Oke, 2007), while in others it simply supports incremental innovation (Jansen et al., 2006). The innovation group must be led by managers depending on the situation and it must adapt quickly. Many companies, even if they make an objective in reaching innovation, fail because they do not organize their employees well and involvement from managers is lukewarm. Measures such as encouraging employees to think creatively, communicate ideas and take responsibilities are welcomed, but sometimes more direct measures are required from managers, such as changing the ways of working, organizing people differently and creating innovation groups, and these are rarely taken.

Communication between employees is important as it determines knowledge sharing; this, in turn, enables innovation. Innovation groups further enhance communication, as people are encouraged to discuss problems and state their opinions on possible solutions to be taken. The managers can also facilitate this process, or specific individuals can act as a driver or coach. Innovation groups can function in a similar way to long term dedicated workshops, in order to share best practices and further the understanding of the business. These form the basis upon which more complex ideas can be elaborated and solutions implemented.

By introducing a new organizational structure such as an innovation group, the approach views it as a social process determined by the contributions and motivation of the employees. It is essential to determine what triggers each individual in order to find the best way to motivate them. Innovation is encouraged by making everyone understand that they can contribute to the creation of value. The innovation group must be set in an environment where people feel supported and must be characterized by openness and engagement. The goals must be structured, but the approaches to reach them must be less so, as every employee must be allowed to have his own interpretation about the needs, problems and solutions and communicate it to the others. The goals must be clearly defined so that all employees have a clear impression of what is required from them and, subsequently, they must be allowed the autonomy required to construct an individual approach.

Some managers treat innovation as something that happens on a daily basis, when solving issues and problems in teams or meetings. However, innovation must not be confused with problem solving, as it is not immediately necessary and is more proactive in scope. Some companies do not have structured groups or processes for innovation and claim that every situation is unique and requires creative thinking, so it is more like pursuing innovation on the go. This is a reactive approach and is not indicative of long-term thinking or planning. Employees in these companies are not actively encouraged to pursue innovation.

Innovation may also come from departments other than R&D, such as internal processes or customer support. It is acceptable and worthwhile to reach out and involve employees in innovation that are not usually responsible for identifying new ideas. Having a broad base of employees actively contributing toward innovation makes it more likely to achieve and to create value outside of the usual areas (Birkinshaw et al., 2011).

Units outside of the traditional R&D can contribute with high scores to the innovation index. Front-line employees have specialized knowledge accumulated while conducting their activity, such as the details associated with a new product launch, the way to set up effective customer contact or improving technical solutions. Internal process departments can also contribute by improving IT services. The advantage that these employees have is their proximity to the customer. Customer support employees have direct access to their customers, as they interact with them daily. If employees have a good understanding of the customers and their issues, they will find it easier to generate ideas and to take subsequent actions to put those ideas into practice (Dougherty, 1992). That is why the contribution of employees from different departments is especially important in an innovation group.

Developers from R&D departments do not often come in direct contact with customers. The responsibilities to identify new product needs is delegated to the marketing department. However, an important amount of information is lost when departments send information to one another. That is why innovation groups contribute to the circulation of knowledge, as employees can directly communicate. If developers have an enhanced understanding of customer needs, they can integrate customized improvements directly into the design step of the product development process. If R&D departments have an implemented way of working with customers, this can enhance the

innovation process. Communication between people with different viewpoints can aid in obtaining a more thorough solution that is suitable in a wider range of contexts.

Innovation tends to be associated with product development as opposed to improving processes or identifying new business opportunities (Nijssen et al., 2006). However, there are also studies that center on the contribution of employees towards innovation in services, such as Sundbo and Gallouj (2015) who identify a number of innovation patterns and, in some, the employees have a pivotal role. In the neo-industrial variant of the classic R&D pattern, both technology and the contribution of service professionals determine innovation. In the service professional pattern, found in medium sized firms in knowledge-intensive services, the main driving factor is individual expertise and competencies. In the organized strategic innovation pattern, there is no R&D department; therefore, everyone is responsible for creating new ideas. There is only development that is accomplished by projects teams. In this pattern, the innovation policy is supported by two important actions: knowledge collection and quality control. The employees have the autonomy to act as corporate entrepreneurs, but the corporate entrepreneurial process is controlled by management, based on the strategy and goals. The innovation process can start with a corporate entrepreneurial phase, followed by a guided development phase and ending with a marketing activity in order to evaluate the obtained result.

Communication, along with reputation and image are part of the initial message received by customers. Image is important because, in the service industry, customers might be less aware of the offer range provided and more aware of the institutions behind them (Easingwood and Storey, 1992). Communication influences perceived service quality and company image can perform similarly to a filtering device (Zeithaml, Berry and Parasuraman, 1993). External service quality is influenced by internal service quality. Employees are willing to provide a high-quality service in the extent to which they are treated fairly and properly supported to do their job.

Involving the customers is easier if the company already has an established reputation. The activities through which this involvement runs its course are conducted by employees. In order for them to successfully interact with customers for innovation, they must first be able to know how to interact with customers in a usual setting. Employees will allow the company to innovate after collecting knowledge from the market by interacting with customers and forming a general opinion about the processes and distribution systems of the company and how these overlap with market needs. Employees will know whether a specific product or service is received by the market and what barriers and difficulties customers encounter during purchase or use. They will also have an initial idea of how to remove such barriers and these need to be extended through meetings or innovation groups in order to create new products or processes that are suitable for wider market segments.

When using innovation to develop new tangible products, product advantage is considered the number one success factor. In services, the service itself is less important than the perceived quality of the interaction with the customer and this is determined by the skills of the employees (Cooper et al., 1994). The empathy, responsiveness and assurance of frontline staff has a direct effect on how customers perceive service qual-

ity. The quality of the launch strategy is also a key factor for the success of new implementations. There is merit in internal communications and employee training, as a culture of support for the new product or service is established and employees are provided with the relevant instructions and knowledge.

Employee involvement is not only important by itself, it is also a means through which customer involvement is carried out, as employees are responsible for this interaction. Customers must be able to clearly see that the new products and services have improved characteristics, enhanced performance and additional features; consequently, employees must be able to present them convincingly and professionally. Innovation does not stop with the creation of new products and services, it also includes commercialization and marketing strategies. Internal communication is sometimes called internal marketing and relies on the knowledge of employees in order to successfully launch a product. A considerable factor is also staff training, as it can influence the quality of a launch strategy (de Brentani, 1991).

A company's innovation process can be defined in dual terms of technology and market drivers; a key factor influencing the success of a new product or service is the extent to which the competencies and resources of the company are used, and these include the skills and knowledge of the employees. Innovation can be considered as a discontinuous venture and this type of initiative has a lower resource fit than improvements or line extensions. The company is left to operate in uncharted areas, with obsolete information and longer development times which is why the knowledge of employees is essential, as especially skilled individuals can bring their own experiences and competencies to the table, in order to supplement the knowledge store of the company. Launching an entirely new core offering in the service industry is even riskier because of the highly intangible nature of services and because they are perceived by customers to be closely related to the company's reputation and past business history.

The importance of employee knowledge is the reason for creating innovation groups and for promoting employees to be product or venture champions as their experiences from the field can direct the company efforts in worthwhile directions and horizons. Innovation is not simply discovered but is a result of proper organizational structure and processes. The priorities set by the company, the decisions taken by the managers and the work carried out by the employees can significantly increase the likelihood that innovation will be achieved. For example, for a company that sets out to accomplish innovation there are several ways to do so. One is a formal system relying on managers to move things along and to minimize surplus actions and expandable steps. Another is a company that encourages creative potential, fosters a culture of collaboration and involves employees differently in order to benefit from their skills and knowledge. Neither path can be said to be right or wrong; each depends on the priorities of the company and what it sets out to do. However, what is clear is that if a company wants to pursue innovation, it must actively engage this objective by changing its organizational structure and by creating innovation groups that are specialized for that purpose.

2.3 INNOVATION AND ROUTINES

Innovation is based on the ability of the company to create and implement new knowledge. Routines are a way to convert information to knowledge. By performing routines, the company is able to carry out a learning process. Organizational learning represents improving practices and expanding into new areas by creating new knowledge (Senge, 1990). A learning organization is skilled at creating its own knowledge and at modifying its actions and behavior according to this new knowledge (Nonaka, 1994).

A classic theory about organizational learning is based on the assumption that organizations are based on routines that allow them to repeat successful behaviors and give up on those that were not (Lundberg, 1995). The adaptive learning concept states that learning by doing leads to creating or adjusting routines that can give them a competitive advantage (Van de Ven and Polley, 1991). Learning describes the collection, transfer and depositing of information and knowledge in a company (Huber, 1991; Levitt and March, 1988). In contrast, this study interprets learning as collecting information and converting it to knowledge. This slightly different approach is caused by viewing information and knowledge as separate concepts. Knowledge is more specific to the company and is easier to apply.

Routines can also be improved, and this leads to organizational change and expands the potential for learning (Feldman, 2000). A change in routines influences innovation more than a change in the features of a product. Routines are seen as structured activities that are repetitive and allow the building of capabilities. The examination of routines is linked to the fact that they assist in the examination of the development process of a company at a micro level (Nelson & Winter, 1982).

The process of change can be interpreted as an initial step towards innovation. A deliberate strategy can influence the process of innovation more than internal or external factors. A change in routines can determine improvements in outputs, processes, marketing strategies or business models. To accomplish this, the company should use its new knowledge to make changes that can create value and opportunities. The potential for change is included in the routines the company uses to organize and carry out its activity. The routines allow change, but they are also a source of stability.

The stability characteristic of routines is noticeable when considering replication. The exact transfer or replication of a company's routines can allow it to increase its operational capabilities and performance (Winter and Szulanski, 2001). Replication consists in creating a number of subsidiaries in different locations that deliver the same product and services, to better capitalize on the knowledge assets of the company. The replication of a routine is how competitive advantage is gained (Teece et al., 1997).

The tension between replication and innovation which implies changing or adapting a template is called the replication dilemma. Examination of the tension between innovation and replication has been limited in scope until now. The focus has been on simple organizations, where the incentives to innovate are not so high, because of the

relative simplicity of the routines, the business environment and the company (Szulanski and Jensen, 2008). It is relevant to ask how the dilemma can unfold in more complex organizations where it is unclear whether is better to pursue innovation or replication.

The exact replication of routines and technologies can provide new insights on how the replicating companies perform across business environments and locations. It is possible that social ensembles can create complementary and competitive routine dynamics which can affect the organization's ability to address its objectives.

Change by itself is not required to create improvements or innovations but, in an organizational context, a change in template is a change in the transfer of routines. This can influence the creation of a different product or service, which is better or worse than the original, so there is a potential for improvement. If the change is substantial and is set in a rapid and competitive environment, it can influence the creation of an innovation.

2.3.1 Routines

A routine is a repetitive, recognizable pattern of interdependent actions, involving multiple actors (Feldman and Pentland, 2003). This section examines routines as processes and their relationship with practice theory and organizational dynamics, in order to determine the extent to which they can be integrated into this study.

Organizational routines are a set of collective actions in the organizational workflow that contain knowledge (Becker et al., 2005). They are the pattern in which organizational knowledge is represented in order to support the employees' knowledge (Hansen and Vogel, 2011). Routines are the basic preconditions that support a suitable and efficient working environment.

Because of the inherent internal complexity of organizations and the shifting environment in which they operate, routines are a way to shape and manage the entire organizational activities, across departments and subsidiaries (Hannan and Freeman, 1983). They support and direct the way employees are doing their job, by creating a secure and stable workplace meant to counterbalance the complexity of job interactions (Kim et al., 2011). Routines as a concept need to be understood in the context of modern dynamic working environments, as they can influence the work output characteristics and innovation.

The routines terminology has been introduced by Stene (1940) and, since then, they have been considered as the primary means through which companies carry out their activities. They have been documented as a source of inertia (Hannan and Freeman, 1983) and inflexibility (Gersick and Hackman, 1990). Even so, organizational routines also have the inherent capacity to generate change, by their simple ongoing performance (Feldman and Pentland, 2003). This phenomenon has been labelled by Cyert and March (1992) as adaptation and by Nelson and Winter (1982) as mutation.

Routines are important to this research because they are a way to convert information in knowledge by learning. Organizational learning consists in refining procedures and

gaining capabilities by creating new knowledge (Senge, 1990). This knowledge is created by acquiring and interpreting information (Brown and Duguid, 1998). Routines are indicative of the learning process and of obtaining knowledge from information. Routines are the practices, guidelines and processes that have performed the best until the present time. This approach to routines considers them a way to carry out operational activities but also to learn and obtain new knowledge. By changing its routines, a company can obtain knowledge quicker or identify new knowledge to be used. This new knowledge stands at the base of the innovation process.

Routines can be theorized as practices (Feldman and Orlikowski, 2011). This means that they are linked with action, do not exist without it and they materialize by putting them in practice. Routines receive this name because they are activities that must become established within the organizational structure. Each stage or phase entails the establishment of a certain number of routines, which enable individuals and teams to have clear objectives and enable critical reflection on the nature of those same activities. While appealing from a theoretical perspective there is, yet, a lack of consensus among authors regarding the number of routines that should be included in the innovation process. Some researchers, for instance, propose a relatively short list of 13 routines (Eveleens, 2010), while others go as far as proposing a list of 50 routines for organizations to follow (Cormican and O'Sullivan, 2004). This lack of consensus means that the study of innovation processes is ongoing and that a series of important challenges remain, which makes general theory a complex task: firm size, business models, product characteristics, risk management practices and knowledge management practices are, among others, complex issues that the study of innovation must tackle.

The perspective on routines as processes states that they have a dynamic that allows individuals to choose between different actions depending on context. People take multiple actions and establish links in the course of going through multiple iterations of a routine. Pentland and Rueter (1994) introduce the term of effortful accomplishment in relation to routines which means that individuals repair the cycle if this is something required, so that it continues to produce outcomes similar to those previously obtained. In contrast, the term emergent accomplishment refers to new ideas and outcomes that are obtained when individuals have better knowledge on what can be achieved.

The dualities encountered in practice theory between action and structure on one hand and between stability and change on the other are also valid for routines. Since there is a duality, and not a dualism, between these terms, they are mutually constitutive. Stability and change are part of the same rather than separate dynamics and they can both be explained by routines.

Another way to explain the duality between stability and change in routines is the punctuated equilibrium theory (Gersick, 1991). This states that individuals can ignore small changes in a context or system until they accumulate in order to form really big problems, so that routines have to be abandoned or changed in order to solve the new issues. This study also considers the change in routines but interprets it to be more continuous than what is stated in the punctuated equilibrium theory. Routines are a source of both stability and change, but it does not mean that it is necessary for problems to appear so that the company reworks its routines. Managers are responsible

for switching between stability and change with the use of routines. Stability can be required in times of crisis and change may be required when the old ways prove to be obsolete or there are opportunities the company can benefit from. Knowing when to switch gears is left to the managers and this is done by restructuring the dynamic system of routines of the company.

Feldman and Pentland (2003) state that routines are made of two parts: the ostensive part which is the abstract understanding and the performative part which is the actual performance of routines carried out by certain people at specific times and in specific places. The ostensive part is reminiscent of structure, while the performative part echoes agency.

Routines have been interpreted as rules (Becker and Zirpoli, 2008), behavior (Pentland and Rueter, 1994) and action (Pentland et al., 2012). This pluralism of interpretations that can ultimately lead to confusion or at least a lack of clarity, is precisely the result of separating routines in an ostensive and performative part. If routines are interpreted as behavior, then it is challenging to identify them because of the multitude of possible manifestations. Perhaps a better approach would be to consider them as structured behavior or habits in the workplace. In this way, visualizing a set of patterns makes it easier to identify and explain the routines. Researchers have also focused on routines as actions or steps used by actors to accomplish organizational tasks (Pentland et al., 2012). This is a good approach and this study will use such interpretation of routines. However, there are difficulties when equating rules with the ostensive part and behavior with the performative part of the routine. Rules are artefacts that can be mistaken for the ostensive part of the routine. They are more like indicators for the ostensive aspect or effort to codify the ostensive aspect. As there are no easily identifiable synonyms for the ostensive and performative part of the routines, it is easy to make mistakes when it comes to the terminology; therefore, the study will treat them as such and not try to equate them with something which they are not.

There is a metaphor of routines as truces, which explains how misunderstandings and arguments can be resolved with managerial implication (Nelson and Winter, 1982). There has been a lot of focus on the routine's internal dynamics and the multiplicity of ostensive and performative aspects. Individuals of multiple typologies produce routines according to their requirements, preferences and interpretations. Organizations can have both coherence and the ability to change through routines and their ostensive patterns (Turner and Rindova, 2012).

In more complex and distributed cases that present high task complexity and ambiguity and increased organizational heterogeneity, routines are not likely to make all the actors in the organization content. It is also a stretch to say they can be easily mapped in common objectives. Several conflicting but coexisting performances are not easily harmonized over time and across organizational locations in which there are equally strong and competing actors (Birnholtz et al., 2007).

Stating that routines are made of parts like Feldman and Pentland (2003) do, can by itself be misleading or incorrect, because parts imply segmentation, but they go on to clarify that these parts are recursively interlinked in practice and mutually constitute

each other. Research on routines has been centered on specific tasks, such as designing, manufacturing or packaging routines. They have shown the tasks that are carried out while innovating and not the entire process of innovation. This also fails to address how new action emerges within organizations (Obstfeld, 2012). It can be shown that a change in routines can result in new procedures and new actions that are indicative of a new learning process.

Routines are assumed to be embodiments of knowledge which have been theorized as mechanisms of organizational learning for innovation (Zollo and Winter, 2002). This definition makes it clear that a company learns and obtains new knowledge through its routines. Routines are related with the information acquisition process, in the form of the passive experiential process of learning and the more complex cognitive process of codifying and exchanging collective knowledge. Operating routines are responsible for the operational functioning of the company.

The duality between stability and change of routines has to be considered again. Routines can influence stability, but they are not a source of intrinsic change. Change happens by modifying routines such that, after the restructuring, the company will have a new set of routines. This is in line with what was said in the previous section, that managers are responsible for switching gears when the situation requires it. Routines are a source of stability, but the company's strategic planning can require them to be modified, in order to ensure that its practices are up to date and relevant when compared to the market. Innovation can be interpreted to be precisely the result of a series of changes to routines. However, innovating companies carry out these changes not because of necessity, but because they want to be one step ahead of the competition. Innovation is the result of a proactive approach, in which the company uses its resources in a different way, to obtain a new result.

The business environment requires that organizations go through a process of continuous change, in order to maintain their position in the market and their competitive advantage. Organizations, by following routines, create the preconditions for a smooth workflow process (Feldman and Rafaeli, 2002). By having a set of requirements that employees are urged to follow, they are more likely to produce new conducive ideas, which are a step towards innovation. It is debatable whether routines can directly influence innovation. However, by managing the work process and making it easier for employees to organize and share the work volume, routines have at least a supporting role in creating and obtaining innovation.

In the literature, opinions are divided on routines being a productive source of innovation. The studies that agree with this emphasize that routines are responsible for companies undertaking innovation, as they can be changed together with norms and procedures. Setting suitable routines will allow the company to be in a position to innovate, as all the operations activities will partly contribute toward this purpose (Edmondson et al., 2001). Routines by themselves will not have any influence on innovation, what matters is their suitability, reliability and performance. Managers are responsible for observing routines within organizations and monitoring the influence on innovation. If they see that existing routines hinder or discourage innovation, it is their job to see the extent to which the intrinsic policies and procedures of the company can be changed in order to promote innovation.

There are other authors who are more reserved towards the ability of routines to nourish the creative potential of employees. For example, Runde et al. (2008) state that by setting additional rules and procedures, innovation will not be promoted within the company. Setting formal rules inside the working environment will be translated into a reduced flexibility and also reduce creativity as the potential for new innovations is lowered. Hoeve and Nieuwenhuis (2006) also state that organizational rules and routines are the main sources of inertia and, for that reason, blocking stages appear. However, it is not clearly demonstrated that reduced flexibility determines reduced innovation potential. Flexibility by itself cannot determine innovation, as a general sense of direction is also required. Finding the right balance between flexibility and direction is the key to creating an environment capable of fostering innovation.

The contradiction between routines as a source of both flexibility and inflexibility can be resolved by considering the fact that routines themselves can change. This can happen in the early stages of establishing a company, in periods of ambiguity, but also in old established organizations in stable environments. A routine can also be considered as the best rules and procedures implemented by a company at a specific time and in a specific environment. If the routines are a source of inflexibility, the fault can be attributed to the company and managers who did not take measures to change them when it was required.

Routines have been compared to individual habits, as they are automatic and require no thought (Stene, 1940). They have also been likened to programs, heuristics or scripts (Carley, 1996). This comparison is more encompassing, as programs are more complex than habits, as they include branches, choices and decision points but, in the case of routines, these are known in advance. They are also compared to genetic material, as they are a persistent feature of an organization and determine its behavior, in the same way genes influence organisms (Nelson and Winter, 1982). All these metaphors are indicative of the inertial characteristics of routines and do not show the potential for flexibility and change.

Even so, the potential for change is present and this is made obvious by routines being the product of organizational learning (Argote, 1999). Routines are the result of a continuous process of change called organizational learning, meant to reduce variability, ensure standardization and prevent failure which means routines are the product of change and their inflexibility during a specific time interval has numerous reasons. Some of these are minimizing costs, increasing managerial control and enhancing the legitimacy of the organization. That is why organizations do not want to reinvent and revise procedures that are already in place. This will cost significant time and effort, so there is an efficiency reason. There is also a legitimacy reason, as employees and other actors will be suspicious if the norms and procedures change too often. Organizations have legitimacy as institutions precisely, because of their behavior, conform to established norms.

Routines are a way to avoid arguments in the organization, by ensuring that all employees agree on what needs to be done and how. The priority is getting the work done and routines influence organizational participants to put aside their differences and work together (Nelson and Winter, 1982). In this instance, routines are interpreted as an agreement on how to do the work. Managerial control is also a way to

ensure standardization, but in this case, disagreements are suppressed more often than reduced. The company does not need differences in opinion during the operational activities, as this can mean wasted resources and efficiency.

Routines are composed of organizational capabilities and knowledge and are a result of organizational learning, so they function in a similar way to memory (Huber, 1991). The knowledge and capabilities collected over time by the company are stored in routines, considered to be a collection of best practices. When routines must change, this is often because of external circumstances that require increased performance. Even if, in the literature, the more stable and rigid aspects of routines are emphasized, they remain a part of organizational learning and are capable of change when this is required.

Routines have a duality of structure and agency. The structure is the abstract idea of the routine, while the agency is actually carrying out the routine by specific individuals. Along with flexibility and change, it is also easy to leave out the considerations of agency, but these are important because people perform the routines. The reason why agency is often left out of the definition of the routine is that people do not decide or modify the routines they follow. If organizational routines ensure cognitive efficiency, this results in the absence of agency from the routine itself. If factors cause the creation of modification of the routine, they are considered to be outside of it. In this way, routines are past decisions that only have to be revised when circumstances change (Weiss and Ilgen, 1985). The literature shows that even when circumstances do change, routines are often not reconsidered for revision (Morison, 1966). That is why the concept of agency is important, because people are responsible for creating and revising routines in order to be suitable for the environment in which the company operates.

In order to overcome the plurality of interpretations, routines are considered in this study as actions or steps taken by actors to perform organizational tasks (Pentland et al., 2012). The duality between the ostensive and performative part, the structure and agency, and stability and change are also considered. Routines are patterns of knowledge and show how this knowledge can be put in practice by individuals in order to carry out their activity. Routines can be linked to knowledge, because they are a pattern through which organizational knowledge is represented in order to support the knowledge of the employees (Hansen and Vogel, 2011). Routines are also the product of organizational learning (Argote, 1999). They are indicative of the knowledge store of the company and are the way in which the company puts this knowledge into practice. Knowledge can determine better routines and better routines increase the amount and quality of the obtained knowledge, so the relation is cyclical and iterative. This is a link that has to be studied thoroughly. The best way to do so is to consider the change in routines and feedback loops.

2.3.2 Change in routines

It has already been mentioned that routines incorporate both elements of stability and change. The thesis is more interested in the change in routines and how this is accomplished. There are multiple ways to explain this change.

Routines develop through the repeated execution of a behavior or, in case of a skill, through practice (VanLehn, 1996). When the skill is acquired, performance becomes faster, the attentional load on the person is reduced and performance requires less conscious processing (Norman and Bobrow, 1975). On one hand, routines and creative actions can be seen as competitors (Ford and Gioia, 2000). However, routinization frees cognitive resources to think about other aspects of work. This allows creativity and innovation as more cognitive resources are directed towards them. Creative actions will appear when the company has to distinguish itself from the competition. Routines are useful for their stability, but they have to be adapted and improved when the environment is confronted with a substantive change.

The definition of routines as patterns of behavior that do not change much in subsequent iterations (Nelson and Winter, 1982) is not consistent with this research. It has been stated in the literature that routines undergo substantial change. Though change is not seen as a dominant aspect of organizational routines, many scholars have acknowledged it. There are a number of reasons for change in routines: a new business context, noticing a failure, obstacles in developing and launching a product or a modification in organizational structure (Gersick and Hackman, 1990).

There are financial crises or new trends in industries that cause routines to change. Technology is one explicit impetus that was shown to bring changes in how the work is organized (Orlikowski, 1992). Large external factors such as new beginnings or major transitions can change the way the work is carried out, but they are not the only way in which organizational routines change. The possibility that routines are continuously changing has to be examined.

Some evolved tasks can be considered to be routines and their stability depends on the organizational context, their characteristics and the traits of the individuals who implemented them (Miner, 1991). Change in organizational routines can be the result of managers at the middle level, as opposed to decisions by top management (Burgelman, 1994). In order to understand routine change it is necessary to include the role of the influencing variable called agency.

Routines have the characteristics of both stability and change, as stated by Pentland (1995) who uses a grammatical analogy which is that routine is a pattern of multiple actions that can be chosen by individuals depending on the task and context. This pattern can be considered a repertoire of actions. The choice of what action to take is influenced by the preceding actions and by the grammar or rules stating which actions go together.

Routines have some variation as they are put in practice because they are not mindless but effortful accomplishments (Pentland and Rueter, 1994). Change is present in the repertoire of actions, but the repertoire itself and the rules that influence choice can also change. Routines are not only effortful but also emergent accomplishments (Feldman, 2000). The source that determines a change in a routine can be an external influence, but it can also be the internal dynamics of a routine. Routines can be interpreted as being loops of ideas, actions and outcomes that influence one another. Change is caused by the succession of these components. It has to be noticed that this transition is not always smooth and linear. Ideas can generate actions that do not put

the ideas into practice. Actions can generate negative outcomes that require new actions to be implemented. Expected outcomes have the potential to generate new ideas.

This perspective on change in routines considers agency as an important aspect. A better understanding of a routine can be achieved when the people performing the routine are not separated from the routine. The reactions of individuals are situated in institutional, organizational and personal contexts. Their actions are motivated by will or intention. All of these elements that influence organizational routines create in them a significant potential for change. The internal dynamic of a routine can include the reactions of the participants to the results of previous iterations of a routine.

There are several reasons why participants in a routine change them: not attaining the required company objectives, noticing some new problems or the possibility to gain from new resources and new opportunities. A greater efficiency can be achieved by obtaining a greater effect for the same effort, or the same effect for lesser effort. The efficacy is related to achieving the objectives of the company, so the change influences what the routine accomplishes.

There are researchers that have indicated routines are a source of organizational learning, but the view is not widely held. Another way to say it is that engaging in the process of organizational routines can be a process of learning. Individuals do things, see the results and make changes because of routines.

Nonaka and Takeuchi (1995) see learning as a process that takes place across levels of hierarchy within an organization. In contrast, Feldman (2000) sees it as a process that takes place within organizational routines. The process of change in is also a process of learning where individuals take actions and the company interprets them.

Change in routines can also be compared to dynamic capabilities. These examine the sources of wealth creation and capture by companies (Teece et al., 1997). Dynamic capabilities are new forms to achieve competitive advantage. The term dynamic refers to the capacity to adjust capabilities and innovate to respond to the changing business environment consisting in better planning requirements, technological advancement and increase in competition.

The term capabilities emphasize how management adapts, integrates and reconfigures organizational skills, resources and competences to be able to function in changing markets.

Competences can provide competitive advantage and profitability only if they result from routines, skills and assets that are new or difficult to emulate or imitate. A particular set of routines can lose their value if they support a competence which is not relevant in the market, or if they can be easily replicated or emulated by competitors. Imitation happens when a company discovers and simply copies another company's organizational routines and procedures. Emulation happens when companies discover alternative ways to achieve the same results.

In most cases, the capabilities and routines of companies are difficult to replicate. The difficulty in replication can be determined by the complexity or lack of transparency

of the procedures and the technologies that are used in the company. There are sources of competitive advantage that are so complex that the company itself, let alone its competitors, does not understand them (Lippman and Rumelt, 1992). Many organizational routines are tacit in nature (Nelson and Winter, 1982). Imitation can be hindered because few routines are independent. Coherence may require that a change in one set of routines belonging to a segment such as production requires changes in another belonging to a segment such as research.

Routines are the key to understanding change at the level of the organization. In this context, the lack of change is defined as a behavior that continues to be guided by the stable and usual routines. A real change is one that will influence innovation and will require a change in routines. The routines are fundamental to change as they are sometimes designed to produce it or provide access to sources of an endogenous change (Nelson and Winter, 1982). Routines allow to see in more detail how change manifests and how it is carried out by the representatives of the company. Considering routines allows the researcher to look at dynamics at the micro level and identify driving forces of change at that level. The driving forces of change are connected to organizational routines.

Routines are part of the organizational memory and represent knowledge. To create new routines sometimes requires to convert tacit from explicit knowledge. Tacit knowledge can be influenced by its bearer when applied and replicated, thereby presenting a source of endogenous variation. It is important to examine how tacit knowledge is stored, accessed and implemented. This can offer insights about the biases and drivers of change.

The modification and adjustment of the routines by individuals as they do their work can result in discovering new ones that are more suited to business requirements and to the market. Such a dynamic might involve the physical and social dimension of organizational routines (Nelson and Sampat, 2001). The physical dimension is like a recipe or program. The social dimension is how the work is divided among individuals and organizational units and how they are guided and overseen.

Simply performing a routine is enough for it to change and be improved, as opposed to requiring some specific external agent. That is because a routine produces an outcome that can be examined and interpreted. If it is the case, the routine can be changed in order to achieve a better outcome, solve a specific problem or because a new opportunity has appeared. The process of change is incremental and is an ongoing accomplishment. If the environment changes, it is possible that the company needs to change its routines in order to adapt.

Changing or improving a routine is an act of learning. The position of the company depends on the path it has travelled and what it has learned along the way. Its history is determined by its investments and repertoire of routines. Learning tends to be local, so the knowledge the company has collected is tacit in nature. Learning depends on past activities and concerns specific processes and environments that are connected to the company and that are known in detail.

Routines are how organizational learning for innovation is carried out (Zollo and Winter, 2002). They are also the product of organizational learning (Argote, 1999). If both

definitions are considered, we arrive at an iterative process. The company learns, obtains new knowledge and then improves its routines. The improved routines create a new learning process and another set of knowledge. The cycle is continued until the company obtains innovation. A good way to illustrate the cyclical nature of learning and improving routines is through feedback loops.

2.3.3 Feedback loops

Feedback is present when the output of a process is the input of another iteration so that a circuit or loop appears. In these conditions, it is not enough to identify causes and effects, as the model as a whole has to be examined. Feedback can also be defined as the amount needed to fill a gap to a reference value (Ramaprasad, 1983). The feedback loop forms a closed sequence of action and information (Richardson and Pugh, 1981). Feedback loops can also be applied to management systems in order to better understand their behavior. The feedback structures can give valuable information about the patterns of behavior of that system.

An open loop is a linear chain of causes and does not close. In general, feedback loop systems do not use open loops, or they use them as sparingly as possible, because they present a linear sequence of events and do not consider the full spectrum of implications when pursuing a course of action. A diagram consists of elements and arrows that can also be interpreted as causal links that connect the system together. They can have a positive or negative sign. A relation from one node to another is positive if the first contributes to the increase of the second or if they both change in the same direction. In a similar way, the link is negative if the first node causes the second to be reduced or they change in opposite directions.

After a loop is completed, it is also given a sign. If the number of all minus (-) signs along the loops is even, the loop will be positive or reinforcing. If the number of all minus (-) signs is odd, the loop is negative. In this way, positive feedback loops reinforce change with even more change, thus determining an exponential growth. In the management context, a minor problem situated in a positive feedback loop can become a great one. Some relevant examples include pollution and population growth. A negative loop has the objective of reaching a certain reference value. In this way, if the present value is higher than the reference value, the loop structure will push it down and if it is lower, the loop's structure will push it up. These types of loops will be stable, but they will also prevent change, so that the entire structure of the company must be changed in order to allow progress.

If there are delays in feedback loops, oscillations may also appear. As a loop reaches for a certain reference value, the oscillations will gradually decrease. This is encountered in production and distribution activities, where timely information about customer requirements is not known, so production continues even after the supply meets the existing demand.

The next section addresses topics about knowledge management: tacit and explicit knowledge, knowledge models and how it is obtained and implemented in the case of innovation.

2.4 KNOWLEDGE MANAGEMENT

Knowledge is an intangible asset and, as such, has no boundaries, is context-specific and carries value only if used at the right time and place (Nonaka and Konno, 1998). The creation and management of knowledge differ, therefore, from the management of other firm assets. Alongside this, knowledge is central to successful innovation development (Darroch and McNaughton, 2002).

Knowledge management and acquisition have more recently been linked with creativity, where the former is seen as a way to enable creativity, understood as a capability that results in new knowledge that can aid in the product development process (Kazanjian and Drazin, 2012). Creative tasks encourage cooperation and require knowledge to be shared (DeMaio et al., 1994; Drazin et al., 1999; Kazanjian et al., 2002). Examples of innovations that are the result of effective knowledge sharing and acquisition in a decentralized manner include the development of a new aircraft, new automobiles, space projects at NASA and defense contracting (Horwitch, 1982; Sabbagh, 1996; Clark and Fujimoto, 1991; Hoffman, 1997; Sayles and Chandler, 1971; Scudder et al., 1989).

The governance of knowledge has evolved over time. The learning processes of companies, their knowledge management and their capabilities have a supporting role in economic development and progress (Adams et al., 2011). The boundaries of companies are influenced by supply and demand, but also by knowledge. The knowledge boundaries have expanded in order to surpass legal boundaries or industries. The role of consumers as a source of knowledge has expanded in a similar extent.

One of the first areas of difficulty within the literature is defining the difference between knowledge and information. There is no absolute agreement on this, but the prevailing trend is to view information as little more than unstructured data; it has no particular value unless and until it is connected to some particular human context and experience. Knowledge, arguably, is what happens to information when it goes through that process (Alavi and Leidner, 1999). As this overview suggests, knowledge management, creativity and innovation appear interlinked, with knowledge management being either a precondition or a correlated factor in the innovation development process.

2.4.1 Tacit and explicit knowledge

The separation between tacit and explicit knowledge is important to this research. The reason is that organizational knowledge that stands at the base of innovation is usually tacit in nature. It cannot be transferred as easily as individual knowledge through socialization. Companies are not inclined to distribute organizational knowledge as it gives them a competitive advantage and often involves confidentiality policies. This knowledge is also not easy to transfer as it is in a format required by the company. Organizational knowledge has value because of its specific and untransferrable nature. The separation between tacit and explicit knowledge indicates how difficult it is to obtain.

Researchers argue that, in order to understand knowledge creation, it is key to have, first, a clear understanding of the differences between kinds of knowledge (Nonaka and Konno, 1998); knowledge differences mean that knowledge sharing, and transition cannot be conceived as a uniform task and that knowledge in general cannot be presumed to be generalizable and universal in nature. Nonaka (1994) states knowledge can be of two kinds, explicit or implicit.

Explicit knowledge is said to be formal and systematic in nature and is exemplified in manuals and product specifications (Nonaka and Konno, 1998). The benefits of explicit knowledge are that it is readily available for communication, entails known concepts and methodologies within a firm and can be subject to critical assessment. The shortcomings of explicit knowledge, however, are that it tends to be abstract in nature, which makes it difficult to localize elsewhere, such as applying it in new areas of the business, and when established, it can actually become static and outdated (Nonaka and Konno, 1998).

Tacit knowledge, in addition, refers to processes that are exemplified in the relationship between master and apprentice, where learning by doing and role-modelling tend to be fundamental to successful learning (Nonaka, 1991). This type of learning or creating knowledge is not suitable for traditional organizations because it is not easily scalable and relatable to others in the organization. Tacit knowledge, furthermore, has two dimensions, technical and cognitive (Nonaka and Konno, 1998). The first refers to know-how, while the second refers to beliefs, ideals, values and mental models which are often used heuristically, by those who possess it; such knowledge can be taken for granted in the sense of being an automatic response that is difficult to analyze and articulate in language. The challenge of tacit knowledge begins, hence, by being able to identity it and make it communicable. Mental models, belief systems and complex ideas, which are heuristic in nature are, therefore, difficult to articulate; that is, they are difficult to make explicit or formalized, as explicit knowledge.

Tacit knowledge, moreover, is harder to communicate because it is often perceived as personal and the holder of such knowledge may only be partially aware of what he/she knows or can teach (Nonaka, 1991). Belief systems and mental models are seldom seen as objective knowledge, even though their function within a social environment makes it necessarily so; higher echelons frequently neglect tacit knowledge, where the right tools may simply not exist.

Tacit knowledge is a type of knowledge that cannot be expressed. It can be located in physical skills, such as senses, movements or voice. It can also be located in intuition or implicit rules of thumb. For example, let us consider the skills of a pianist, a carpenter or a marathon runner. It is impossible for a pianist to pass his knowledge to an apprentice in an explicit way, simply by drawing, writing or talking. The skills of the pianist have been acquired over years of work, extensive practice and experiments meant to create an original interpretation of music. Since they have been acquired over a long period, instructing another will also be a complex process. These skills are deeply ingrained in the hand movements of the pianist and are tacit. At the opposite end of the spectrum, solving a mathematical equation is explicit knowledge, as it consists of a number of steps and the underlying principles can be easily conveyed in writing.

Rather than dismissing tacit knowledge, Nonaka argues in favor of identifying and making effective use it; for him the merit of Japanese organizational culture lies precisely in its ability to use and benefit from the tacit knowledge it possesses. From a knowledge management point of view emphasis must be put on the types of learning that can be analyzed based on this distinction between tacit and objective knowledge.

2.4.2 Knowledge models

The knowledge spiral model is based on the SECI definition of knowledge (Nonaka and Takeuchi, 1995). SECI is socialization, externalization, combination and internalization which is used to describe how tacit knowledge can move through a process where it is made available to others and then re-internalized within them, ready for the process to start again (Nonaka and Takeuchi, 1995). The visual metaphor deployed, here, is that knowledge can be envisioned as a spiraling process of extraction and internalization; which gives the impression of a method of managing knowledge rather than simply defining it.

The transition from tacit to explicit knowledge can be characterized by the concepts of articulation and externalization, while the transition from explicit to tacit is best described by the concept of internalization. The four combinations between kinds of knowledge (tacit to tacit, explicit to explicit, tacit to explicit and explicit to tacit) are all part of what Nonaka (1991) calls the knowledge spiral (See Figure 2-1, page 62).

The image of the spiral (also a metaphor) is intended to highlight the importance of knowledge conversion and to present the latter as mainly a self-transcending process (Nonaka and Konno, 1998). Self-transcending means that the purpose of all knowledge is to go beyond individual needs and skills in order to become part of a collective resource pool of knowledge, where its benefits also go beyond individual needs (Nonaka and Konno, 1998). It is in being able to transform tacit into explicit knowledge that allows Japanese companies to outperform others in NPD (Nonaka, 1991).

The processes in Figure 2-1 (page 62) can be described accordingly. Externalization and socialization are the contextual factors determining successful knowledge translation (from explicit to tacit and vice versa): Socialization is the requirement for tacit knowledge to become explicit; by creating and using a shared language, tacit knowledge becomes meaningful to other team members. Socialization also enables critical readings to emerge; interpretations and argumentation to become part of the knowledge creation process, and for tacit to become explicit knowledge (Nonaka and Konno, 1998). Externalization, in turn, refers to the way in which an individual transfers knowledge to others through a process of identification that leaves the personal self behind and embraces a group identity, which may refer to a team, a business unit or an organization (Nonaka and Konno, 1998). Through externalization the personal aspects of tacit knowledge are left behind, allowing for knowledge to transcend individual purposes and intentions and to be used for shared objectives (Nonaka and Konno, 1998).

Internalization refers, in contrast, to the transformation of explicit into implicit knowledge (Nonaka and Konno, 1998). It is a process in which the individual realizes that explicit knowledge can be relevant to advance their own objectives within the

firm; learning by example, training and exercises are activities that allow for individuals to access and assimilate explicit knowledge (Nonaka and Konno, 1998). Nonaka's approach must, however, be contrasted with the broader knowledge management literature, where several of the concepts introduced overall with those used from a resource-based view perspective of the firm and where capabilities and resource organization become the core objects of study of the analysis.

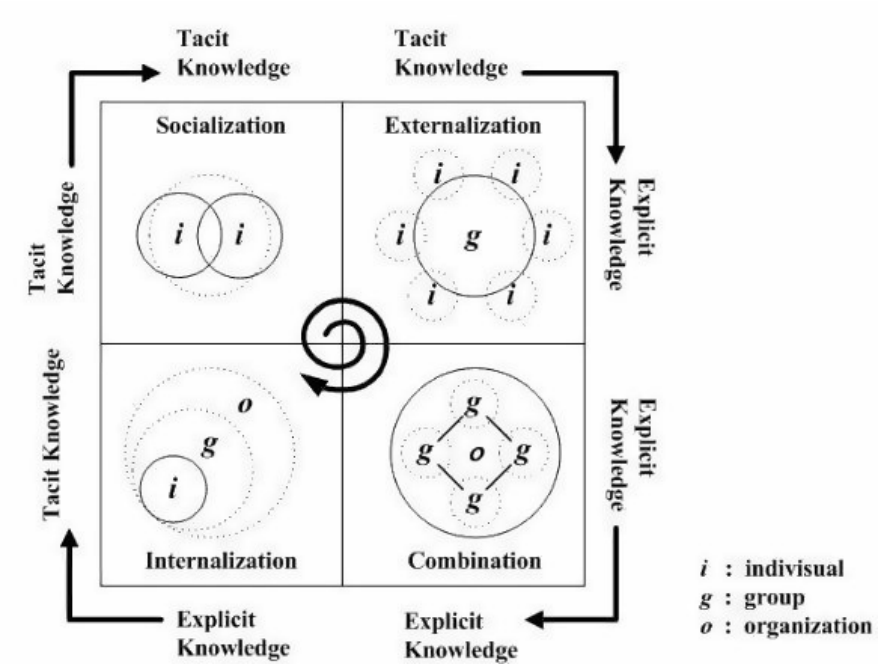

Figure 2-1: The Knowledge Spiral (Source: Nonaka, 1998, p. 43)

There are a number of critiques of this model, but the most pertinent, here, is that the model assumes that the knowledge already exists, and it is available to be part of this spiraling system of extraction and internalization. Scholars of innovation have noted that this does not work well with models of innovation that are focused on the creation of new knowledge; aside from the philosophical critiques around whether any knowledge can ever be entirely new, this is a worthwhile point to consider in the context of this thesis. Where innovation is examined as a process, the new knowledge that is obtained is based on existing information and knowledge. The refined or largely new piece of knowledge that is obtained is a result of a much larger process that entails a number of steps. That is why, for the purpose of the study, obtaining new knowledge for innovation is not in contradiction with knowledge conversion.

There are other criticisms that can be applied to Nonaka and Konno's model. The spiral of organizational knowledge considered in the model causes knowledge to flow from middle management both upwards and downwards. However, in Western companies the decision-making is a top-down process. There is no pressure difference in the hierarchy of a company able to generate a flow of knowledge, so the practical application of this theory is limited.

Even if we accept the concept of knowledge flow, Nonaka does not consider that a considerable part of the initial knowledge is flowing through the cycle many times

(Harsh, 2009). Organizational knowledge is updated over time and effective knowledge management must consider reusing knowledge. A model illustrating knowledge dynamics has to include reusable knowledge as a variable. Internalization can also be interpreted as a learning process and it requires time, but time is not a factor in Nonaka's model. Activities such as internalization can take more time than socialization. Combination is described as obtaining new explicit knowledge from existing explicit knowledge. However, the process of obtaining new knowledge, such as sorting through information in order to become knowledge, is not described in detail. The socialization activity is explained by the story about the development of a domestic bread-making machine; however, this also can apply to externalization. The case does not provide evidence for the externalization of technical tacit knowledge; however, it can be interpreted as once the development team knew how to knead bread, which is not technical knowledge, they were able to improve and re-design the prototype. A lot of experimentation took place when designing the prototype but the role of this activity in creating innovation is not reported.

It is unclear why converting knowledge has socialization as a first step, because it can begin with internalization or with a combination as a synthesis of explicit knowledge. There are only two modes of knowledge conversion in Nonaka's model: tacit to explicit and explicit to tacit. Converting tacit to tacit or explicit to explicit are in a different category, these are modes of knowledge transfer. This distinction has not been accepted entirely by the subsequent literature and causes a number of conceptual problems.

Nonaka has been praised for a definition of corporate action as including action as well as scientific knowledge, but he was criticized for placing too much emphasis on managerial authority and not examining how well scientific criteria work together with corporate knowledge (Essers and Schreinemakers, 1997). He also failed to recognize that resolving conflicts of ideas between groups with managerial authority is not a way to foster creativity and innovation. Another criticism is that Nonaka's model does not explain how new ideas are produced (Bereiter, 2002). Collaborative work is not described in detail in order to illustrate how it produces innovation.

Nonaka's knowledge transition, characterized by the knowledge spiral, illustrates the transformation that knowledge goes through, in order to become beneficial to a firm; that is, in order for a firm to be able to curate, share and generate new knowledge and to do so on a regular basis and in a structured manner. The structure that underpins the ability of a firm to internalize, socialize, externalize and combine different forms of knowledge is best summarized as a firm's absorptive capacity. The starting condition behind the concept of absorptive capacity is that organizations need pre-existing related knowledge in order to appropriate and use new knowledge (Cohen and Levinthal, 1990). Transformations between different forms of knowledge (tacit and explicit knowledge) require individuals, teams and sub-units to have the ability to acquire new forms of knowledge—they must be able to transform tacit into explicit knowledge, explicit into tacit, etc.

Another model of knowledge management is the I-Space model of Boisot (1998). According to this model the social learning curve is situated in the three-dimensional I-Space or information space. This is graphically represented by a cube, where the axes

are codification, abstraction and diffusion. The learning is represented as a cycle with six steps: scanning, codification, abstraction, diffusion, absorption and impacting.

Scanning is collecting original raw data and makes the data less diffuse. Codification is the individual response and interpretation to the data that were collected, which it codifies. Abstraction is when knowledge is generalized in order to make it applicable to a wider range of situations, so it makes it more abstract. Diffusion can happen once the knowledge is codified and abstract and makes it more diffuse. Absorption takes place when an individual has collected diffused knowledge and uses it through learning by doing to obtain practical experience, making the knowledge less codified. Impacting is when the absorbed knowledge is adapted to concrete situations, making it less abstract.

The codification-abstraction-diffusion path in the I-space represents the means through which an individual shares knowledge with others. This is similar to the socialization-externalization activities in Nonaka's knowledge spiral. The absorption-impacting-scanning path can be compared to Nonaka's combination-internalization activities. Undiffused, concrete and uncodified knowledge is similar to the tacit knowledge of an individual. Diffuse, abstract and codified knowledge is similar to explicit knowledge.

2.4.3 Knowledge management in the context of innovation

Knowledge that is applicable for innovation is an important consideration in this study. An important component of it is market knowledge that can be collected through customer involvement. Demand for increased customization drives customer involvement in product development processes, product evaluation and feedback mechanisms (Greer and Lei, 2012). Customization increases the value perceived by a customer as well as the degree of differentiation between a firm and its incumbent (Tidd, 2001). Digital technologies have, in addition, allowed for increased customer-supplier interaction (Biemens, 1991). Developments in information and communication technologies have helped to bring customer and supplier together. In the technology industry customers share opinions, while suppliers can submit products for evaluation and are constantly in touch with a consumer base interested in contributing (Greer and Lei, 2012).

Collaboration between customers and developers with the aim of obtaining feedback and identifying areas of improvement have become frequent and are prescribed as essential to a firm's success (Stahlberg and Maila, 2012). Being able to establish the requirements of customers allows companies to identify those competences that are crucial to the development of an innovation (Lettl, 2007; Gruner and Homburg, 2000; von Hippel, 1986). These competences may vary according to the different phases of development and are likely to be industry- and even firm-specific (Lettl, 2007).

Secondly, firms must know which types of interactions with consumers are suitable in their innovation projects (Kaulio, 1998; Gruner and Homburg, 2000). Lettl (2007, p. 55) argues "the literature reveals that this dimension contains variables like the personal level of interaction, the number of users, the temporary extents of interaction,

and the network competence of the user interaction personnel (interaction dimension)". Companies must, therefore, plan and, to a certain extent, test different types of interactions (face-to-face, anonymous feedback, direct involvement in a process, individual or team based, among others) before they can establish the role of customers within the innovation development process (Leifer et al., 2000). There are, as can be expected, important challenges that can hinder a firm's efforts in this respect. Monetary incentives, for instance, have a lag with respect to the development of the innovation itself (Chandy and Tellis, 2000), which means that rewarding consumer involvement in this manner may not be effective. Researchers also argue that companies should not listen to customers because the latter have a natural myopia, making their suggestions conservative in nature (Tzeng, 2009). Lettl (2007) refers to this short-sightedness as a "barrier of not knowing", meaning that consumers can have serious difficulties relating to new functionalities, and may also belong in a context of use, which they cannot simply and willingly abandon.

Third, many consumers are simply unwilling to get involved in the development of innovations: Highly anticipated costs of switching and the fear of existing knowledge becoming obsolete actually drive people away from involvement (Anderson and Narus, 2003; Ram, 1987; Ram and Sheth, 1989).

The company should focus on identifying "lead users" (von Hippel, 2005). These are active and innovating customers and they can also be opinion leaders or influencers. They are an indicator of how the market is going to evolve, as their present needs will become the future needs of general consumers. By identifying lead users and learning from them, the company may enhance innovation development and identify successful products (von Hippel et al., 2000). It can be difficult to identify lead users whose present needs are the same as the future needs of general customers. Therefore, it is important to communicate directly with customers in order to obtain more detailed knowledge about their purchase behavior and their future needs, in order to integrate them into the process of innovation.

Firms that are able to surpass these common issues and identify their customers and the best type of involvement will be able to find a positive role for their current customer-base within their innovation development. This research is particularly interested in gaining a deeper understanding of customer involvement as it is a component of the information acquisition process and is a way to obtain relevant knowledge.

Recombining and extending existing knowledge (the knowledge spiral in Nonaka and Konno) allows firms to take advantage of opportunities in new areas, often outside their industry (Kazanjian and Drazin, 2012). Innovations often come because of implementing and combining available tehcnologies for different purposes. For example, the first CT scanner was introduced by EMI, a company with no medical background which focused mostly on aerospace products (Teece, 1986); the CT scanner was an innovation developed from well-known technologies related to data processing, x-ray, and screen displays (Kazanjian and Drazin, 2012). Leonard (1998) discusses a similar case: the firm 3M developed plastic soap pads that were non-rusting and non-scratching based on existing capabilities in abrasives, adhesives and coatings. Being able to acquire external knowledge, which depends on a firm's absorptive capacity is, there-

fore, a necessary condition for customer involvement in innovations; whether the purpose is to gather new knowledge, to set up co-creation and co-development activities, absorptive capacities are central to their success.

Mei and Nie (2007) undertook an empirical study based on the Wuhan Optoelectronics cluster in China, with the aim of understanding the relationship between knowledge sharing between customers and suppliers, and firm innovation performance. They found, in agreement with the theory (Cohen and Levinthal, 1990), that knowledge sharing has a positive influence on innovation and that the former was directly influenced by a firm's absorptive capacity (Belkahla et al., 2014). Liao et al. (2009) share the same results, although based on the empirical study of a different context, situated in Taiwan: They were interested in understanding the relationship between knowledge sharing, absorptive capacity and innovation capabilities. Their results show, following a contrary causal line from Mei and Nie (2007), that knowledge sharing has a positive influence on absorptive capacity and in a later step it supports the innovation process (Liao et al., 2009). It is precisely based on this relationship that Nonaka (1991) characterizes *the knowledge creating company* as one that stands out for its ability to identify potential knowledge from both internal and external sources and to enable that same knowledge to become accessible to different areas of the business (through intentional transitions).

Belbay and Houze (2007) and Lawer (2005) studied the relationship between New Product Development (NPD) and customer knowledge creation. Lawer (2005) concludes that effective customer knowledge management (i.e., knowledge acquisition from customers) leads to increased co-creation value and higher innovation capabilities, when mediated by knowledge sharing. Belbay and Houze (2007) conclude that NPD is positively influenced by acquisition of customer knowledge, especially where there is a high degree of collaboration between a firm's employees and its customers and where knowledge sharing is a widespread practice across business units and subunits.

Given that knowledge management entails both organizational and individual perspectives, the dynamic aspects of knowledge management systems, illustrated in the knowledge spiral (Nonaka and Konno, 1998) and synthesized in the central tasks of knowledge management (Kazanjian and Drazin, 2012), requires for emphasis to be put on how the knowledge is obtained. Customer involvement will support innovation, and its necessary "information acquisition process" within the collaboration enabled by effective knowledge management (Greer and Lei, 2012, p. 74).

Firm innovativeness and firm performance are related to Schumpeter's (1942) theory of profit product of innovation, where competitive advantage depends on innovation development, in which firms gain "a temporary quasi-monopolistic position, which enables them to extract rents" (Rubera and Kirca, 2012, p. 131). Therefore, it must be kept in mind that innovation can be directly related to firm performance, with respect to competitors and to past performance within different areas of the same firm. A firm's innovativeness very much depends on generating new knowledge or allowing existing knowledge to become shareable and functional across different areas of a firm.

What is more straightforward is the purpose that all of this academic research is put to; there is widespread agreement on the advantages knowledge management as a professional practice can bring, even if there is not on the best way of doing it. When knowledge management emerged in commercial practice in the early 1990s it was because of recognition within businesses that the knowledge they had within them was likely to become the key source of competitive advantage over coming decades. There were a number of approaches to this that have since exploded into extremely diverse practices for specific industries and onwards into the public and third sectors (Liao, 2003).

What underscored this realization in the early 1990s was the burgeoning computer boom and the nascent possibilities of the internet. Early pioneers recognized that this would radically change the way organizations see and use information; and if they did it correctly, it would be how they would beat competitors (Liaw et al., 2010). Management 'guru' figures like Peter Drucker (1994) argue that knowledge would overtake other organizational resources such as capital and equipment as the prime organizational asset and would be the frontier of competition; that is not to argue that other things become redundant, simply subsidiary.

These kinds of arguments have spurred many different approaches to knowledge management. Within the technology and science sector it came to be associated with a ferocious interest in intellectual property and patents (Choo and Bontis, 2002; Booker et al., 2008) both in terms of a new realization about the value of these things as assets, and also about the potential dangers of things like the internet for the security of these assets. This is very important in the context of innovation because knowledge management becomes the mechanism by which some of the most valuable corporate assets are created and maintained (Booker et al., 2008; Wiig, 1997). This approach reached either its zenith or nadir, depending on one's perspective, with the so-called 'patent wars' between companies like Apple, Google and Samsung, and the purchase of Motorola by Google for no other reason than access to its patent portfolio.

Aside from the management of intellectual property, knowledge management has broadened into a general view that organizations can be more effective than the sum of their individual members if they can harness the experience and technical expertise that they all possess, and then change it into a form that can easily be passed to others (Rubenstein-Montano, 2001; Shankar et al., 2003), which is where all the previous debates about the nature of knowledge and how to transfer it become relevant. Nevertheless, the essential purpose of doing this is that companies that work out a suitable method will undoubtedly be better than their competitors in all key metrics; their products or services will be superior; they will be more efficient; they will have a happier workplace; and they will be more likely to adapt to new technologies better (Choi et al., 2008). Much of the literature has been based around examining how these contentions have been put into practice in specific organizations or industries, or how many of these benefits will also help organizations in the public sector become more efficient, more responsive to new technologies, and deliver a better service to citizens.

Knowledge is not something that is specific to the company and to the people and systems within it. It can also originate from customers, suppliers and other stakeholders. Innovation cycles also draw information from a very wide variety of sources in the effort to gather together as much information and knowledge as possible, though information gaps remain (López-Nicolás and Meroño-Cerdán, 2011). Thus, there is a need to think through the ways that knowledge management can be attuned to innovation cycles such that it accommodates information generated by external sources; and, thus, information acquisition in knowledge management systems becomes inherently innovative.

Partly, this will depend on the philosophy of knowledge to which one subscribes. The Nonaka model is perhaps the best-established (Nonaka and Takeuchi, 1995), and the fundamental acceptance of dynamism is very appealing in the context of innovation. Furthermore, the notion of extracting embedded knowledge from one location and re-internalizing it in another is something that works quite well in the context of innovation as it indicates the way that innovation cycles can take information from an array of sources and move to synthesize it (Swan and Scarbrough, 2001). However, there is a need to broaden this model out around some of the other information sources that innovation models use; this is not so much a critique of the Nonaka model but, rather, extends it and makes the sources of knowledge acquisition clearer.

Within innovation studies a wide variety of literature focuses on the importance of drawing in knowledge from customers, suppliers and other stakeholders in order to increase both the volume and depth of information feeding into innovation cycles (Darroch, 2005; Du Plessis, 2007; Sanchez and Mahoney, 1996; Goh, 2005). Approaches such as Agile within software and project management studies have emphasized the need for this engagement with these knowledge sources to be reflexive; that is, information is not gleaned from these sources once, at the beginning of the process; instead, the innovation process becomes iterative and information is reused (Majchrzak et al., 2003). Innovation cycles become 'smaller' and customers, suppliers and other stakeholders are involved at very regular intervals to ensure that the maximum amount of their knowledge goes into the innovation process. The purpose of doing this is that it tends to reduce information gaps through drawing on a wide range of knowledge sources to begin with but, arguably, it also stops many information gaps happening at all because feedback of information is so granular that it minimizes the opportunities for misunderstanding or a lack of information.

One of the more interesting ways of framing a new relationship between organization and customer is through the notion of an empathetic, or at least collaborator, experience. The thinking behind this is that for a genuinely enriching – for both parties – relationship to form between an organization and the customer over the long term, it cannot be a purely transactional or utilitarian relationship (Greer and Lei, 2012). The relationship should be at least as much emotional as it is commercial; the organization should position itself so that it begins to understand the wants and needs of its customer, and the customer understands the capabilities of the organization, and they culminate in a symbiotic relationship where they grow together. This has very interesting implications for the notion of information acquisition in a model of innovation,

because it means that the relationship between the organization that is innovating and the customer that is collaborating is not that easy to discern.

Therefore, the greatest challenge in a new model of innovation is to try to link together everything that has been argued in this section in terms of the nature of knowledge, the purpose of knowledge management, and the need to make this relevant to innovation. As noted, the Nonaka and Takeuchi (1995) helicoidal model (i.e., corkscrew-like flow) is a good start because it recognizes the dynamism required; however, any new model would have to have further extensions. The first is to demonstrate explicitly that multiple sources of knowledge acquisition feed into the innovation cycle; it is not a case of extracting knowledge from one location and re-internalizing it at another. Second, the model should recognize that these multiple knowledge acquisition sources are not visited once; they are re-visited repeatedly through the development of innovation.

The model that will be presented in this research will be constructed by considering the characteristics and limitations of what has been done before. The model will include information and knowledge as separate concepts. Information will be converted to knowledge with the routines that illustrate a learning process. Organizational knowledge is considered to have a tacit nature as it is specific to a company and cannot be easily transferred. Obtaining knowledge is an iterative process as it consists of collecting information, learning and improving routines. This new knowledge is important in order to obtain innovative products and services.

2.5 CONCEPTUAL FRAMEWORK

The conceptual framework proposed provides the basic structure on which this research is built, and provides the grounds for this study (Bell, 2005). It further facilitates a better understanding by practitioners and researchers of this study's findings (Polit and Hungler, 1995).

The main concepts proposed in this thesis are: information acquisition, customer involvement, employee involvement, knowledge management, change in routines, co-innovation and innovation development. Data is a supplementary concept as it consists of a raw form of information and converting data into information is much simpler than converting information to knowledge. The figure below includes multiple modes of interaction: customer involvement and employee involvement support the information acquisition process, which becomes a process that influences the firm's knowledge management capabilities. The figure also details the type of theoretical support used to analyze customer-supplier interactions and information acquisition by firms.

The concept map (Figure 2-2, page 70) shows the direction in which the study will evolve. Customer involvement and employee involvement are considered first, as a series of seven activities and are examined by using the feedback loops discussed in section 2.3.3. Customer involvement is one of the most important sources of information for obtaining innovation. In this study, innovation is examined as an open process, in line with Chesbrough (2006).

The objective of customer involvement is to increase the knowledge store of the company. An emphasis is placed on tacit and explicit knowledge, as the latter is knowledge that can be used more easily by the company. Tacit knowledge can belong both to customers and employees and converting it into explicit knowledge allows the company to improve its marketing strategy or its internal rules and procedures. By collecting knowledge, the company will correlate more easily its actions with the outcomes. The information acquisition process will determine innovation but, rather than in a direct way, by creating a framework in which innovation is possible to appear. This will depend on a number of factors: the industry in which the company operates, the collected knowledge, the skills of the employees, the quality of the policies and procedures of the company and the structure of the company.

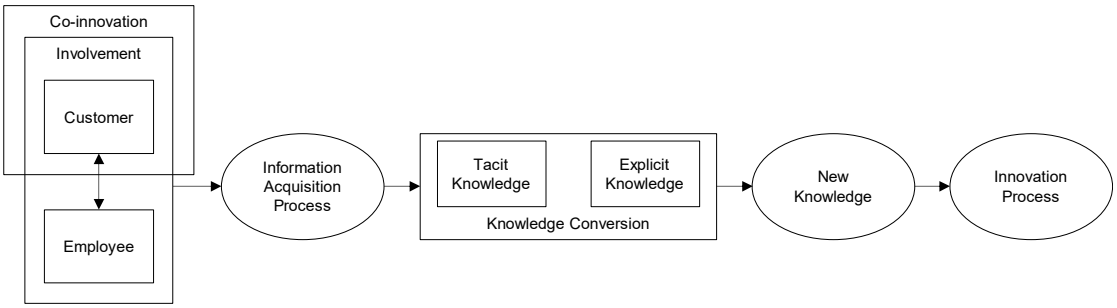

Figure 2-2: Concept map

The gaps identified in the literature review are in close connection to the concept map. The study describes the information acquisition process of customer involvement and employee involvement. The ways in which this information is gathered from customers and employees is examined in order to determine the best approach and activities that are the most suitable. As previously specified, the study distinguishes between information and knowledge. Information becomes knowledge as soon as it is applied or used. Obtaining this information from customers is valuable to the company, as it is possible to transform it into knowledge. If the information gap is defined as the difference between the amount of information required and the information available, so that collecting information from customers will result in it being closed.

How the information acquisition process and knowledge management support innovation development is central to the study and the topics related to this process have been presented. The concept map links the notions described in this chapter in order to show how the gaps existing in the literature can be addressed.

2.6 SUMMARY

The chapter presented the literature review and the concepts that will be used throughout the thesis. Section 2.1 presented what has been written about innovation until now. The literature on co-innovation is also detailed, because it is an important concept that suitably describes customer involvement. The relation between innovation and routines has been clarified, as a change in routines is translated in learning

and innovative capacity. Routines are patterns of action at the company level and their change can result in products, services and processes that have different characteristics. They can present an improvement or a step backwards and there are also cases where they can influence the innovation to appear. The change in routines can be caused by internal or external factors or by a proactive company strategy.

The information acquisition process was presented that included customer involvement and employee involvement. In order to properly understand information acquisition, the distinction between data, information and knowledge was included. If customers participate in innovation development, suppliers can have a more thorough understanding of their needs and preferences so that the new products and services will reflect them and be positively perceived by the market. Researchers advocate in favor of increased customer involvement in the case of innovations in order to increase company effectiveness and performance. Customer involvement is also a way to surpass the information defect by finding the required market information. The information acquisition process is also based on employees as a result of the amount of skills they have accumulated while working in the company, their tacit knowledge and the information they have from working with customers.

Routines allow converting information to knowledge by learning. The routines are the product of organizational learning but also the way in which the company learns and obtains new knowledge. This indicates that obtaining new knowledge is an iterative process as routines are improved and then the company learns by implementing them. New knowledge influences the company to be more likely to obtain innovation by carrying out refining and prototyping activities.

Knowledge management and a number of relevant studies have been presented as they are a step toward obtaining innovation. The distinction between tacit and explicit knowledge has been outlined, along with the existing models of knowledge conversion. Organizational knowledge is usually tacit in nature because it is specific to a company and cannot be quickly transferred into another context without replicating its routines. Routines are repositories of knowledge and reflect the best practices of a company.

The capacity of a company to obtain knowledge is connected with the learning capacities of its individuals. New knowledge starts with the individual and is then adapted or localized depending on the requirements. There are also obstacles for obtaining knowledge, such as excessive specialization and a closed internal language that can hinder a company from communicating well with the exterior. One approach that can partially mitigate this aspect is rotating personnel through different departments, in order to prevent excessive specialization and to give employees a holistic perspective concerning the company. Team-building activities, team-based projects and shared responsibilities are another way to ensure that the flow of information is suitable and that employees have the possibility to learn, either explicit or tacit knowledge.

The chapter concluded with the conceptual structure that presented a concept map to bring together the various theoretical strands. It illustrated how the chosen concepts interrelate and how they aid in the study of the phenomenon of information acquisition and knowledge management for enabling innovation.

3 RESEARCH METHODOLOGY

3.1 INTRODUCTION

The preceding chapter set out a conceptual model with which this thesis would engage in the context of innovations and the customer and supplier relationship. This chapter sets out a number of parameters for the methodology, chief among which is that the objects of analysis are not immediately clear and must be located as part of the initial stages of the methodology; furthermore, the purpose of locating these objects of analysis is not to assemble them into a model for the purposes of validation, but to try and understand their relative influence on the information acquisition process that supports innovation. Therefore, this methodology is structured in a manner designed to pursue and achieve this objective.

The opening section of the methodology first sets out the philosophical approach to research that underscores this thesis, i.e., the critical realist epistemology. It illustrates how that links to the overall ambitions of this research in terms of developing a model that could be deployed in real organizations. Case study research has been selected as the methodology this study will use. The combination of longitudinal case studies and retrospective interviews will allow the study to have both efficiency and richness of data.

The methodology presents the steps taken for carrying out the study. These include choosing the concepts to be used, collecting data by conducting interviews and analyzing data with the NVivo software program and presenting the results with Vensim PLE. Other steps include comparing the study findings with the relevant literature, developing new theory based on the data and verifying its validity. The methodology sets out a two-phase process of data collection and analysis, whereby the initial phase is designed to use a brace of exploratory cases to inductively locate a set of potential components of innovation. The data collection is presented in the section Research Strategy. The list of companies where the interviews were carried out, the information about them and the interview schedule are stated here. The data sources are the companies that were examined or were the subject of a real case study. The methods in which these companies innovated, and the resulting products, are given considerable attention.

The study builds on the concept of customer involvement, which plays a considerable role throughout the interviewing process. These interviews are meant to clarify the concepts of innovation, customer involvement, employee involvement and the variables associated with them. For the two main case studies examined, Avaloq and Synosia, the interviews are structured into sessions, so that each session may shed some light on one of the previous three concepts. For the remaining cases, a combined interview format was chosen. After that, for the two main case studies, Avaloq and Synosia, another session of interviews was conducted in order to create the emergent innovation model. The final interviews focus on refining the emergent innovation model. This is achieved by an ongoing banking case that is based on a major bank.

The inductive coding process is presented in the research design section. It states how the data were processed in order to be usable. The interviews were digitally recorded, field notes were taken, and the discussions were then transcribed. By examining the recordings, the main codes were chosen. The coding process generated 30 codes, from which seven codes, which are activities, were chosen. These codes, further subdivided into sub-codes, allow a more intricate examination of the activities. The data were examined both within-case and cross-case in order to establish relationships between concepts. In this research, a case is a collection of interviews carried out with different respondents. The codes were discovered by searching for patterns in all the interviews and identifying similarities. The seven main activities were compared with Nonaka and Konno's (1998) activities in the knowledge spiral. The method in which the codes were included in diagrams that were illustrated in Vensim PLE is presented. The case study method and the motivation for the ongoing case are then explained. The steps of analysis are presented next.

In many ways, this chapter describes a methodology that is reflexive, in the sense that the mode of data collection and analysis has to be adapted through the actual process itself, as issues come up; such that the interviewing technique alone was not precise enough to uncover deep linkages, and so the data were subject to analysis from professional modelling software to help identify these links. This chapter provides a comprehensive exposition of the process for completing each stage of the data collection and analysis, and the potential drawbacks of the chosen route.

This methodology also sets out the case studies used for companies in both phases of the research, the type of companies and the process of innovation they have followed. The technical details of the data collection process are also clearly set out to include the style and organization of the interview process, and the technical means by which the interview transcripts were subject to analysis and modelling. As part of this, the methodology also identifies the ethical issues involved in generating primary data through interviews, and acknowledges the steps taken to ensure that the participants were treated appropriately.

3.2 RESEARCH PARADIGM

This section develops the overall philosophy of research that determines how the research questions are addressed. Following Creswell (2003), a research methodology must include two main aspects: 1) research paradigm, which refers to the philosophical underpinning of a text and its relation to the relevant theory and the type of knowledge proposed; and, 2) research strategy which includes the methods used for the collection and analysis of data, as well as the specific requirements of the research approach and design. This section deals primarily with the first of these considerations, and the latter is addressed later in the chapter.

When considering philosophies of research there are, very broadly, two stages to address: ontology and epistemology. Ontology is the philosophy of how the world actually is, while epistemology is the philosophy of how we come to know that world howsoever it is interpreted.

The method for data analysis comprises, primarily, qualitative analytical procedures directed at designing and refining a model of innovation (Miles and Huberman, 1994). Qualitative research places a premium on achieving trustworthy findings by observing the dynamics of phenomena and accepting both predictable patterns and one-off events. It pursues what Denzin and Lincoln (2005) call "empirically grounded and scientifically credible" results (p. 276). Nonetheless, the purpose of this research thesis is, in part, to provide a practical model that can be deployed in non-academic settings, and this requires that the model also be consistently replicable across time and space; the purpose of this section of the methodology is to determine the philosophical grounding for doing this through qualitative data.

The objects of analysis that this methodology needs to engage with are the attributes of innovation; consequently, there is a two-phase process: 1) identifying these attributes through a process of inductive coding; and 2) refining the model, as these attributes are tested within an ongoing innovation case. The purpose will be to identify those key feedback loops which can illustrate the dynamics of the information acquisition process surrounding the development of innovations. Customer-supplier interactions will frame the induction-based feedback loops and their effect on innovation.

These are complex requirements for a research project to meet, and even more so within the confines of an individual DBA thesis, so the following sections have two objectives. The first is to properly develop these requirements and the methodological tools that are available to address them; second, the following sections also aim to justify why such methodological complexity is necessary in terms of delivering the unique contributions that the thesis aims to make, and why alternative approaches are not explored. All research projects have a wide array of potential methods available to them, so the philosophy and approach ultimately taken needs to be carefully justified.

The research philosophy is chosen to be critical realism that combines a realist ontology with a relativist epistemology. It is presented in the next section together with the reasoning of why it is suitable for this research.

3.2.1 Ontology and epistemology

The ontology and epistemology this research adheres to is critical realism as opposed to other approaches that are either fully objective or fully subjective. It is situated between the objectivity of positivism and empiricism and the subjectivity of interpretivism and rationalism, so it is a more balanced philosophical stance.

Critical realist scholars assume the existence of an objective world that can be discovered by science but recognize that this knowledge is subjective, influenced by discourse and a variable social construction. For social science, and for the objectives of this research, suitable methodological practices are a bridge between the ontological reality and our epistemological knowledge. A good research approach means that we can understand the world better. Critical realism with its ontological and epistemological stances also presents some challenges to qualitative social scientists such as how to obtain findings from qualitative datasets when participants may be unaware or misinterpret the social formations that they are a part of.

The answer to this dilemma is that critical realist scholars should should implement any qualitative or quantitative techniques that are useful. The approach to data collection and interpretation will likely be different from those who have other ontological positions because of the distinct theoretical approach.

The origin of critical realism as a philosophy of science is attributed to Roy Bhaskar (1979). He argues that the universe, including the social world, is a stratified and open system of emergent entities. This definition warrants additional clarifications starting with the terminology.

Entities have specific characteristics and are not defined by the parts they are composed of (Fleetwood, 2005). Organizations, individuals and molecules are all entities even though one may be comprised of others. It is a difference between real essences that are physical characteristics of the thing and nominal essences that are the properties of the thing necessary in order to be identified as a certain type (Bhaskar, 2008). We can take a book as an example that can be identified nominally as a sequence of pages, but its real essence is about the language in which is written, genre or intended audience.

Entities have causal powers that depend on the relational properties of their constituents. Relational properties can be interpreted as essences. An essence is a primary characteristic or what makes something that thing and not something else (O'Mahoney, 2011). Plants have the power to produce oxygen, organizations have the power to create products and services and money has legal status and the power to purchase. The combination of multiple causal powers can determine new outcomes. The transformation of entities can allow them to have new properties and this is a result of the interactions between causal powers.

A power can exist in different ways. One is that an entity can possess a power because of its properties, such as a central bank that has the power to decrease inflation. This power can be exercised by the entity by putting it into practice, such as a central bank increasing the interest rate. The power cannot be realized or come to pass because of other counterbalancing powers, such as the central bank not succeeding in stopping inflation because imports are too high. This is why a power may not be realized dependent on the specific context. The social world is full of powers that are prevented from being realized by other powers within the open system in which they are located.

Open systems are the reason why social mechanisms cannot be studied by simply conducting a number of laboratory experiments. Social mechanisms should thus be interpreted as laminated systems and be studied holistically. (Bhaskar, 2008). Some examples include capitalism, the British public sector or the Italian stock market. Whilst these cannot be separated from the rest of society, they are composed of systems, mechanisms and entities that can be considered and conceptualized together.

Critical realism accepts that actual events do take place but proposes that these events are caused by real mechanisms that are difficult to see for the researcher. The realist ontology that critical realism adheres to is, thus, stratified in empirical, actual and real layers. Empirical is what we perceive to be the case or which are the human sensory experiences and perceptions. The actual is composed of events that take place in space and time and can be different than what is perceived. The real is constituted by

the mechanisms and structures that generate events and this is the most complex of all the layers.

It follows that this stratified concept of causation offers a more suitable understanding of how material and social powers that operate on different levels are related. Because reality is multiply determined with no single mechanism determining events (Bhaskar, 1975), it is possible to identify multiple causes though a detailed exploration of a setting. A key commitment of critical realist research is to discover the generating mechanisms that are situated at deeper levels.

In order to understand and explain the mechanisms that determine empirical and actual events, critical realism is interested in causal explanations, moving from the question "what?" to the question "why?" It follows that critical realist scholars do not just rely on simplistic regression analyses that say how X results in a percentage change of Y, but try to understand how different contexts, conditions and aspects of X are likely to cause an outcome of Y.

The generative mechanism in an open system cannot be isolated from its usual setting that contains other factors. This is according to Pawson and Tilley's (1997) equation: Mechanism + Context = Outcome. The mechanism describes how the properties of one or more entities affect those of others. The context includes the conditions needed for an entity to exercise its causal mechanisms. The outcome represents the empirical manifestations produced by causal mechanisms being exercised in a given context.

Critical realism has a very flexible approach to data collection and the methodological choices (Sayer, 2000). Research that follows a critical realist perspective is often based on case study methods such as interviews and ethnography, but it can also involve observation, focus groups, literature reviews and surveys.

Both induction and deduction are used as an analytical method in critical realist research. However, causal mechanisms require moving from the empirical to the real so that the focus tends to be on abstraction and retroduction. Abstraction consists of representing the different constituents of a phenomenon in order to synthesize how they work in combination to affect events (Sayer, 1998). The findings are reinterpreted as a causal mechanism or process between related constituents which helps to explain them (O'Mahoney and Vincent, 2014). Researchers reinterpret the data in terms of the abstracted theory in order to describe the sequence of causation or the relations between things that make the pattern of events predictable. Abstraction involves combining observations in order to produce the most plausible explanation for the generative mechanism of the event sequence.

Retroduction consists of imagining a mechanism which, if it were real, would define the processes associated with the phenomena in question. It intends to ascertain what the world must be like in order for phenomena to be observed as they are. This research approach involves identifying patterns over periods of time and in distinct contexts and to ask "what if?" questions with the purpose of discovering hidden causal mechanisms. Multiple causal processes can influence the mechanism in question, and this allows the opportunity to learn more about it and the context in which it operates.

When abstraction and retroduction succeed they they can confer a new perspective on the research subject. A successful critical realist research with the help of a new theorization can reinterpret the studied phenomenon and present it in a different way together with relevant processes.

Critical realism is a philosophical approach that combines a general philosophy of science called transcendental realism with a philosophy of social science called critical naturalism (Collier, 1994). This approach creates a link between the natural and social worlds that are fundamentally different but can be studied with a single strategy if it is adapted to both. Transcendental realism is similar to an ontology and critical naturalism is similar to an epistemology in a general interpretation.

Transcendental realism states that in order to conduct a scientific investigation the researched phenomenon must have real and adjustable internal mechanisms that can be actualized to produce outcomes. This is opposed to the empiricist researchers' belief that all that can be done to investigate a phenomenon is to identify the relation between cause and effect and impose meaning. The empiricist and positivist philosophies look for causal relationships at the level of events, while critical realism looks for them at the level of the generative mechanism. Critical realism argues that causal relations are irreducible to empirical constant conjunctions, so they are not determined by correlation and a constant conjunctive relation between events is not sufficient or even necessary to identify a causal relationship.

Critical naturalism argues that the transcendental realist model of science can be applied to both the physical and human worlds in equal measure. However, the method for studying the human world has to be adapted because the mechanisms producing social events can register greater changes and in shorter intervals than those in the physical world. Individuals who inhabit social structures are capable of reflecting upon them and changing them together with the actions that produce them.

In summary, critical realism has a relativist epistemology and a realist ontology. The realist ontology illustrates that there is an objective world where real events are taking place, but the relativist epistemology recognizes that the human knowledge about this world is subjective and limited. As previously stated, critical realism considers the world to be stratified in the empirical, actual and real layers. The ontology considers all the layers, but the epistemology is mostly centered on the empirical layer as human knowledge has some difficulties in discovering the actual and the real.

Critical realism is a suitable research philosophy for the social science of management and innovation. This approach requires focusing on discovering the generative mechanisms of innovation that are more difficult to identify than a simple relation between cause and effect. It is possible that the causal mechanisms that determine innovation can be unexercised, unrealized or go unnoticed by individuals, but this does not make them any less factual and worthy of discovery. The causal mechanisms are hidden determinants of innovation and they have to be identified in order to explain the innovation process.

In order to be in line with the critical realism philosophy, the influence of context on the creation of an outcome also has to be considered in detail. This context can be separated by industry, company or department and while some incentivize obtaining

innovation, there are others that can ignore or inhibit it. The activities that support innovation and also the knowledge conversion process can be influenced by context and, in order to show this, examples of context should be provided and the most helpful context for innovation should be discovered and interpreted.

The advantage of critical realism is that it has a flexible approach to the methods that can be chosen. The methodology depends on the phenomenon that is studied and how the researcher wants to approach it. The method of case studies based on interviews is the usual approach, with the advantage of including the context where the researched phenomenon is usually placed. This method is chosen for the research and will be presented next.

3.2.2 Case study as a research methodology

Conducting fieldwork requires the researcher to define the purpose of the study and select the study's respondents accordingly (Eisenhardt, 1989; Yin, 2003). Most of the in-house documentation of a firm that is relevant to the development of innovations does not provide the necessary - and for this study relevant - information which would reveal the mechanism that underlies the customer and supplier interaction and its variables. It can also be assumed that any strategic documentation on a firm's innovations is not publicly available, for reasons related to the protection of a firm's property. Therefore, this thesis focuses on the answers provided by managers of innovations as the principal source of information and data. This is why the case studies are conceptualized as sequences of interviews with multiple respondents.

Every qualitative research faces various kinds of interactions between the researcher, the research scenarios, and the research areas of interest (Creswell, 2003). For this study, the research strategy is a case-based method with a focus on "how" and "what" type of questions (see Yin, 2003).

Since the literature review notes that the objects of analysis of these pieces of research are not altogether clear, the first task in defining a case study based methodology is to locate the objects of analysis; this is best done through framing a series of questions that can lead to some concrete elements of the customer and supplier relationship that can be used as the key factors of innovation. Designing a multiple case-based research makes the definition of the research question its main task (Eisenhardt, 1989; Yin, 2003). In multi-case study research, one or more research questions are ideal for investigating a particular area of interest (Stake, 2006).

Case study research allows scientists to explore and understand complex phenomena. It is a robust and suitable research method, especially when a holistic and detailed investigation has to be carried out. Case studies overcome the limits of quantitative methods when addressing social and behavioral themes. They enable a researcher to go beyond statistical tools and interpretations, in order to understand behavioral conditions through the perspective of the respondents.

Case study research usually starts by selecting a reduced sample size. They explore phenomena by focusing on practical aspects, in order to examine thoroughly a reduced number of events and conditions and the relationship between them.

Case studies can be single or multiple-case designs; there, the latter must be the result of replication, rather than an increased number of samples. The generalization of results is made to theory and not to populations (Yin, 1994). The results can be strengthened by pattern-matching and, in this way, are proven to be more robust. Pattern matching is a useful way to link data to propositions. It can show the extent to which pieces of information from the case are related to the available or emergent theory. This allows for presumed causes and relationships between concepts to be linked with theory, in order to test this theory in other cases.

There are several types of case studies: exploratory, descriptive and explanatory (Yin, 1984). Exploratory cases are based on a single case and sometimes consist of a starting point for the main research as it is a way to determine the research questions and the hypotheses. Initial fieldwork and small-scale data collection can be achieved with this case study. Characteristics in data useful to the researcher can be explored and can open the door for further examination of the chosen subject. A pilot study is an example of an exploratory case study. Cases must be selected in order to maximize what can be learned and the subjects must be easy to contact.

Descriptive cases require the process to be explained with descriptive theory. This type of study can form hypotheses of cause-effect relationships and there are cases where a pattern-matching procedure is used. The resultant descriptive theory must have a sufficient degree of generalizability in order to explain the details and specifics of the studied case. It also must support the description of the phenomenon or story. If this is not true, then it means that the case study has no rigor and problems may appear during the study.

Explanatory cases use larger samples of subjects and are suitable for causal studies. These case studies examine both the surface and deep level in order to explain the phenomena in the data. It is also common for these to be used in causal studies to investigate selected phenomena with pattern-matching in very complex and multivariate cases. Explanatory case studies are the most extensive because, in addition to constructing a theory, they also test it. An example is Yin and Moore (1987) who study the reasons why some research findings are converted into practical use.

Another classification of case studies is made by Stake (1995) who identifies three categories: the intrinsic, the instrumental and the collective. An intrinsic case study is where the researcher examines the case for its own sake. The reasoning behind such a case can be to discover why a specific company is successful. In an instrumental study the researcher chooses a group of subjects to understand whether there is a pattern of behavior. This group can consist of companies operating in a specific industry such as retail. The collective case study is one in which the researcher collects data from different sources which can consist of companies operating in several industries. Instrumental and collective case studies allow the findings to be generalized to a larger area.

The case study approach includes a number of advantages. The first is that the data are based on events that are examined in the context where they usually take place. This is a more practical approach than an experiment, for example, where the phenomenon under study is deliberately isolated from its context. In management and in

social studies in general it is difficult to conduct an experiment because the researched phenomenon, such as a company, cannot be isolated from the larger context where it interacts with a significant number of factors. The variations in collecting data of case studies permit for both quantitative and qualitative interpretations. Evidence can be sought from both the numerical and categorical answers of respondents. Case studies are not the same with qualitative research, but they can be based almost exclusively on qualitative evidence. Case studies, because they examine the data in a real environment, can contribute toward addressing the complexities of situations and the relationships between the causes in a way that cannot be accomplished through experiments or surveys.

Case studies can identify, heuristically, new hypotheses and variables. This can happen during fieldwork, when studying archival documents, examining the statements of experts or conducting interviews with participants. The element of human interaction is a great advantage over statistical research, as the respondent can contradict the researcher and state a new hypothesis or variable that had not been considered before. Statistical methods such as data mining can identify potentially relevant variables, but they are limited because they can identify something that was previously coded and so was found already useful in order to be worth coding. That is why case studies can help the researcher obtain something new that is real and applicable to the examined phenomenon.

Case studies have difficulties in showing causality when equifinality is in the data. Equifinality is the possibility that the same outcome can arise through different paths or because of different variables. This can determine rejecting factors that lead to an outcome in some contexts but not others and it can also determine accepting a variable as causal when, in reality, its relationship with the outcome is spurious. If a case study is suitably constructed, it can address equifinality. This can be done by identifying and providing generalizations for each path or combination and examining the processes behind each one.

Case studies can address complex interaction effects and path dependency (Ragin, 1987). By considering cases to be configurations of variables, they can present the complex interactions and model the interactions between them. There is a price for addressing complexity, as the more detailed a typological theory or an emergent theoretical model is, the less parsimonious it becomes, and it can apply to only a small number of cases.

There are also criticisms that case studies have a total absence of control to be of almost no scientific value (Campbell and Stanley, 1966). However, later, Campbell significantly changed his views on case studies and became one of the strongest proponents of the strategy. He later states that common sense naturalistic observation is not objective, dependable or unbiased, but is all researchers have and the only route to knowledge (Campbell, 1975). Case studies, even when they do not help in proving anything, are of use in order to learn something (Eysenck, 1976). The context-dependent knowledge embedded in case studies is at the base of learning. Only because of experience with cases can one move from being a rule-governed beginner to an expert with fluid performance and tacit skills. If individuals were to be trained in context-

independent knowledge and rules, or explicit knowledge, they would remain at the beginner stage of the learning process.

Construct validity is a problem and a criticism in case study research. There is an issue of internal validity in explanatory cases because of possible investigator subjectivity. External validity reflects if the results can be generalized beyond the examined case. Reliability is a concern that needs to be addressed before generalizing results on the basis of case studies. There are several ways to achieve this, such as pattern matching and the implementation of a case study protocol.

When undertaking management research, case study research strategies that include qualitative approaches are the most appropriate (Smith, 1991). In this case, it is difficult to make reliable quantitative measurements because of the possible uncontrollable variables. There are also criticisms toward qualitative case studies stating that they lack the rigor, reliability and generalizability of quantitative methods (Woodside and Wilson, 2003). However, this type of argument no longer applies, as a method is not strong or weak by itself but is dependent on the way in which it is applied (Cassell and Symon, 1994). There are two important factors that show if a method is appropriate: the relationship between theory and method and how the potential weaknesses of the method are addressed. To establish the quality of any empirical research, tests have to be employed (Yin, 2003). Generalizability is also called external validity and establishes the domain in which a study's achievements can be generalized. It is a main issue that may appear when working with quantitative or qualitative data. In other words, generalizing from case studies is as difficult as generalizing from quantitative studies because if the sample is not typical, its size is also not sufficiently large.

Generalization in case studies is about theoretical propositions, not populations. The objective is to generalize and expand theories (analytic generalization) and not to consider the frequencies (statistical generalization). Confidence in the results increases if more than one case study is considered. Several case studies make the theory more robust, because the propositions are based on empirical evidence.

Another issue that affects the quality of research is bias which appears in experiments and other research studies. In case study research, these problems may appear more often. Some solutions also allow a researcher to deal with bias. One is to carefully check the concepts and theory against various sources of evidence. Another is triangulation, by examining other sources of evidence in order to confirm the answers of the responders and to be as accurate as possible.

Building theory is an inductive approach and why it is preferable to theory testing has to be justified. When pursuing an inductive approach, it needs to be justified that the research question is significant and that there is no existing theory that offers a suitable explanation for the observed phenomenon (Eisenhardt and Graebner, 2007). In the present study, the research question is significant as it concerns the role of customer and employee involvement in achieving innovation. There is no existing theory, because the study is centered on the activities of customer and employee involvement in detail and the relationships between them.

In order to ensure that the cases are representative, theoretical sampling is applied, instead of random or stratified sampling. Theoretical sampling means that the cases

are selected because they are the most suitable for explaining the relationships between concepts and they offer the most amount of information. The chosen cases have the highest likelihood of offering theoretical insight. In the present study, most of the cases are based on companies that have already achieved innovation. Companies that were about to achieve innovation were also important for methodological consideration but were proved to be unfeasible because of practical considerations. The probability of a company achieving innovation during the time in which this research was constructed was low. The contrast between industries was important for the study, in order to show how different companies and approaches can produce different types of innovation.

3.3 RESEARCH STRATEGY

According to Creswell (2003) the purpose of the research strategy is to determine the logic, activities, techniques, and instruments to be used in the research, while other parts are used to generate valid research results (Royer and Zarlowski, 2001). The study's research strategy applies inductive theory building (Bamberger, 2008). Its purpose is "relationship building" (Handfield and Melnyk, 1998, p. 324), discovering patterns or links between the activities of customer involvement and employee involvement. Hence, "an order in the relationships [can] be identified" (p. 324).

Eisenhardt's (1989) design of multi-case studies was taken as the main guideline and adjusted to the specific requirements of this thesis. The design includes a previous identification of the expected research results needed to answer the research question raised and the reverse engineering processes or steps required to achieve this (Royer and Zarlowski, 2001). Different techniques, tactics, and instruments of qualitative data analysis from qualitative research were reviewed (Miles and Huberman, 1994); those applicable were chosen and adapted to the study's requirements. While analyzing data, parts of the research strategy were iteratively revised to avoid limitations, i.e., remaining flexible and transparent, and being able to correctly link data and concepts.

As critical realism is chosen as the research epistemology, data from the interviews are not the only factor determining the construction of a model of innovation. As a result of the relativist epistemology, the data obtained from the respondents only concern the empirical layer or what the individuals have observed from the working environment they are a part of. Insight about the actual and real layers is more probable to be given by a skilled researcher after some considerable work on the subject. This is why the data from the interviews are helpful in identifying some codes and activities but provide limited guidance to determine causality, knowledge conversion and the influence of contexts in order to better illustrate a model of innovation.

The procedures to adapt the methods used in this research follow from the relevant literature (Stake, 2006; Stebbins, 2001; Glaser and Strauss, 1967; Corbin and Strauss, 2008; Miles & Huberman, 1994; Eisenhardt, 1989). Table 3-1 (page 83) illustrates the various steps (and their activities) taken during the research design.

Multiple interviews were conducted with the respondents and these interviews were different depending on interview phase and if it was part of a case study or simply a background interview. Motivation for this is supported by the literature and is clearly discussed as follows. Research questions in qualitative analysis are prone to reformulation as the study develops and the characteristics of the data gathered refine the answers to be derived from the data (Creswell, 2003).

Table 3-1: Research design: Steps and main activities

RESEARCH DESIGN WITH ITS STEPS AND ACTIVITIES	
Step	**Activity**
Definitions and preparations	▪ Define study purpose ▪ Define first concepts ▪ Define research questions ▪ Define unit of analysis ▪ Select case design ▪ Develop case study protocol ▪ Develop interview guide ▪ Conduct first case ▪ Select further cases ▪ Select respondents
Data collection	▪ **Conduct interviews** – Interview phase 1: Exploring the innovation process – Interview phase 2: Understanding customer involvement and identifying its routines – Interview phase 3: Verifying the identified activities of the customer involvement for acquiring information – Interview phase 4: Verifying the identified seven activities or main codes – Interview phase 5: Improving theoretical model with the ongoing banking innovation case – Interview phase 6: Learning and revising the emerging Causal Loop Diagrams with the seven activities
Data analysis	**NVivo** ▪ Transcribe interviews ▪ Maintain case database ▪ Create contact summary sheet ▪ Create coding scheme, coding transcripts ▪ Identify the main codes ▪ Integrate/link codes into underlying theory and generate an initial version of an innovation model **Vensim PLE (Personal Learning Edition)** ▪ Using the main codes to create and illustrate the model structure ▪ Introducing a knowledge conversion model for innovation ▪ Link explanatory case data to empirical emerging theoretical model (theory development)
Review of literature relevant to study findings	▪ Compare with conflicting/similar literature; concatenate findings
Development of theory and reaching closure	▪ Develop assertions with respect to study question ▪ Link case evidence to assertions ▪ Reach closure
Verification	▪ Verify validity ▪ Verify generalizability ▪ Verify reliability
Write up findings	▪ Write up findings

The respondents were asked to answer to multiple interview phases because the questions changed as the research developed and additional concepts were identified. The research questions were also slightly adjusted. The initial interview phases were about company background and innovation framework, but subsequent interview

phases were about the specific activities that support innovation as these were uncovered. The questions that were too long, too generic or not very relevant were also changed.

The following sections will explain the preparatory steps undertaken to make sure that research is conducted according to ethics and general academic principles.

3.3.1 Defining and preparing the case settings

This research began with trying to determine how information acquisition and routines support innovation and how information is converted into knowledge. None of the studies presented in the literature review address these questions. It is shown that the idea of vertically acquiring knowledge from other sources and the activity of involving customers is correlated with the possibility of obtaining innovation. However, the mechanism of customer involvement and employee involvement is not presented, nor is the information acquisition process (Greer and Lei, 2012). This study is interested in exploring how information flows are used as ways to improve the innovation's development. Another aspect is to describe how knowledge conversion is carried out in the case of innovation. This will include filtering information to find what is useful and applicable, integrating information in organizational practices and adjusting routines because of information.

Table 3-2 (page 84) provides details over the three phases of analysis followed by this research (i.e., pre-interview, interview and post-interview) and the responsibilities of the researcher; aspects such as the mode of interaction, and other minor issues are also considered.

The managers selected were in charge of innovation projects and led different teams involved in their development. The interviews were conducted in a non-intrusive manner. However, potential distractions such as 'researcher bias' and 'reactivity' cannot be controlled in their entirety, given the personal character of such interviews, leaving, in turn, the possibility of invalid conclusions open, albeit minimized (Maxwell, 2005; Miles & Huberman, 1994; Stebbins, 2001).

Table 3-2: Phases with researcher role, method of communication and issues

RESEARCH PHASES AND SETTINGS			
Phase	**Responsibilities**	**Method of communication**	**Issues**
Pre-interview	▪ Create information sheet ▪ Create and have participant confirmation sheet signed by the interviewee and the institute ▪ Sampling of cases and respondents ▪ Contacting target candidates ▪ Generating interest in study participation ▪ Negotiating access ▪ Scheduling interviews ▪ Providing the interview guide on request	▪ Telephone, email	

RESEARCH PHASES AND SETTINGS			
Interview	▪ Developing rapport and trust ▪ Maintaining an open atmosphere ▪ Explaining interview schedule ▪ Conducting interview in accordance with case study protocol/interview guide ▪ Adhering to ethics	▪ Direct, one-to-one contact at the work location of respondents	▪ Ethics: – Researcher bias – Reflectivity – Power relationship
Post-interview	▪ Contacting respondents for clarifications ▪ Data analysis, interpretation ▪ Reporting results if desired	▪ Telephone, email	▪ Ethics: – Researcher bias – Reflectivity – Power relationship

To minimize any such distraction, the research considered Kellehear's (1993) guidelines and ethical recommendations in the data collection process, data analysis, and reporting. Using and interpreting the study's results followed similar guidelines (Creswell, 2003).

The data collection phase followed the principle of informed consent, such that all participants had the research explained to them in a manner that they could understand, including how their individual contributions would be stored and used in the thesis, and all participants were ultimately given the opportunity to withdraw at any point if they so wished. Commercially sensitive competitive information and data regarding innovations were treated with particular care. To ensure the ethical treatment of the information and data usage, the respondents were asked in an agreement email (Appendix 2, section 3.2, page 241) whether their name, the name of the company, and the name of the innovation could be included as part of the thesis. The agreements of the participants are provided in Table 3-3, Appendix 2, section 3.3, page 242. These confirmations were sent to the Department of Strategy and Organization of the Business Science Institute.

The case study protocol is, for multi-case research design, a valuable tool for collecting and reporting information and data (Yin, 2003). The protocols selected are used in a consistent and reproducible manner that supports the conduction of the research efforts and ensures its success in addressing the research questions raised (Yin, 2003). In short, this study adopted a case study protocol made from two documents: a general case study protocol and an interview guide (Manrodt and Vitasek, 2004, p. 4). The case study protocol includes the purpose of the study, case study questions, field procedures, and reporting guidelines (Table 3-4, section 3.4, page 243).

This study used semi-structured interviews, which included thematically ordered closed and open-ended questions. The interview questions and the protocol structure are derived from section 2.5 Conceptual framework (page 69), the research questions of section 1.2 Statement of problem (page 14), and from the empirical studies on customer involvement and employee involvement in the innovation process. The interview guide was reviewed and revised iteratively with this thesis' supervisors; as such the case study protocol and the interview guide were modified according to the lessons learned from the first cases and as the research developed.

The first cases are an important part of the research design, serving two purposes: 1) Testing and adapting the case study protocol and interview guide, and 2) Refining the research design (Yin, 2003). Moreover, the first cases can often differ from the main research: covering a broader spectrum of issues or by being more generic (Yin, 2003). The first cases, comprising one or more cases, are chosen based on 'convenience', 'access' and 'geographic proximity' (Yin, 2003, p. 79).

The first cases in the current research, Avaloq and Synosia, were chosen on the basis of their relevance to the research area of interest, theoretical importance, accessibility of respondents and geographical location. An advantage of this selection is that it was possible to conduct multiple interviews with the respondents from these companies. The first cases allowed the identification of organizational patterns and research directions made possible by the data collected from respondents.

The participants were either interviewed at their firm's location, via a computer or by telephone. During the interview field notes were taken, the interviews were audio-recorded, and afterwards transcribed by a professional agency, in order to be used in progressive induction. The field notes were also used in order to assess the quality of the semi-structured interview and to identify changes, which can be seen as part of the 'lessons learned'. Changes originating from the lessons learned, if reasonable, were incorporated into following cycles and documents (Table 3-3, page 86).

Since case selection is pivotal to multi-case studies (Eisenhardt, 1989), the objective of this exploratory multi-case study is to understand the phenomenon of the information acquisition process and innovation in depth and to identify those aspects which would be conducive to generalization in line with the synthesized theory (Handfield and Melnyk, 1998). The objective of the two exploratory case studies, Avaloq and Synosia, was to identify the influential effects of the empirically found variables or activities, in turn, answering the question "why variables or constructs came about or why they are connected" (Sutton and Straw, 1995). Essentially, these two case studies helped locate and define the objects of analysis to be tested in later stages of the data collection. The expert interviews and the banking case are explanatory in nature as they use a larger sample of subjects to identify causal relations.

Table 3-3: Lessons learned from first cases

LESSONS LEARNED – FIRST CASES		
First Cases	**Lessons learned**	**Modifications made**
Avaloq	▪ Questionnaire too long ▪ Questions partially too generic, too detailed, or too difficult ▪ Sequence of interview topics not ideal ▪ Funnel mechanism to direct discussion towards resource differentials missing ▪ Level of interest varies with topic ▪ Voice quality of audio tape too low	▪ Study questions revised ▪ Structure and content of interview guide refined ▪ Audio recording equipment replaced

LESSONS LEARNED – FIRST CASES		
First Cases	**Lessons learned**	**Modifications made**
Synosia	▪ Some questions not relevant to the industry-specific settings ▪ Formulation of some questions ambiguous ▪ Transcription extremely time consuming ▪ Too much time spent on questions related to competitive environment	▪ Interview questions reviewed and, where necessary, replaced with more concise formulations ▪ Interview procedure changed (selective use of questions applicable to all industries/businesses)

This research's interest in the mechanism and activities of the customer-supplier interaction, a theoretical concept of the customer-supplier interaction, meant that theoretical sampling was chosen. Theoretical sampling is a process that consists of the simultaneous collection, coding and analysis of data, with the aim of choosing which data to collect next (Coyne, 1997; Glaser, 1992). This is the reason why the cases and interviews were conducted in multiple stages and resulted in different versions of innovation models.

Theoretical sampling is based on grounded theory (Coyne, 1997) which is, in turn, based on data that provides theory (Koerber and McMichael, 2008). Koerber and McMichael (2008) explain that a researcher "identifies a situation or phenomenon that cannot be adequately explained by existing theories and then initiates a research project to glean data that will build and test a new theory" (p. 465). In theoretical sampling, trends are identified based on emerging data, in which new data is purposively reviewed that either question or confirm the trend (Coyne, 1997; Strauss and Corbin, 1998). In this research, data are coded and analyzed according to this approach which, therefore, provides the direction of the sampling (Coyne, 1997). The coding categories are then reviewed and redefined, in which further samples are chosen to further review and redefine coding categories (Coyne, 1997) iteratively (Higginbottom, 2004).

In terms of size, the case sample is selected at the beginning of the data collection stage as suggested in the literature (Miles and Huberman, 1994; Stake, 2006). Stake (2006) proposes that researchers select a sample of four to ten cases, which are deemed adequate in terms of specificity, diversity, and manageability. Smaller or larger sample sizes are acceptable if there is enough confidence in that they produce reasonable and justifiable results. Since generalizations are strictly out of bounds for this type of approach, the sample size can be seen mainly as a question of judgment (Eisenhardt, 1989; Stebbins, 2001; Yin, 2003). Still, it is argued that larger samples do increase levels of certainty (Yin, 2003) and can deliver a substantial amount of data, which is essential when studying complex phenomena (Glesne, 1999). The mentioned intuition, stating that innovations are rare and infrequent (Tushman et al., 1986), is used to identify reasonable cases and helps the research dismiss cases that seem unlikely or improbable; the marginal benefit of each selected case is key in defining the sample size (Yin, 2003). Eisenhardt (1989) suggests using four to ten cases, which enable researchers to propose results that are relevant, compelling and consistent with an empirically sound theory while, at the same time, avoiding data overload. Bearing

in mind the complexity of the phenomenon under scrutiny and the rareness and infrequency of innovations (Tushman et al., 1986), a reasonable size is considered to lie within six to twelve cases. This research uses a sample of three cases, two retrospective and one ongoing, but they are supplemented by ten background information interviews. The initial retrospective cases, Avaloq and Synosia, are exploratory and the interviews and the ongoing case are explanatory. This approach allows balancing a detailed description of the main cases with expert information that is useful for identifying the context of innovative companies.

Since the research area of interest already narrowed the relevant audience, this research used the following three sampling criteria: 1) Manager of innovations, 2) possessing knowledge and experience, and 3) English-speaking. The reason for opting for the first criterion is that managers, who were directly involved in innovations, would have the best knowledge of the process, ensuing issues, timing and the like related to the development of innovations. Those selected were directly involved in the development of innovations which, in this case, were either CEOs, R&D managers or other managers. Since, this thesis is in English, the third criterion, the interviewee being English-speaking, was adopted to avoid common issues related to translations such as loss of context, changes in meaning and the like. In short, as Easterby-Smith et al. (2002) indicate, executing and analyzing data in the same language, and avoiding translations, can significantly decrease the effort and complexity of a study.

3.3.2 Data sources

The following discussion introduces the innovation cases and interviews from which the data were collected. In this section the innovations corresponding to them are briefly described and an argument is provided for why each one was selected.

The table below includes a list of the data sources used in this research: two exploratory case studies, Avaloq and Synosia, ten background information interviews and an ongoing banking innovation case.

Table 3-4: Sources identified as innovations

CLASSIFYING THE INNOVATION OF THE SOURCES			
Source	**Description of Innovation**	**Case Study**	**Background Information Interview**
Avaloq (retrospective)	Transformation from a paper-based to automated back office	√	
Synosia (retrospective)	New imaging method that allows detailed analysis of brain activity	√	
Synosia and Roche collaboration	Licensing of SYN-115		√
Mobile	Using radio wave instead of copper cables for transmitting electrical signals		√
Mouse Scanner	Employing the same technology as a traditional scanner		√
Internet: ▪ Packet switching ▪ Communication protocol ▪ World Wide Web	Using a packet switching network system. A protocol allowing dispersed users including companies on different networks to communicate. A platform that allows users to reach others via computer globally.		√

CLASSIFYING THE INNOVATION OF THE SOURCES			
Source	**Description of Innovation**	**Case Study**	**Background Information Interview**
Token Ring	Different base principle or concept as a networking transmission system		√
Millipede Project	Moving the storage medium relative to the cantilever array by adopting a silicon-based x/y micro scanner		√
Laptop Osborne 1	Change in layout		√
New World of Work	Shift static to dynamic work routines		√
VoIP Enterprise Solution	Shift from analogue to digital transmission		√
Ongoing bank innovation	New daily banking product model, based on tiles of the Windows Metro UI style	√	
Galactic	The poly-lactic acid		√

The cases were selected because of their relevance to the companies that were chosen; they were not too focused on a specific field of activity. A few of the cases are well known and had wide ramifications concerning how to obtain innovation and use it to improve their product line. The majority of the cases are in technology but there are also others in different industries.

3.3.2.1 Retrospective case studies

The initial two cases, Avaloq and Synosia, are exploratory in nature and were useful in determining the research direction and themes to be followed. The companies were selected on the criteria of having obtained innovation. The respondents also had to be involved in the innovation process, they were required to have knowledge and experience and were able to speak in English during the interviews. The persons interviewed were CEOs, developers or managers of innovation.

Avaloq

The Group is a mid-sized information technology firm operating mainly in Switzerland, where it leads the market in standardized banking software. Avaloq Banking System is a fully integrated core banking solution that offers utmost functionality in the range of banking products it supports and the value it adds. Banks that adopt Avaloq Banking System's modern and open architecture to their business requirements can be assured their processes are efficiently modelled. This study focused on identifying codes within the innovation and variables within the innovation process interactive mechanism in the banking industry.

Avaloq's innovation is its integrated software, which provides full coverage of banking processes. In the early 1990s in the banking industry computer power reached maturity in that it provided automated software systems, which allowed replacement of the previously used paper-based solutions. The transformation from paper-based to automated back office was a significant change in the 1990s.

Synosia Therapeutics

Synosia is the second case study undertaking drug development for the pharmaceutical industry. Founded in December 2005 and headquartered in Switzerland, Synosia is managed by a team with 200 years of accumulated drug development experience, is backed by $91.5 million in funding from high-quality investors, and maintains a rich portfolio of compounds (Massey, 2011). The company has partnerships with Roche, Novartis and Syngenta in order to develop six clinical drugs (Meya, 2011). In its pipeline are two marketable drugs for treating bipolar disorder and Parkinson's disease. The examination of this case study focused on identifying codes within innovation and on identifying variables within the innovation process interactive mechanism in biotechnology.

Small pharmaceutical companies like Synosia are generally established upon one innovation or invention, one particular compound with one specific molecular target (Meya, 2010). Synosia's innovation consisted of changing the methodology for developing hard disease treatments to allow early detection of molecules unsuitable for further development (Meya, 2011). Synosia set up its research around seven compounds, each with a unique molecular target. This approach is more risk-balanced; if one compound fails, six remain to be tested, and one could be a gold mine (Meya, 2011). The methodology can be adapted to preliminary results from ongoing studies, drawing samples from fewer patients—14 instead of more than 100. Synosia's approach was aided by the advent of a new imaging method that allows detailed analysis of brain activity. Compared to previous methods, this constitutes a change in base principle (Massey, 2011). The research examined in this case study involved the SYN-115 drug to treat Parkinson's disease.

3.3.2.2 Background information interviews

This section lists the background information interviews that were included in order to increase the number of observations and provide a wide perspective of innovation. The interviews allowed to achieve a greater context and generalizability and also to balance efficiency with the quantity of data. Unlike the case studies, the interviews were conducted in a single session with company representatives. The companies are from a diverse number of industries, but all have obtained innovation in some way.

SYN-115 – Synosia - Customer View Roche

In order to also have a customer perspective on one of the innovations, one of the developers of the innovation SYN-115 - Synosia was considered.

Roche out-licensed SYN-115 to Synosia because, as Sarry (2012) explains, "All these drugs and projects Synosia is working on [including the SYN-115] related to CNS, central nervous systems" (p. 3) were no longer in the focus of the Roche's research area.

The explanation for such an out-licensing is that the drug development can last 12 or more years and cost nearly $1 billion. The extended time and cost are a result of the high risks of failure and the unknowns entailed in drug acceptance procedures, including toxicology and safety testing, regulatory requirements, and regulatory review of acquired data. These difficulties prompted the creation of a smaller and innovative firm – Synosia - to develop compounds through processes that potentially reduce

risks, and costs for the customer and supplier. Increasing innovativeness reduces development time, costs, and risks.

Mobile

Led by Martin Cooper, Motorola developed the mobile phone in the 1970s during a legendary rivalry with AT&T whose wireless communication system was inadequate. AT&T reached into its database and found creative people who proposed cellular technology as a solution. Motorola agreed that cellular technology was promising but believed that consumers preferred personal communication devices rather than car phones. Motorola had extensive experience in two-way radio, but two-way radio transmitters needed an outside battery that required a car to carry it. Motorola developed the transistor and refined the technology until personal devices no longer required automobile transport. Hence, the case study documents an evolution in the technology of batteries, transmitters, and receivers.

The telephone transforms speech into electrical signals travelling along copper cables. Since mobile phones send and receive calls as radio wave signals, they are not physically connected to the telephone network. Radio wave signals constituted an innovation compared with cable-conducted signals.

Software for Mouse Scanner

The software for dynamic scanning with a mouse was developed to bridge technology and business. The goal was to produce a mouse that everyone could use for scanning and editing any application. This innovation would change how people work.

The Mouse Scanner employs the same technology as a traditional scanner. It is still an innovation, because of its universal functionality and compatibility with multiple applications. Its upgrade in functionality makes information easily available to more users and boosts quality by reducing errors (e.g., via online payment, creation of spreadsheets, scanning of passports and IDs). Price is another competitive advantage: The Mouse Scanner, with software, costs less than $100 versus $200-$500 for traditional scanners (Dacuda Mouse Scanner, 2011).

Internet

The internet employs a hardware and software “infrastructure” (Perez 2009, p. 8) in a loosely organized, interconnected computer network (Hart et.al., 1992). It created a shift from paper-based to electronic infrastructure for communication and data transfer. As a new information technology system, it “not only modifies the business space but also the institutional context and even the culture” (Perez 2009, p. 4); i.e., it opens a new system trajectory, strongly inter-related and inter-dependent (p. 5).

The innovation originated with Bolt, Beranek and Newman (BBN), the private contractors for ARPANET, creating a commercial version after the US legalized value-added carriers. Their network, the Telenet, began operation in 1975 when BBN installed free public dial-up access throughout the US. Telenet was the first publicly available packet-switching network system. Commercialization of the internet started with the BBN team of Frank Heart and Dave Walden. The internet required three major inventions before commercialization-innovation could be launched: 1) Packet switching, 2) a protocol (TCP/IP) allowing dispersed users (including firms) on differing networks to communicate with each other (e.g., email), 3) and the internet, the platform allowing

users to reach others via computer, globally. The fourth step, the actual commercialization of the invention, comprised the innovation process of the sizing; i.e., charging for connection, instead of being charged by piece of medium (Post Office). Instead of charging for network use based on distance and size (like the Post Office) or time and distance (like phone companies), the ARPANET charged according to the size (size of information or bandwidth) of the connection per year or month. The use of the ARPANET increased exponentially after charges for network access were fixed in an institution's yearly budget, freeing users from visible monthly bills that would inhibit usage. While building ARPANET, Larry Roberts decided that distance was not an economic factor and evaluated cost per packet rather than cost according to the distance between supplier and customer.

IBM Token Ring

Research into the token ring started in 1979 and was launched as a product in 1985. It is a closed-loop network transmission system that comprises differing coordination of access (access protocol) through which controlled access was used. Therefore, this entails a deterministic behavior: an algorithm, model, procedure and process, which is completely determined by its initial state and not random. To access the network, users had to wait for a special signal, i.e., the token. In contrast, Ethernet uses random access. As Fontana (2000) explains, "Multi-protocol routers entailed an innovation from the technological viewpoint and therefore accompanied by a certain degree of uncertainty" (p. 25). Hence, the token ring represents an innovation in networking transmission systems. It became the local network system among IBM's large customers, who could employ individual local networking strategies.

IBM Millipede Project

The millipede is a nano-mechanical atomic force microscope (AFM)-based data storage system, a probe storage system. Its core components are a two-dimensional array of silicon probes (cantilevers) and a micro-mechanical scanner that moves the storage medium relative to the array. It is an innovation in that the millipede's underlying concept involves moving the storage medium relative to the cantilever array by adopting a silicon-based x/y micro scanner. This differs from the base concept of keypunch machines as the primary input medium for computer programs and data.

The Osborne 1 Laptop

Lee Felsenstein was the chief and design engineer of the system and circuit board for the world's first laptop, the Osborne 1. His challenges were to design the laptop's main circuit board and to select and price the components of its floppy drive. His earlier creation, the memory map video display, provided the high-speed display access necessary for real-time operational output. With the development and launch of Osborne 1, the market for laptops was born.

An innovation in the computer industry, the laptop, composed of a memory map video display, was based on a new underlying concept, which differed from that of its predecessors - mainframe and personal computers. Nevertheless, the Osborne Computer is an innovation based on another one, the memory map video display. According to Felsenstein, technology constraints influenced this innovation. The difficulties he encountered included failures in physical timing of digital signals (physical timing analy-

sis), which created financial risks (resource and organizational risks). At that time, developers also faced a scarcity of engineers (human resources). Additional factors included the virtuosity of engineering design, appreciation from other engineers, and opportunity for financial gain.

New World of Work - Microsoft

The "new world of work" was born from a white paper by Bill Gates in which he discussed transparency, trust, and empowerment. The world is becoming different, he argued, and is inspired by social and technical change.

Acting cooperatively in the workplace entails a paradigm shift with respect to business management; in the new world of work, the "when" and "how" are left to the worker. This new world of work constitutes a new base principle. Its innovations were the shifts from control-based to trust-based work, from a culture of actual to virtual workspaces (email, instant messaging, video conferencing, remote workstations), from individual contributors to teams of web-based collaborators scattered worldwide, and from 9-to-5 "rigid hours" to flexible work schedules.

Following Gates' white paper, the first innovation process interactions relevant to this innovation occurred among internal teams of Microsoft employees. Dan Rasmus asked these internal customers for ideas about new working principles and their challenges (learning the business needs). The manager in charge of the global implementation of this new world of work, Kevin Eva Norton, also interacted with these internal customers.

VoIP Enterprise Solutions

The innovation in this interview was the development of Voice over Internet Protocol (VoIP) as an enterprise solution. VoIP technology converts analogue voice calls into a digital format relayed over the internet. The shift from analogue to digital transmission was a shift in concept, from landline telephony, which employs transmission lines that connect homes, to the phone network.

Internet telephony appeared in 1970. Siemens deployed unified messaging for private customers - VoIP for private users - in 2000. Media-Streams developed a new VoIP stream for enterprise solutions and distributed its VoIP Enterprise Solution platform to the market. The major change brought by this innovation was the potential for VoIP Enterprise Solution to change the telephony industry.

Galactic's poly-lactic acid

Galactic is a company that produces chemicals for the food, healthcare and industrial markets. Their products are healthy and environmently-friendly and are not based on fossil chemicals. It has a network with many distributors and customers, which enabled it to have an innovative and solution-oriented approach.

Galactic is, as a company, a product of innovation. Back in the 1980s, its founder developed a completely new purification process for lactic acid. The process, cheaper to operate and leading to unprecedented quality levels, revolutionized the lactic acid industry and became, over the years, the most used purification process among all the lactic acid producers worldwide. This innovation allowed the company quickly to be-

come the world's second largest producer. Thanks to its cost efficiency, this technology contributed to reduce lactic acid production costs to an extent that made it possible to produce PLA (poly-lactic acid) in a competitive way against oil-based traditional plastics. PLA is biodegradable polyester derived from renewable resources which had, already in 2010, the second highest consumption volume of any bioplastic of the world. PLA is used in the form of film (for packaging and agricultural applications) or fibers (woven for textiles or non-woven for disposable garments and diapers). PLA is also used as a feedstock material in desktop fused filament fabrication-based 3D printers.

Therefore, the innovation is the new purification process for lactic acid based on new technology contributing to reduce lactic acid production costs to an extent that made it possible to produce PLA (poly-lactic acid) in a competitive way against oil-based traditional plastics; thus, being based on a new concept.

3.3.2.3 Ongoing banking innovation case

The new daily banking product model will allow the customer, through drag-and-drop, to dynamically bundle products and services from a list of features, and pay on the go, only for features chosen. This revolutionizes the "daily banking experience" for the customer. The customer, based on tiles (features topics, and features) of the Windows Metro UI style, chooses and bundles his individual feature basket of core and non-core banking products and services.

This new daily banking product model required a new system landscape, which is currently being developed by the bank's global digital transformation initiative. Because of a non-disclosure agreement (NDA) with the bank, no further details are provided. The corresponding transcriptions of the interviews are stored with the Department of Strategy and Organization of Strathclyde University Business School. Some of the innovations are based on previous ones so they are incremental in nature. For the Mouse Scanner, the scanning technology is the same as in regular scanners. For the Laptop Osborne, the layout of the product is the same. The laptop operated on a new memory map video display, based on a new base principle or concept, compared to its predecessor mainframe and personal computers.

3.3.3 Interview process

In this research, semi-structured interviews with executives involved in the respective companies' innovations (Table 3-6, page 99 and Table 3-8, page 101) sought to identify precise information about the innovation, strategic context of the innovative development, and characteristics of customer-supplier interactions.

Interviews began with theoretical questions that explored the technology in each researched case. Questions were designed to assess whether customer and supplier interactions had a role in improving the information acquisition process of innovations. Preparing a list of questions and themes in advance assured the comparability across interviews and case studies. The list allowed respondents to familiarize themselves with the definition of innovations and with the mechanism of inter-firm interaction.

Interview settings were comfortable, impartial, and conducive to empathetic and active interviewing allowing for unscripted questions, such as follow-ups to interviewees' responses. The interviewer chose, thus, which information about the content and context was relevant for the research. Rephrasing and paraphrasing of the interviewees' responses was used in order to confirm the understanding and accuracy of the information. With the permission of interviewees, interviews were digitally recorded and transcribed following Miles and Huberman's (1994) guidelines, which is a procedure that is expected to also enhance the quality of the instrument.

The Table 3-6 (page 99) provides an overview of the various interview phases held with the respondents, for a total of 31 interviews. The initial 10 interviews are from the main case studies, Avaloq and Synosia, and 10 are background information interviews. The next six interviews are related to the banking case for improving the causal loop model and five interviews are conducted with two academic specialists and three innovation managers for refining the model. The improved model will feature minor changes, but the revised one with the specialists in the field will feature significant ones It illustrates the data collecting strategy in narrowing from the big picture of innovation down to the missing variables of customer involvement. Further, it locates the variables within the first innovation model.

In a similar way to Leonard-Barton (1990), the methodology consists of case studies and retrospective interviews (for details see Table 3-4, page 88). This is a suitable approach, as it balances efficiency with richness of data. In this way, the study examines an increased number of companies, in order to identify the context of customer involvement and to achieve greater generalizability. From an objectivity standpoint, the methodology allows the study to not be too focused on a specific company and also diminishes the respondent bias specific to individual interviews. The mixed methodology allows the examination of innovation processes from different viewpoints: a macro perspective from the retrospective interviews and a micro perspective from the case studies. Retrospective interviews help to identify patterns and the ongoing case studies can elaborate on these patterns as they evolve over time.

Background interviews are used to increase the number of observations, especially as this is a way to confront the 'rareness' of innovation (Tushman et al., 1986; Tushman and Rosenkopf, 1992). Further, in a similar way to Leonard-Barton (1990), ten background interviews were used in this research to "to deliberately vary the context" of customer involvement and the nature of innovation for reaching "greater generalisability" (p. 251) and "variety of situations" (p. 253), i.e., to provide external validity to research design. The data from these ten retrospective interviews provides comprehensive explanatory views on innovation, customer involvement and its variables. Ongoing cases offer in-depth explanatory views on the phenomenon under study, providing a "good opportunity to establish cause and effect", thereby reaching "internal validity" (p. 253). The advantage of combining retrospective and ongoing cases lies in moving back and forth between them. This helps formulate a theory in one setting and confirming or refining it in another. The combination of the two types establishes internal validity in providing "better evidence for hypotheses about causal relationships between variables" (p. 259). In short, the specific strengths of each method compensate for the weaknesses in the other.

This study, in employing multiple sources of data, sets to obtain “evidence of a construct's validity” (Leonard-Barton, 1990, p. 258). A concept is an abstraction from observed events or a shorthand representation of a variety of facts. Its purpose is “to simplify thinking by subsuming a number of events under one general heading” (McClelland, 1951). Some concepts that are easily identifiable. For example, the concept of a mountain can be illustrated by pointing at a specific mountain. Some concepts are more abstract, for example attitudes, motivations and roles. Constructs are concepts that have a great degree of abstraction. Constructs can also be identified by their “sets of propositions stating their relationships to other variables, constructs or behaviour” (Selltiz, Wrightsman and Cook 1976, p. 173).

In this research, the constructs are the activities of information acquisition, customer involvement and employee involvement that support or enable the process of innovation. A construct is validated by examining if the propositions about its relationship to other variables are confirmed.

In order to establish the validity of a construct, a number of observations are necessary, so this is why the longitudinal case study is supplemented by retrospective interviews. The constructs are measured by the interview responses from employees working in a wide range of companies that have obtained innovation.

Table 3-5: Interview schedule, purpose and case type

Type	Source	Purpose	Function	Number of interviews	Phase 1: Interviews	Phase 2: Interviews	Phase 3: Interviews	Phase 4: Interviews	Phase 5: Interviews	Phase 6: Feedback Sessions
					Exploring the innovation process, answering the main RQ	Understanding customer involvement and identifying its routines, answering sub-RQ1 and sub-RQ2	Verifying the identified recurring routines of the customer involvement for acquiring information, answering sub-RQ1 and sub-RQ2	Verifying customer involvement in the innovation process answering sub-RQ1 and sub-RQ2	Improving the theoretical model with the ongoing banking innovation case, answering sub-RQ1 and sub-RQ2	Learning and revising the emerging CLD with its 7 recurring routines
Interviews conducted during the exploratory case study	Avaloq	Exploring context and patterns	CEO	3	**X**	**X**	**X**			
			Engineer 1	1		**X**				
			Engineer 2	1		**X**				
Interviews conducted during the exploratory case study	Synosia	Exploring context and patterns	R&D Manager	3	**X**	**X**	**X**			
			COO	1		**X**				
			Roche Customer View	1		**X**				
Retrospective explanatory interviews	Interviews with 10 innovation managers	Explaining context and patterns	Inventor / Innovation Manager	10				**X**		
Ongoing explanatory interview	MyBank	Improving the model by adjusting the causalities	Manager, and project team members	6					**X**	
		Testing and revising the CLD model structure	Professor Dr. Fanny Simon	1						**X**

Type	Source	Purpose	Function	Number of interviews	Phase 1: Interviews	Phase 2: Interviews	Phase 3: Interviews	Phase 4: Interviews	Phase 5: Interviews	Phase 6: Feedback Sessions
					Exploring the innovation process, answering the main RQ	Understanding customer involvement and identifying its routines, answering sub-RQ1 and sub-RQ2	Verifying the identified recurring routines of the customer involvement for acquiring information, answering sub-RQ1 and sub-RQ2	Verifying customer involvement in the innovation process answering sub-RQ1 and sub-RQ2	Improving the theoretical model with the ongoing banking innovation case, answering sub-RQ1 and sub-RQ2	Learning and revising the emerging CLD with its 7 recurring routines
		Testing and revising the CLD model structure	Professor Dr. Martin Cloutier	1						**X**
		Testing and revising the CLD model structure	Innovation Manager Ruth Mojentale	1						**X**
		Testing and revising the CLD model structure	Innovation Manager Frederik Gregaard	1						**X**
		Testing and revising the CLD model structure	Innovation Manager Frederik Arns	1						**X**

The first two cases led to three interview phases (interview phases 1 - 3) from two main sources, i.e., Avaloq and Synosia; the details about the schedule, source, theme, interviewee and date are all illustrated in the Appendix in Table 3-6 (page 245).

The following section illustrates the questions corresponding to each interview phase, the reasoning for the phases and what happened in each interview that was relevant for the purpose of the research.

3.3.4 Interview guides

The questions from all the interviews are listed and arranged chronologically according to the phases. The interviews from phases 1, 2 and 3 were conducted with representatives from Avaloq and Synosia; phase 4 consists of background information interviews; phase 5 includes interviews from the ongoing banking case; and, phase 6 comprises interviews with specialists in the field of management and innovation. The initial phases have interviews with more general questions and the following phases have interviews with more specific questions that were formulated as the research developed and new concepts identified.

Phase 1: Interviews about viewing the innovation process
Questions for the phase 1 interviews (Table 3-6) were chosen to gather initial ideas about the nature of the innovation and the firm's situation, including details about the innovation itself, what customer involvement was like, and whether similar patterns emerged.

In the face-to-face interviews for phase 1 the CEO of Avaloq and the R&D manager of Synosia participated. The interviews lasted about 60 minutes each and were divided between introductory and main questions concerning innovation.

Table 3-6: Questions of interview phase 1

	INTERVIEW QUESTIONS
Introduction	Tell me about your background and history with the company.
	Tell me three important things about the company.
	Tell me why these are important and where they come from.
Main questions	What was your company's most significant innovation?
	What motivated you to pursue this innovation?
	Can you explain in detail the process of this particular innovation?
	Which participants in your company were involved in the process?
	What was the outcome of the innovation process (e.g., a new technology, a new product, a confirmed need for more research)?

The former aimed at gaining an understanding of the firm and the latter intended to collect information about innovation. The interviewees explained in detail their innovation process, which provided a first indication of direction, themes and rough concepts. This interview also disclosed the participants involved in such a process. These two interviews from the first cases provided the opportunity to create an initial picture about the process of innovation and its constraints and challenges.

Phase 2: Interviews about customer involvement and its activities
The questions of interview phase 2 (Table 3-7) go in more detail about customer involvement in the innovation process and how it is realized.

Interviews sought to identify whether interactions occurred, the purpose they served if so, and who the interacting parties were. This facilitated seeking details about the cause and effect of the activities of the information acquisition process for innovation.

In the two face-to-face interviews, which lasted about 60 minutes each and where the CEO of Avaloq and the R&D manager of Synosia participated, specific questions were, likewise, divided into introductory and main questions. This time the interview intended to gather information that would explain the innovation's main contribution to the business and industry, the participants in the innovation process and how the customers contributed to obtaining it.

By answering the main questions, the interviewees explained in detail the involvement of the various participants. Furthermore, the interviews revealed that customer involvement was implemented and provided, in turn, a detailed description of these interactions in terms of influences and effects. The interviewees were also asked about the culture of the supplier and illustrated when and how the innovation was born.

Table 3-7: Interview questions of phase 2

	INTERVIEW QUESTIONS
Introduction	Does your innovation contribute significantly to your business?
	Please recall the horse and car analogy. Is your innovation grounded in a new base principle or base concept?
Main questions	Which principal agents were involved in the innovation? For customer and supplier how many participants were involved? Type of participants?
	Did customer-supplier interaction occur during the innovation?
	How many? Were they random or occasional? Was there any specific sequence? What were the main purposes of the interactions? Were the topics always the same? What were the topics for learning (information-gathering about requirements, design, and features)? Generative learning (problem-solving and solution-finding)? Confirmation for re-design?
	Did the customer involvement influence the innovation? How so? What were the effects?
	What was the culture of the supplier?
	What was the culture of the customer?
	Where was the innovation born?
	How was the innovation born?

Phase 3: Interviews about verifying the activities of customer involvement
The interviews in this phase each lasted about 60 minutes. They were conducted with the CEO of Avaloq and the R&D manager of Synosia, who sought to confirm the activities of the customer involvement identified in interview phases 1 and 2; additional activities and routines were added during this interview (Table 3-8, page 101).

In these face-to-face interviews, the interviewees were presented with the routines identified in the first two phases; the participant was asked to confirm or deny the presence of these routines, their location within the causal loop model and the relations that can be identified between them.

The variables were then described and matched to the appropriate research question and theoretical concept. These codes are inductive, progressing from sub-codes to main codes. This coding led to the main codes and sub-codes (Table 3-24, page 123) at the basis of the coding strategy.

Table 3-8: Questions of interview phase 3

INTERVIEW QUESTIONS
The emergent theoretical model. In the previous interview, I identified important variables within the innovation process. Please explain. Are variables missing? What are they?
Customer involvement. In the previous interview, I identified the following activities that were realized with the help of the customers: Brainstorming, Structuring Problem, Collecting Data, Reflecting Information, Exchanging Knowledge, Filtering Knowledge and Feedback.
Are those the activities? Are any missing? Which ones? To what stages of the model can the individual activities be allocated? Did the stages contribute equally to value of the innovation process? If not, when did which activities contribute what value?
Additional explanations. Please explain the demand for new technology that you realized during the innovation. Please explain the technological evaluation you faced when realizing that the old system reached its limits of base principle and base concept.

Along these lines, it became apparent that this method of structured interviewing could not, by itself, capture the complexity and multi-dimensionality of a multi-level analysis including main and sub-codes in a causal loop diagram. Therefore, the Vensim PLE software modelling and simulation software was chosen. The initial modelling sessions sought to verify that the identified routines actually support innovation. The innovation model or causal loop diagram (Figure 4-1, page 145, and Figure 4-2, page 156) was constructed with the seven discovered variables during this phase of interviews. The Vensim PLE software facilitates multi-level modelling, including first levels or the main codes and sub-levels or the sub-codes of each concept. The next step was to identify the increasing (+) or decreasing (-) relations between concepts, as shown in Figure 4-1 (page 145), and Figure 4-2 (page 156). The data and findings served for constructing an innovation model based on a causal loop diagram. This was done with the Vensim PLE software.

Phase 4: Interviews about customer involvement in the innovation process
After the first case studies were conducted with Avaloq and Synosia and the first categories of codes or main codes with their coding strategy defined (Table 3-24, page 123) the findings and lessons learned from interview phases 1, 2 and 3 led to a revised interview format for the remaining 10 retrospective interviews.

Interview phase 4 sought to identify whether customer involvement occurred, its nature, and whether these innovations were successfully brought to market.

The interviewees explained their involvement, responsibilities and roles in their innovation. They further elaborated influential factors, i.e., involvement of the customer and provided a description of how they perceived such involvement. They were shown the already identified routines and asked to either confirm or deny them and, if applicable, add missing variables. Variables discovered during the initial three interviews facilitated further detailed coding.

In these video-facilitated and audio-recorded interviews with innovation managers around the globe, the interviewees described their innovations, and elaborated what, in particular, had changed (Table 3-9).

Table 3-9: Interview questions for the background interviews

INTERVIEW QUESTIONS
Involvement in the innovation ▪ What was your role in the innovation? ▪ What did you do?
Tell me about the innovation. What was it?
What did the innovation in particular change?
What factors influenced the innovation?
Was there a particular pattern of influential factors, in your innovation—e.g., involvement of the customer?
Does this pattern comprise particular activities; e.g., brainstorming, structuring problem, collecting data, reflecting information, exchanging knowledge, filtering knowledge and feedback? ▪ When you were involved in customer involvement, did you observe specific activities? ▪ Did a common pattern appear repeatedly? Please name and explain them. What was the appearance of the activities in the entire innovation process? How do they connect? What worked? What did not? Why?

In this respect, the interviewees were asked whether they had repeatedly observed common patterns regarding the routines and where, if so, these patterns appeared within the theoretical model or the causal loop diagram.

Phase 5: Improving the theoretical model with the banking case

The next round of interviews, conducted in a bank, had the purpose of refining the theoretical model based on causal loop diagrams. The model was slightly adjusted because of this. Table 3-10 (page 248) provides the interview themes, respondents and dates. It is clear that the customers influence the development of banking products by their consumption patterns that allow the bank to have information about what products are successful to the public. However, there are cases where the customer is involved, largely, in the innovation project. The focus of the interview was to establish the relationship of the customers with the innovative project My Banking.

The interview questions (Table 3-10 and Table 3-11, page 102) are provided next, which led to improvement of the emerging theoretical model.

In the second interview, a project team member and a project sponsor were contacted. They were first asked questions about the innovation project itself in order to ascertain the reason why the project was started and what was different about it from other products and services offered by the bank.

Table 3-10: Interview 1 of the ongoing banking case

ONGOING INNOVATION INTERVIEW 1 QUESTIONS
Why did the bank do the MyBanking innovation project?
What is the difference between the status quo and MyBanking?
What were the main steps/parts of the MyBanking innovation development?
Did you get any external knowledge/information (e.g., research, studies, surveys, interviews)? What were these external knowledge/information sources? Can you name them?

ONGOING INNOVATION INTERVIEW 1 QUESTIONS
How did you get the various knowledge/information?
What kind of external knowledge/information did you get?
Who was involved in that external knowledge/information acquisition?
In the main steps/parts of the MyBanking innovation development, how did you generate missing necessary knowledge/information for each step? Please name the steps of the innovation and indicate what knowledge/information was required, how it was generated and who the participants were?
Who were the actors (stakeholders, participants, business units) in your company involved in the MyBanking innovation development?
What was the outcome of the MyBanking innovation (new technology, new product, is more research required)?
Did or will you involve the customer in the MyBanking innovation development? If yes, why did or do you involve the customer in the development; for what?
What did you get from the customer involvement?
What did you achieve through the customer involvement?
Is your customer the end-user of MyBanking? If not, what is he?

Subsequently, the questions were meant to identify the kind of knowledge necessary for the project, how it was acquired and how the information gaps were resolved. The questions tried to place the customer in the innovation development, by establishing its contribution and involvement in the project development.

Table 3-11: Interview 2 of the ongoing banking case

ONGOING INNOVATION INTERVIEW 2 QUESTIONS
Please explain in detail the knowledge generation. Indicate who was involved, what difficulties you faced, and how you solved those difficulties.
Please explain the paper prototype development.
Please explain the system prototype development.
Did or will you involve the end-user in the MyBanking innovation development? If yes, why did or do you involve the customer in the development; for what, latent/expressed?
What did you get from the customer (end-user) involvement? Explain in detail.
What did you achieve through the customer (end-user) involvement? Explain in detail.

Interview 2 furthers the objectives of interview 1 by going into detail regarding the process of generating knowledge, the individuals responsible for obtaining it and the difficulties experienced. The questions were meant to establish what happens at the initial stage of development, as the respondents clarified aspects about the paper and system prototype. There are further questions that go into detail about the end-user's involvement, by trying to discover the benefits obtained from involving the customer or end-user in the development of the product.

The answers were revealing and interesting as, for innovation development, complex workshops were organized, where more than 100 creative ideas were discussed and collected. From these, relevant knowledge was sorted, allowing for clear concepts to emerge and for the practical model to be developed. From the new product model, a business model was constructed, along with a new business strategy. In this way, the path from idea to implementation was remarkably short.

In interview 3 (Table 3-12) the main focus was to determine whether the activities of information acquisition were the same in order to verify, add or change the feedback loops and routines of the innovation model if required.

Table 3-12: Interview 3 of the ongoing banking case

ONGOING INNOVATION INTERVIEW 3 QUESTIONS
What activities happened during the meetings, workshops? ▪ Please name them.
Please describe what happened during these activities?
Did these activities happen individually or in groups or teams? ▪ Which individually? ▪ Which in groups/teams/workshops?

The main purpose of interview 4 (Table 3-13) of the banking case study was to identify how information changes to knowledge through filtering, which is a significant process that presents the transformative property of knowledge, in a similar way to the knowledge continuum of Nonaka and von Krogh (2009) or the knowledge spiral of Nonaka and Konno (1998).

Table 3-13: Interview 4 of the ongoing banking case

ONGOING INNOVATION INTERVIEW 4 QUESTIONS
Filtering knowledge ▪ What are the types of information you collect that have the highest volume and are difficult to organize? ▪ What departments are responsible for the sorting?
Knowledge integration ▪ Can you talk about some cases where the strategy or the procedures of the company were changed? ▪ Who initiated this change and what approvals were required to put it in practice? ▪ Did that person act upon a specific information?

Knowledge filtering is, therefore, a way to select useful pieces of information and to separate what its important from what is not.

Phase 6: Testing and refining the model structure

The interviews with specialists and researchers in the field of innovation and knowledge management are useful to test the structure of the models.

Table 3-14: Interview for testing the knowledge conversion model's structure

QUESTIONS ON TESTING THE KNOWLEDGE CONVERSION MODEL STRUCTURE
In the knowledge conversion model, I stated that knowledge is obtained by applying information and finding solutions in a real context. Do you agree with this interpretation? ▪ Do you agree that the structuring problem activity is related with design? ▪ Do you agree that finding a solution is an iterative process that is influenced by feedback? ▪ Is including heuristics as an intermediate step toward knowledge correct? ▪ Do you agree on the activities? What other activities should be included? ▪ Do you agree on the causal links between activities? ▪ How should the causal links be modified?

The first set of questions tries to determine if the structure of the knowledge conversion model is correct, particularly the activity of filtering information and its iterative

use to create intermediate solutions and receive feedback from the customers to adjust them. The purpose of this second set of questions is to verify the revised innovation model, including the generative mechanisms of innovation and on how the context has an influence according to critical realism. The responses and some original research are the base for a revised model of innovation. The questions in this section also address the influence of the organizational structure on the innovation process and the responses are an initial step toward constructing a causal loop diagram about this subject that illustrates the important principles according to which it can function.

Table 3-15: Interview for testing the innovation model's structure

QUESTIONS ON TESTING THE INNOVATION MODEL STRUCTURE
In the innovation model I stated that part of the innovation process that concerns information acquisition and knowledge conversion can be routinized. Do you agree with this approach? ▪ Do you agree that a big company with several hierarchical levels and a start-up have different ways and motivations to obtain innovation? ▪ Do you believe that innovation is influenced by context and the organizational structure? ▪ Do you believe the knowledge flow is influenced by the organizational structure? ▪ Do you agree on the activities? What other activities should be included? ▪ How should the path between invention and innovation be illustrated and what activities does it include? ▪ Do you agree on the causal links between activities? ▪ How should the causal links be modified?

Overall, the data collected were an incentive for the refinement of the innovation model of this thesis. The next section elaborates the inductive data coding, from which codes are grouped into concepts, and then formed into categories. Based on these categories an innovation model is constructed.

3.4 RESEARCH DESIGN

In this section, the inductive coding process and the ways in which the data were analyzed are described. It also includes the principles of system dynamics that resulted in constructing the diagrams of innovation and of knowledge conversion. According to inductive theory, a number of codes and sub-codes were chosen in order to better organize the data. Based on this data, a new model emerges that includes feedback loops. The seven activities or codes are compared to Nonaka and Konno's knowledge spiral (1998). The motivation for the ongoing case concludes.

This section explains how data were inductively analyzed to identify activities within the customer and supplier interaction and how they were integrated into a casual loop diagram that represents the model of innovation.

This section begins by stating the literature on inductive coding as this was chosen as a way to interpret the data. How the data were prepared is presented next along with the results of the coding process. The main codes found by inductive coding and the relations between them have been used to create the theatrical model that stands at the center of this whole research. The steps that have been followed to create a model from text and recordings are specified and the data sources that represent what companies were included in this research are stated.

3.4.1 Theoretical considerations of conducting inductive coding research

When pursuing an inductive approach, it is important to follow theoretical guidelines while also obtaining new ideas and concepts. The methodology has to be clearly stated in order for the research to be systematic and rigorous and appear to the readers as understandable and also plausible in its statements and conclusion.

Theory development work is often carried out according to the requirements of the traditional scientific method. This leads researchers to improve existing knowledge as a way to discover new knowledge. The approach mostly consists of refining existing ideas in order to create new ones. Principles like these are widely implemented and can be useful but have the disadvantage of not incentivizing originality in theory building (Corley and Gioia, 2011).

The traditional approach is based on constructs that are abstract theoretical interpretations about phenomena of interest (Pedhazur and Schmelkin, 1991). The usefulness of a construct is that it can be operationalized and possibly quantified as a variable. A qualitative approach is not so focused on construct development and measurement as concept identification also has to be considered. A concept is a more general notion that states the qualities of a phenomenon. It is important to consider concepts in theory building so that constructs can then be created and validated. Theory building, and testing allow organizational studies to have originality and applicability.

Studying organizations with construct building and measurement has performed suitably until now. It is, however, a sense that something is missing that can improve our ability to gain knowledge about the dynamics of the organization. The missing part is about organizational perception and also about the processes by which organizing is carried out (Langley, 1999). In organizational study, much of the world we know is socially constructed so the focus should be on how organizational members construct and understand what they perceive and not on the number of measurable happenings.

A systematic inductive approach is chosen in this study to identify and describe concepts. Using qualitative data to inductively develop grounded theory can result in rich and detailed theoretical descriptions of the contexts in which organizations operate. Yet, there are many scholars who do not think that inductive approaches are rigorous or have a high standard (Bryman, 1988; Campbell, 1975). In order to address this issue, it has to be demonstrated that inductive approaches are systematic and meet the requirements of organizational theory.

Inductive approaches in qualitative research have been called out for not justifying their assertions and it has been thought that authors are only theorizing in a creative way but without much support for their statements (Gioia et al., 2013).

The resolution of this argument was to present a systematic approach for inductive coding. This consists of a first- and second-order analysis. The first-order analysis has the terms and codes of the informant while the second-order analysis has the themes and concepts used by the researcher. This allows the study to consider the voices of both informant and researcher and to rigorously demonstrate the relations between the data and the introduction of new theory.

A variety of informant terms, codes and categories can appear at the beginning of the research. This is similar to the notion of open coding introduced by Strauss and Corbin (1998). In the first-order analysis there is no attempt to reduce the number of categories by combining them. The vast number of categories allows the researcher to understand the terms of the informant. As the research progresses the researcher starts to search for similarities and differences among the categories. They are given labels or phrasal descriptors from which the researcher tries to determine whether there is a deeper structure in the array of categories. The researcher has to think at multiple levels in order to determine this.

In the second-order analysis, conducted with Vensim PLE, the researcher searches for concepts that can identify and describe the various phenomena of interest. Once the themes and concepts are found it is possible to generalize them further in aggregate dimensions. The themes in this step are identical to the main codes in our research.

The first-order themes, the second-order themes and the aggregate dimensions form a data structure which is pivotal to the whole research approach. The data structure is a visual aid and also a graphical representation of how we progressed from data to themes and then to theory building. This allows us to think about the data theoretically in addition to simply methodologically. It is not required for the data structure to specify the relationships between themes as these come later when the theoretical model is constructed.

The data structure does not yet contribute to process theory as it is a static picture of a dynamic phenomenon. It will investigate processes if it is turned from a static picture to a whole motion picture, to make an analogy. The objective is to make an inductive model that is grounded in data and captures the perceptions of informants in theoretical terms. The grounded theory model that results will describe the dynamic relations between the concepts that are central to the phenomenon of interest.

The model will account for the major concepts, themes and also for dynamic interrelations. This can be done with boxes and arrows with a special focus on the arrows as they set everything in motion (Nag et al., 2007). The grounded theory model will show the concepts and themes but also the relational dynamics between them. The relations between concepts allow theoretical insights that would not have been possible simply by looking at the data structure itself.

There is also the issue of applying the model in commercial organizations which means transferability. Obtaining transferable concepts and principles allows the results to have a larger audience. Some interpretivists could say that organizational structures are idiosyncratic because they are created and performed by individuals acting in unique contexts. This is a point that can be disagreed with as many concepts and processes are similar or structurally equivalent across domains and industries (Morgeson and Hofmann, 1999). It is possible to generalize from a case study if it has concepts or principles that are relevant to another domain or industry. It is good if the results of this study can be generalized to theory (Bansal and Corley, 2011). The key is to find a specific case that illustrates a general principle that can be a transferable generality.

The main purpose of the inductive approach is to allow researchers to identify patterns that appear in the raw data. Unlike the deductive approach, there are no preconceptions when collecting and examining data, such as in hypothesis and experimental testing.

Following the inductive approach, a large quantity of raw text data from interviews, transcripts or other types of input can be converted in a format that is more compact and easier to read and interpret. The raw data will make it possible to identify links between different pieces of information and ensure their visibility and justification. After that, it will be possible to construct an innovation model in which the interdependencies and connections between variables are represented and explained using the supporting data.

After a thorough and systematic reading and coding of the raw data, major patterns can appear. Sections of the interviews can be coded in order to enable an analysis on a specific theme, the connections between themes and those most important for respondents.

Inductive coding is encountered in grounded theory (Strauss & Corbin, 1999), discourse analysis (Strauss & Corbin, 1990) and narrative analysis (Leiblich, 1998). A general inductive approach is used by a great number of researchers, even if it is not identified as such in their works (Bryman & Burgess, 1994; Dey, 1993).

The inductive method is used here as a way to accomplish the research objectives. Inductive reasoning consists in developing a theory, as opposed to deductive reasoning that consists in testing a theory. This research did not start with making assumptions and was concerned with putting together the data from the interviews to discover some general principles of information acquisition for innovation and knowledge conversion. The research thus follows an inductive approach.

In the inductive approach, interpretations can differ between researchers, so a degree of subjectivity is unavoidable. Depending on the interpretation, different findings can appear. However, by following rigorous principles, a proper interpretation can be obtained. There are several techniques in which the correctness of the findings can be obtained: a separate replication of the research, comparisons with other research and feedback from respondents or the applicants of the findings.

The first step is a thorough reading of the interviews, transcripts or other text and identifying sections containing meaningful keywords or codes. Codes in this context are similar to categories and are set up at the beginning of the research but can also be added after examining the responses. In this way, general codes will be derived from the research objectives, while more specific codes will be derived from the raw data. The responses are placed in their respective categories. Depending on the responses, one part of the text can be included in more than one category and it is also possible for parts of the text not to be included in any categories, if they are not relevant to the study.

Once the codes are established, sub-codes can be searched. Sub-codes offer a more detailed look at the category, enabling a more nuanced approach. The codes can be

combined if the meanings are found to be similar. The codes must be sufficiently different from one another so that they each identify key areas in the raw data, which are evaluated to be the most important themes for the research objectives.

The coding process must go through several steps. First, there is an initial read through of the text data and then segments of information are identified (Creswell, 2002). These segments are labelled in order to create a number of categories. Similar categories are grouped together in order to achieve a number of codes that are sufficiently differentiated so that there are no significant redundancies. The resulting number of codes is best between three and eight. These codes are used to create a model showing the various interdependencies between variables.

In order to create consistency checks, an independent coder can try to reach the same objectives, while using the same text. To check only the coding consistency, a separate coder can be given the codes and the sections of the text and be asked to find the correspondences between them.

Another solution to verify consistency is by using stakeholder checks. These can enhance the credibility of findings by allowing interested parties to comment on them and their interpretation; stakeholder checking may be formal or informal. Feedback from stakeholders can be received after completing the initial interviews, subsequent interviews, and informal conversations, when copies are provided for the preliminary version of the study or before submitting the final report.

The general inductive approach allows a suitable way to examine qualitative data regardless of the research objectives. Results can be similar to those obtained from grounded theory. It is more straightforward, and it does not require many technical terms.

There are two approaches for the inductive grounded theory. Glaser (1992) chooses a specific study area and sees the issues arising during the research process. This approach depends on the perceptions of the respondents and the researcher. The methodological approach is based on comparing issues, events and interdependencies with the objective of finding contradictions or inconsistencies. Strauss and Corbin (1990) focus on a specific issue or phenomenon. This approach enables the researcher to start his activity with a predetermined objective. The steps taken are more limited but, also, they are more easily determined as there is less ambiguity about the research subject.

The main purpose of a coding scheme of qualitative data analysis is to categorize the data collected (Glaser and Strauss, 1967). Codes represent names for categories and category attributes (Glaser and Strauss, 1967) which are then coupled to segments within the text of the transcribed interviews (Miles and Huberman, 1994). From a theoretical point of view, segments are incidents of a category or category property (Glaser and Strauss, 1967) and can appear either as a brief description, referring to a category, or a more detailed elaboration describing a multifaceted concept (Miles and Huberman, 1994). Segments can consist of single words or a group of logically connected words, i.e., phrases or paragraphs (Miles and Huberman, 1994).

Coding itself is, in short, the process under which data lines or paragraphs for identifying distinctive ideas, events or objects are examined and later referred to a set of previously defined concepts (Strauss and Corbin, 1998). Coding is, in principle, an inductive process, because concrete aspects are abstracted and generalized accordingly. However, coding can also entail reasoning as abstracted codes, which are used to inform a deterministic structure, making initial concepts into guiding references that order and provide structure to a phenomenon.

For this study, recorded interviews were transcribed into Word documents and after initial tentative coding entered into NVivo for first-step analysis, which refines the open coding and proposes a first set of categorizations; texts relevant to this research were color-coded into related clusters. These codes form the basis for later synthesizing into concepts that are core codes: these concepts refer to the seven revealed activities within the interaction between customer, employee and company. This conceptual interpretation of data shaped the theoretical causal loop model derived from the seven activities of information collection. These activities were contrasted with Nonaka and Konno's (1998) knowledge spiral Figure 2-1 (page 62), from which theoretical concepts were deduced and related (Table 4-1, page 150). This information was used to model the innovation development in each case.

3.4.2 Inductive Coding with NVivo based on interviews

This section elaborates upon the inductive coding with NVivo of the variables of the information acquisition process. It shows how the coding was performed to identify the missing activities occurring in this interaction. Whenever the empirical nodes or codes were unclear, the preceding data were reviewed, clarifying the content related to that code. This section presents the activities that occur throughout interactions of customers and employees (related to innovation), and illustrates them through associated coding.

For each activity, an introduction is presented, stating how it is defined in the existent literature. There is a coding section which shows the number of identified codes for each of the activities. The representative quotes for each activity are provided along with the interview from which they came.

Inductive coding with NVivo identified 24 sub-codes by analyzing 21 interviews with managers who oversee innovations. The interviews are from the two initial case studies and from the background information interviews. By re-evaluating these sub-codes with NVivo according to thematic similarity patterns, seven clusters were developed and defined as main codes. An emergent causal loop diagram was built which uses the seven main codes identified as activities occurring through interactions of customers and employees. Activities are specified based on customers and employees. All the activities are explained and comparisons with Nonaka and Konno's (1998) activities in the knowledge spiral are provided.

The following Table 3-16 (page 111) lists all the interviews carried out and the name of the companies. It also specifies the names and functions of all the individuals questioned in the case studies and background interviews.

Table 3-16: List of interviews

Case study or background information interview	Interviewee	Interviews	Function and company
Avaloq	Francisco Fernandez	Avaloq 1, 2009, Avaloq 2, 2010, Avaloq 3, 2010	CEO Avaloq
	Roland Strässler	Avaloq 4, 2011	Software engineer Avaloq
	Marc Koning	Avaloq 5, 2011	Software engineer Avaloq
Synosia	Uwe Meya	Synosia 1, 2009, Synosia 2, 2010, Synosia 3, 2010	Vice president clinical development Synosia
	Ian Massey	Synosia 4, 2011	CEO Synosia
Synosia and Roche collaboration	Christoph Sarry	Roche 1, 2011	Manager Roche
Osborn 1	Lee Felsenstein	Osborne 1 Laptop	Inventor
Mobile	Marty Cooper	Mobile Phone, 2011	Manager Motorola
World Wide Web	Dave Walden	Internet Telenet 1, 2011	Manager BBN
	Larry Roberts	Internet Telenet 2, 2011	CEO Telnet
Token Ring	Werner Bux	IBM Token Ring, 2011	Programmer IBM
Millipede Project	Erich Rütsche	IBM Millipede, 2011	Project lead IBM
New World of Work	Eva Norton	New World of Work, 2011	Manager Microsoft
Mouse Scanner	Confidential	Dacuda Mouse Scanner, 2011	CEO Dacuda
VoIP Enterprise Solution	Eric Gebhardt	Enterprise VOIP, 2011	CEO Media Strings
Banking case	Confidential	Interview NL 1, Interview NL 2, Interview NL 3	Confidential
	Confidential	Interview RH 1, Interview RH 2, Interview RH 3	Confidential
Chemical company	Jean-Christophe Bogaert	Interview JC	Manager Galactic

3.4.2.1 Brainstorming

Brainstorming is a group creativity technique in which efforts are made to find the solution to a specific problem by collecting a list of ideas spontaneously contributed by its members. It has become one of the most common terms associated with creativity and creative problem solving.

From the initial NVivo coding, 47 instances for the *Brainstorming* main code were identified. This code can be subdivided into the sub-codes *Brainstorming Solution Ideas* and *Brainstorming of Design*.

Brainstorming Solution Ideas (1.1) refers to the spontaneous gathering of participants' ideas for an initial proposed solution. Participants "brainstorm solutions" in meetings, because, as the interviewee (Avaloq 3, 2010) explains, "if you understand the problem..." then "... you can [start brainstorming] for solutions." Brainstorming of Design

(1.2) is carried out after a functional solution has been identified and the most important concern is how to design it. This will result in finding the best way to produce and present the solution and will also show how it will look.

Table 3-17: Coding activity "Brainstorming" and associated sub-codes

	Sub-code	# of Codes	Representative Quotes	Quote References
1.1	Brainstorming Solution Ideas	31	"some customers can contribute solution ideas"	Avaloq 2, 2010
1.2	Brainstorming of Design	16	"… you have an idea for a solution, then you can brainstorm how the design would look like" "… the study design was a brainstorming process which took a period of time" "… in terms of brainstorming we had interactions between different designers and groups."	Avaloq 3, 2010, Synosia 4, 2011, Mobile Phone, 2011

Brainstorming Solution Ideas (1.1) occurs when participants understand the problem and start to "brainstorm for solutions" (Avaloq 3, 2010). "During development of the Internet, we had to work with the customer and perhaps brainstorm to understand how we could solve their problem" (Internet Telenet 2, 2011). This understanding arrives through "structured discussions with customers to understand what their need and where their pain points are" (IBM Token Ring, 2011). The "purpose of the interaction is discussing solution ideas" (Avaloq 2, 2010). Here "we are also talking about the other way" (Avaloq 2, 2010) and ask "what can the customer contribute to innovation?" Hence, "some customers can contribute solution ideas" because "alone, you have one or two ideas," but "If you interact with a diversity of people you have a hundred ideas." Initially an unstructured process, brainstorming was "not so standardized" (Avaloq 4, 2011): "you sit together, you think, first of course you get the requirements, also at that time but you were much closer with the client" through "brainstorming, thinking and analysis before development." The advantage is that when "working with customers you find that you think of ways to solve their problems that may be new things" (Internet Telenet 2, 2011).

The *Brainstorm of Design* (1.2) starts after a solution is identified, because "… you have an idea for a solution, then you can brainstorm how the design will look like" (Avaloq 3, 2010). The design will also influence the visual presentation of the solution and how it is perceived: "So, somebody invents the telephone. Now you start talking about the design and how will it look like. You start talking about different design options" (Avaloq 3, 2010). The ideas of the designers and of people from other departments will help with conceptualizing the solution: "… in terms of brainstorming we had interactions between different designers and groups" (Mobile Phone, 2011). It isonly after agreement concerning design that the solution can reliably go into production.

3.4.2.2 Structuring Problem

Structuring the problem is an activity that can be realized at an individual, company or national level and there are multiple ways in which it can be accomplished.

One way is through a planning or logical framework, which is a means of recording and modelling implementation proposals. It displays a sequential progression through a strategy area, making it possible to see how short-term activities or objectives relate to the longer-term strategy.

Another variant consists of a problem tree. This explores the problem space with a causal analysis of the core problems identified in the situational analysis. These problems are simplified in order to reveal the basic problems that need to be addressed and what the response of the public or other parties might be. The purpose of a problem tree is to make a distinction between core problems, their causes and effects.

From the initial NVivo coding, 18 instances were identified, categorized as a *Structuring Problem* activity (Code 2).

Table 3-18: Coding activity "Structuring Problem" and associated sub-codes

	Sub-code	# of Codes	Representative Quotes	Quote References
2.1	Breaking up and Structuring Problem into Smaller Pieces	15	"break up and structure the problem into smaller pieces" "… [structuring the problem] is an iterative process. So it's a tree, it's a hierarchy of problems"	(Avaloq 3, 2010; Mobile Phone, 2011)
2.2	Structuring Discussions with Customers	3	"… we try to reduce the customer's problem in some facts … and this will lead to identifying the root cause of the problem and proposing the right solution" "… we would have all kinds of structured discussions with customers to understand what their needs were"	(Interview JC, IBM Token Ring, 2011)

This code is sub-divided into two sub-codes: Breaking up and Structuring Problem into Smaller Pieces and Structuring Discussions with Customers (Table 3-18).

Sub-code 2.1 is Breaking up and Structuring the Problem into Smaller Pieces (2.1), making it more "digestible." Doing so allows for building "partial solutions that will, in the aggregation, solve the bigger problem." It permits "reductions of the model and the solution ideas" (Avaloq 2, 2010) and finding "a way to solve many different structural problems to apply … new technology" (Internet Telenet 2, 2011). It allows participants to "cut the study into smaller units, look at results while the study is still ongoing and then adapt your methodology to what you have learned" (Synosia 1, 2009). Structuring problems allows discovering solutions for complex innovations.

The next sub-code is Structuring Discussions with Customers (2.2) and this can make it possible to "… reduce the customer's problem in some facts and to identify the root

cause of the problem" (Interview JC). This approach allows identifying precisely the customer's troubles by conducting the discussion in a structured way. A structured discussion with the customers is a more to the point and focused interview that can reveal the needs or problems of the customers that have to be considered before choosing a solution.

3.4.2.3 Collecting Data

Information provides an answer to a type of question. From information, data and knowledge can be derived; data represents the values of some parameters, while knowledge is the understanding of reality or abstract concepts. Since it is closely related to data, information does not require an observer, as opposed to knowledge, where a cognitive observer is required.

Information reduces uncertainty, which is a situation with imperfect or unknown information, in which the probability for the occurrence of an event is unknown. The more uncertain an event, the more information is required to resolve the uncertainty of that event.

From the initial NVivo coding, 12 instances from ten interviews were identified which are categorized as *Collecting Data* (Code 3, Table 3-19). Code 3 aggregates two sub-codes: *Collecting Data on Market and Customer* (two instances) and *Collecting Requirements* (seven instances).

Table 3-19: Coding activity "Collecting Data" and associated sub-codes

	Sub-code	# of Codes	Representative Quotes	Quote References
3.1	Collecting Data on Market and Customer	2	"gather information about the market, about the customers"	(Avaloq 3, 2010; Synosia 1, 2009)
3.2	Collecting Requirements	7	"gather requirements"	(Avaloq 2, 2010; IBM Millipede, 2011)

Collecting Data involves collecting the necessary, predefined, information from pre-identified stakeholders to support problem-solving and solutions. The purpose of *Collecting Data on Market and Customer* (3.1) is "to gather information about the market, about the customers."

Collecting Requirements gives participants initial understanding of the market and the customer by participants who "gather requirements" (3.2) "from the engineers" (Avaloq 3, 2010), to identify whether the "function prevents the design or the design prevents the functionality." The supplier and customer "sit together" (Avaloq 4, 2011), and "you think, first of course you get the requirements" … "just to get their insight on what kind of requirements they had" (IBM Token Ring, 2011) … and "established relationships." By doing so, "of course, [it is then] much, much easier to get all of the necessary input in terms of requirements."

3.4.2.4 Reflecting Information

Reflecting information is the process of paraphrasing and restating both the words and ideas of the speaker. It is a useful process, because it allows the speaker to focus

on their own thoughts and what they say and think; it shows the speaker the efforts being made by other participants to perceive the world identically and to understand messages, encouraging them to communicate openly. In this research, it allows the innovator to speak in a way which the customer can understand.

From the initial NVivo coding, 37 instances were identified, which are categorized as *Reflecting Information* (Code 4, Table 3-20). Code 4 is sub-divided into six sub-codes: *Acknowledging Contrasting Perspectives* (eight instances), *Knowledge Interaction* (eight instances), *Rethinking Opposite View* (four instances), *Abstracting Ideas and Design* (seven instances), *Stepwise Building and Refining the Design* (eight instances) and *Understanding the Customer's Needs* (two instances).

Table 3-20: Coding activity "Reflecting Information" and associated sub-codes

	Sub-code	**# of Codes**	**Representative Quotes**	**Quote References**
4.1	Acknowledging Contrasting Perspectives	8	"other way"	(Avaloq 2, 2010)
			"start[s] understanding banking, bankers can start understanding what you can do with software"	(Avaloq 1, 2009)
4.2	Knowledge Interaction	8	"everybody gets dyadic understanding and that dyadic understanding...." "… the customer tries to understand your solution"	(Avaloq 2, 2010)
			"… know-how, interaction, transfer" "… if we cannot give them the know-how" "then they do not understand it and we cannot explain that to them we will still misuse or not use the system properly"	(Avaloq 4, 2011)
4.3	Rethinking Opposite View	4	"… speaking to bankers I tried to rethink their world" "… rethink my world…"	(Avaloq 1, 2009)
4.4	Abstracting Ideas and Design	7	"complex" "abstraction" "… so the customer can understand and see and to make it tangible"	(Avaloq 3, 2010)
4.5	Stepwise Building and Refining the Design	8	"get the confirmation of redesign"	(Avaloq 2, 2010)
			"refactor and rework"	(Avaloq 3, 2010)
4.6	Understanding the Customer's Customer Needs	2	"understand the customer of the customer"	(Avaloq 2, 2010)

Acknowledging Contrasting Perspectives (4.1) means comprehending what the customer has in mind or is thinking (reflecting over); e.g., to "understand the bank as a whole and to try to make a model of the bank and then subject all these functionalities

to that model" (Avaloq 1, 2009). Communication between participants conveys information through the exchange of thoughts. To grasp the situation and its requirements, the innovator must understand the customer's point of view or "the opposite view" (Avaloq 2, 2010).

Knowledge Interaction (4.2) is the key because all participants must have "dyadic understanding"[1] of the situation, system, and limitations. The "...customer tries to understand your solution" via "know-how, interaction, transfer." Otherwise, "if we cannot give them the know-how" ... "they do not understand it and we cannot explain that to them … we will still misuse or not use the system properly."

Rethinking Opposite View (4.3) provides the customer with an opportunity to "rethink his world" and to "rethink my world." When ideas are too "complex" they are explained within *Abstracting Ideas and Design* (4.4), where "abstraction" helps the "customer understand and see and to make it tangible." At *Stepwise Building and Refining the Design* (4.5) suppliers "get the confirmation of redesign" that enables them to "refactor and rework." During the stage of *Understanding the Customer's Customer Needs* (4.6), it is crucial for the supplier to "understand the customer of the customer."

Let us explore each of the sub-codes in detail. In *Acknowledging Contrasting Perspectives* (4.1), one "must have something, being able to express his demand and to discuss with the other guy whether he has ideas, how his demand could be fulfilled."

So when one "start[s] understanding banking, bankers can start understanding what you can do with software." Here, participants in the process can refer to the "other way," asking, "How can the customer contribute to the innovation?" When "understanding what you can do with software he might contribute by having his own ideas on what we could change" (Avaloq 2, 2010).

Therefore, "it must go back and forth …from us to the bank people" (Avaloq 4, 2011). Customers must first "understand the system, and if we cannot give them the know-how and they do not understand it and we cannot explain that to them, we will still misuse or not use the system properly" (Avaloq 4, 2011).

To understand other participants' views properly, *Knowledge Interaction* (4.2) is vital between customer and supplier. For example, "you show the customer" the concept, design, or redesign, and ask "Is this what you thought [of]?" (Avaloq 3, 2010), and "the customer tries to understand your solution" (Avaloq 2, 2010).

At this point, "everybody gets dyadic understanding and that dyadic understanding necessarily leads to innovation ideas". In this context, dyadic means both-sided, for the customer and the supplier. It was crucial to obtain "some connections to customers that gave us sufficient insight" (IBM Token Ring, 2011). Through exchange of information "we were able at the start of the entire research project to target it in a promising direction," which led to the definition of the product being "mainly based on customer input".

[1] Dyadic understanding refers to the understanding of both sides - the supplier's and customer's.

For example, (Avaloq 4, 2011):

> *"I had a real good contact and good know-how, interaction, transfer. But also I think this happened both ways or I hope it was like this and I think that's important because you can, if you know what they want, if you sit together with them and you get also the know-how, develop it better. I think at that time it was important. Also, now, still important, I had a guy who was really willing to do that. He did that. We had a good know-how transfer. I think it's really improved the system, made it faster. You can do it faster, both development and innovation. So, for me it was relatively strong. If it was the same for everyone, I don't know, I think so but I cannot say for sure."*

Reciprocal understanding is essential. Customers need to "understand the system". Lacking "know-how" from the supplier, they "do not understand," and can often "misuse or not use the system properly" (Avaloq 4, 2011). Thus, know-how must be reciprocal, so that suppliers must learn how to best explain an innovative functionality or system.

To properly communicate with the customer, the ability of *Rethinking Opposite View* (4.3) is vital. It is important to challenge the reciprocal view: "when I was speaking to bankers I tried to rethink their world," which made the innovator "rethink his world". Assurances are built "if you show the customer a solution based on his opinions and say, 'Is this what you thought?'" (Avaloq 3, 2010).

Abstracting Ideas and Design (4.4) is required when an idea is "too complex to explain it on paper" or "the acceptance on paper is not there because the idea might be too abstract to [be understood by] the customer". The customer will not "be able to follow you with the abstraction so you build it to make the customer understand and see and to make it tangible" (Avaloq 3, 2010). For example, "[s]oftware is something very, very virtual and if you describe software on paper and ask the customer 'would you buy this?', it is very, very difficult to get that understanding or the acceptance of something that is by its very nature virtual and you cannot visualize it". The answer is to "visualize it in an attractive way". In respect to design, on the other hand, it helps to "specify your designing" to "make some tests with it, then you throw it away and you start rebuilding the product from scratch with the knowledge" obtained previously.

With the benefit of reciprocal viewpoints, knowledge and abstraction, *Stepwise Building and Refining the Design* (4.5) is conducted to "get the confirmation of [the] redesign". This is a "step wise refinement process" (Avaloq 2, 2010) that goes on until there is a "real product". Participants must "refactor and rework on it iteratively until it becomes the real product" (Avaloq 3, 2010).

To capture the complete picture requires *Understanding the Customer's Customer Needs* (4.6). "If I understand the needs of the customer, I understand the customer because he in his turn wants to serve his customer" (Avaloq 2, 2010). Customers can also be businesses that want innovative solutions to work with their customers so in this case the innovator must consider the requirements of the customer as being influenced by the requirements of his own customers and how to address them.

3.4.2.5 Exchanging Knowledge

Knowledge is an awareness, familiarity or understanding of information, facts or skills, acquired through experience or education by discovering, perceiving or learning.

From the initial NVivo coding, 45 instances of *Exchange Knowledge* activity (Code 5, Table 3-21, page 118) were identified. Code 5 is sub-divided into five sub-codes that help to identify and present it: *Discussing Criteria for Milestones* (eight instances), *Discussing Design Concept* (sixteen instances), *Discussing Future Decision Points* (four instances), *Discussing New Design Ideas* (seven instances), and *Discussing Updates* (ten instances).

Table 3-21 (page 119) illustrates the components of the code. *Discussing Criteria for Milestones* (5.1) sets criteria for milestones to be reached during the various phases and the successive steps necessary to reach each milestone, such as discussing progress updates and definition of next milestones (Synosia 2, 2010). The code titled *Discussing Design Concept* (5.2) consists of "discussing inventions" with the customer in "joint design" meetings that entail "sitting side by side and designing something". Activities under *Discussing Future Decision Points* (5.3) address "future decision points and criteria," whereas those under *Discussing New Design Ideas* (5.4) involve discussing "improvements" and "redesign". Activities undertaken in *Discussing Updates* (5.5) include "mutual updates," discussing "progress updates" and the "exchange of information".

The activity *Discussing Criteria for Milestones* (5.1) can be carried out with customers or with other companies: "So, for example, … we clarif[ied] with Roche what data they want[ed] to see, what data should we gather to achieve the next milestone, which may be good for their decisions," and "particularly, what data we should collect on this molecule". These discussions were intended "to address future decision points and criteria that we have to meet to achieve the next milestone or decision point" (Synosia 4, 2011).

Discussing Design Concept (5.2) focuses on "discussing inventions with the potential user of that invention and let him challenge …the solution ideas" (Avaloq 2, 2010) and "define what the new work environment, physically, would look like" (New World of Work, 2011). As the example of Avaloq shows, the customers tried "to help the bank with its [limitation of] technology" (Avaloq 1, 2009). Concretely, "we identif[ied] issues" and "we design[ed] them" (Synosia 2, 2010). "I mean, you can fine tune it with a customer, so from time to time we [had] interaction[s] with them, asking are we on the right track" (Synosia 3, 2010).

Numerous meetings were held to "discuss the approach, to design the study, to design the protocol, so very considerable interactions" (Synosia 4, 2010). In "giving our advice [to] these governance committees, normally, our specialists from line functions [participated]" (Roche 1, 2011), thereby "helping to upscale this innovative model". Meetings were mainly to "[discuss] items, and information" and "to discuss specific issues" (IBM Token Ring, 2011) for "joint design where we had the technical [guys] sitting side by side and designing something" (IBM Millipede, 2011). The "technology [was available], but we had to figure out how to apply it to their problem to make it work".

Hence, “with this new technology, solve their problems with the new technology” (Internet Telenet 2, 2011).

Discussing Future Decision Points (5.3) serves “to address future decision points and criteria that we have to meet to achieve the next milestone or decision point” (Synosia 2, 2010; New World of Work, 2011).

Table 3-21: Coding activity “Exchanging Knowledge” and associated sub-codes

	Sub-code	# of Codes	Representative Quotes	Quote References
5.1	Discussing Criteria for Milestones	8	“Progress updates and definition of next milestones”	(Synosia 2, 2010)
5.2	Discussing Design Concept	16	“discussing inventions”	(Avaloq 2, 2010)
			“joint design where we had the technical and legal guys, sitting side by side and designing something”	(IBM Millipede, 2011)
5.3	Discussing Future Decision Points	4	… discussing “future decision points”	(Synosia 2, 2010; New World of Work, 2011)
5.4	Discussing New Design Ideas	7	... focus on discussing “improvements” and “redesign”	(Synosia 2, 2010)
5.5	Discussing Updates	10	... meet to discuss “mutual updates”... and “progress updates,”... “discuss proceedings”	(Synosia 2, 2010)
			... and “exchange of information”	(Roche 1, 2011)

Discussing New Design Ideas (5.4) focuses on discussing new ideas the collaborators have in mind. It calls for “technical interactions between technical experts on both sides to address the specific challenges, the technical challenges” (IBM Millipede, 2011). The purpose is to “think of improvements” and to “redesign” (Synosia 2, 2010), to be able to “figure out how to apply it to their problem to make it work. You might add, with this new technology, solve their problems with the new technology” (Internet Telenet 2, 2011).

Discussing Updates (5.5) involves discussing the updates offered by the customer and supplier (Avaloq 2, 2010):

> *“So, when it’s invented and described production takes seconds to compile and then you can show it and say ‘Oh, it’s wrong, let’s do the loop again; oh, misunderstanding, OK, let’s go back, redesign, re-implement’ and usually these cycles are within hours and within days so you make hundreds and thousands of small loops in invent, design, produce, test, show and re-invent. So, it’s completely different here.”*

These “mutual updates” (Synosia 2, 2010) established “that we could sell them very efficient and effective equipment to operate it, that would work for their network” (Internet Telenet 2, 2011).

> *“You go step by step where your methodology is that you start interviews with the customer, you go back, you design, you code, you prototype, you test, you show the customer, you come back to the understanding, you redesign, you recode, you retest in some stepwise refinement loops until you think you have, again, a new automation step within the process, and then you go to the next step, etc.” (Avaloq 2, 2010).*

Overall, the relevant actions that keep the customer informed involve “[p]rogress updates” (Synosia 2, 2010), “discuss proceedings” (Synosia 2, 2010), and “exchange of information” (Synosia 2, 2011). The innovator uses these updates to show the customers what has been improved to the solution that is suited for them.

3.4.2.6 Filtering Knowledge

In the context of knowledge management, filtering is a process undertaken by a knowledge worker or an automated system to determine which items to accept and retain and which to ignore. It is the activity with the highest return on investment for knowledge management, but also one of the most difficult.

Decision makers are not only overwhelmed with information; they have to contend with conflicting information. For a business decision, incomplete or incoherent information can have a negative effect, often reflected in the bottom line, so ascertaining the relevance of information is a priority. In order to do so, the value of each piece of information has to be established and it has to be determined which is chosen in the pursuit of an answer.

Table 3-22: Coding activity “Filtering Knowledge” and associated sub-codes

	Sub-code	# of Codes	Representative Quotes	Quote References
6.1	Analyzing Information or Data	7	“getting,” “interpreting” and “reporting the results”	(Synosia 1, 2009)
6.2	Prioritization	3	“… everyone can make his point, make the point of what is important or what is not important”	(Interview 3 RH, p. 3)
6.3	Constructing a summary	5	“… then it’s summarized usually in an email…”	(Interview JC, p. 12)
			“… we must be efficient so we have to, again, summarize“	(Interview JC, p. 14)

From the initial NVivo coding, I identified 15 instances of the *Filtering Knowledge* activity (Code 6, Table 3-22). Code 6 is subdivided into three sub-codes: *Analyzing Information or Data* (seven instances), *Prioritization* (three instances) and *Constructing a Summary* (five instances).

As Table 3-22 illustrates, *Analyzing Information or Data* (6.1) refers to "getting," "interpreting," and "reporting the results". *Prioritization* (6.2) is the ability to separate between what is important and what is not: "It's like prioritization. Sometimes I have minus points and everyone gets, for example, three green points and three red points. And then everyone can make his point, make the point of what is important or what is not important" (Interview 3 RH, p. 3).

Constructing a Summary (6.3) is useful in order to make the information more visible to the customer: "...it's discussed internally in a group; then it's summarized usually in an email asking the customer, the appropriate person, the main contact person or team leader on the customer side to validate" (Interview JC, p. 12).

This can enhance the communication with the customer: "...in our communication with the customer we must be efficient so we have to, again, summarize" (Interview JC, p. 14).

It is the last step of filtering knowledge and it has to provide an output that is to the point and concise.

3.4.2.7 Feedback

Customer feedback describes the process of obtaining the customer's opinion about a business, service or product. It is important because it offers company owners and marketers useful information that they can use to improve their business or ensure a better customer experience. The best way is to involve the customer at each step of the design and production process in order to obtain customized feedback that can help the company reach its objectives.

From the initial NVivo coding, I identified 30 instances concerning *Feedback* (Code 7, Table 3-23, page 122). Code 7 is subdivided into three sub-codes: *Identifying Needs* (19 instances), *Identifying Market Segmentation* (five instances) and *Feedback from Customer on Product* (six instances). An explanation of each sub-code is as follows.

The goal of Code 7 activity is to understand the problem, needs, solutions, market and industry segmentation, and product feedback. As Table 3-23 (page 122) illustrates, *Identifying Needs* (7.1), the "requirements" of the customer must be captured and understood (IBM Token Ring, 2011), identifying customer "needs" (Avaloq 1, 2009; IBM Token Ring, 2011; Internet Telenet 2, 2011; New World of Work, 2011). *Identifying Market Segmentation* (7.2) involves understanding the "market," its "magnitude," and being able to know which "markets to target". *Feedback from Customer on Product* (7.3) entails the "usage of feedback" to assess the customer's "acceptance of the product".

We again examine each of these sub-codes. *Identifying Needs* (7.1) is directed at "understanding [of] customer requirements" (IBM Token Ring, 2011). It involves understanding customers' "needs" and what they are "looking for and details" (Mobile Phone, 2011).

It seeks to establish "sufficient customer insight" (IBM Token Ring, 2011) "for not end[ing] up going nowhere" (IBM Token Ring, 2011). The example of Mobile Phone (2011) illustrates the following on identifying requirements:

"We had marketing people who were doing surveys. We were talking to people in the industry who were either looking at the results of other people's research and by the way much of that was contradictory to what we were doing. There were people that told us that it would never work, that their market did not exist but, whatever, the answer is yes, we did a great deal of research."

Identifying Market Segmentation (7.2) involves knowing about the "market" (Avaloq 3, 2010) and its "magnitude" (Mobile Phone, 2011). Information is based on what was "gained on what customers, or at least this particular customer segment" wanted (IBM Token Ring, 2011). This will also indicate how to "go into the marketing activity" (Mobile Phone, 2011), "how [to] distribute and [to] know what distribution" is required, because it is a "very complicated process of bringing the product to market, exposing this thing, building the sales force, doing the public relations, it's the entire marketing process".

Table 3-23: Coding activity "Feedback" and associated sub-codes

	Sub-code	# of Codes	Representative Quotes	Quote References
7.1	Identifying Needs	19	… basically the "requirements" of the customer have to be understood	(IBM Token Ring, 2011)
			... understanding customer "needs"	(Avaloq 1, 2009; IBM Token Ring, 2011; Internet Telenet 2, 2011; New World of Work, 2011)
7.2	Identifying Market Segmentation	5	... the focus is on the "market" ... and its "magnitude" … to understand which "market to target"	(Avaloq 3, 2010; Mobile Phone, 2011)
7.3	Feedback from Customer on Product	6	… the "usage of feedback" … toward the "acceptance of the product" by the customer ...	(New World of Work, 2011; Avaloq 3, 2010).

Activities under *Feedback from Customer on Product* (7.3) "integrate some of the feedback" (New World of Work, 2011) of the customers "about the acceptance of the product" (Avaloq 3, 2010). This feedback gave insight into whether the product "worked," whether it had the required "quality," and its "fit to the existing IT architecture" (Enterprise VOIP, 2011). This feedback is valuable because it specifies what needs to be changed in a product before launching it so that it is likely to be accepted and perceived as useful by the customers who find it relevant. Some studies have tried to understand, from an organizational perspective, the learning process of innovation in enterprises and have used models to illustrate them (Byrne et al., 2002). The world is a complex construction that is difficult for researchers to understand and take action in. Models are a thinking tool, a way to understand the real world by simplifying it. The next section presents the main innovation model constructed in this study.

3.4.3 Results of coding

The coding process generated 24 sub-codes, which were then merged and relabeled, according to similarities and noticeable patterns, to obtain a final list consisting in seven main codes (Table 3-24).

Table 3-24: Main codes and sub-codes

MAIN CODES	SUB-CODES
Brainstorming	Brainstorming Solution Ideas
	Brainstorming of Design
Structuring Problem	Breaking up and Structuring Problem into Smaller Pieces
	Structuring Discussions with Customers
Collecting Data	Collecting Data on Market and Customer
	Collecting Requirements
Reflecting Information	Acknowledging Contrasting Perspectives
	Knowledge Interaction
	Rethinking Opposite View
	Abstracting Ideas and Design
	Stepwise Building and Refining the Design
	Understanding the Customer's Customer Needs
Exchanging Knowledge	Discussing Criteria for Milestones
	Discussing Design Concept
	Discussing Future Decision Points
	Discussing New Design Ideas
	Discussing Updates
Filtering Knowledge	Analyzing Information or Data
	Prioritization
	Constructing a Summary
Feedback	Identifying Needs
	Identifying Market Segmentation
	Feedback from Customer on Product

The sub-codes were obtained from the interviews in the first phases. To give an example, the sub-code Collecting Data on Market and Customer corresponding to the Collecting Data main code was identified in this paragraph:

> *"In the beginning you gather information about the market, about the customers..." (Interview Avaloq 3, p. 11)*

The sub-code Gathering Requirements was identified in a similar way from this paragraph:

> *"But as an engineer you want to build things so probably an inventor or an engineer is more out looking for demands than he's out looking for solutions because solutions come from competitors, from other engineers..." (Interview Avaloq 1, p. 17)*

The clustered sub-codes were used to form main codes; the sub-codes (i.e., sub-concepts) "emerge as the basic building blocks" of the concepts, which "emerge as the

basic building blocks of theory" (Strauss and Corbin, 1998, p. 13), thus, providing robustness for the main codes. The people taking part in the changing routines were customers and employees of the companies examined in the case studies.

The sub-codes are similar to the terms of the first-order analysis and the main codes are similar to the themes of the second-order analysis. This is according to the methodology proposed by Gioia et al. (2013). The terms are the concepts used by the informant and the themes are the concepts used by the researcher. This allows for both voices to be heard but the themes summarize the variables that are researched in the best way and allow creation of a theoretical model that is concise and also informative.

A coding strategy can use different schemes, from a predefined, to an inductive or generic coding scheme (Miles and Huberman, 1994). In this study, inductive coding was applied. First, a coding scheme with about 30 codes, research question, and the questions formulated in the interview guide, was developed.

In the inductive coding new insights on the phenomenon under study lead to the iterative revision of the initial coding scheme (Corbin and Strauss, 2008; Glaser and Strauss, 1967), resulting in the finalized codes: 'activities codes and sub-codes' (Table 3-24, page 123) based on the final coding strategy (Figure 3-1, page 126). The scope and depth of the coding process was dependent on the phrases, sentences or sequence of sentences that were used as units of analysis to assign codes (Miles & Huberman, 1994).

One or more codes were assigned to text segments, as described above, starting with inclusive ones (Miles and Huberman, 1994). For building categories and attributes, the constant comparison method was applied in order to code only text segments connected to the research questions (Glaser and Strauss, 1967). This study's objective was not only to saturate categories, i.e., concepts, but also to understand the logic of individual cases and to identify similarities and differences across cases. To achieve theoretical saturation and subsequent generalization, the study related the findings to broader management literature that focused on innovation, knowledge management and customer-supplier interaction.

According to Glaser and Strauss (1967) theoretical saturation is reached when the researcher identifies similar instances being repeated. Theoretical saturation was reached through "aggregation or comparison of independent studies" (Schofield, 2002) and the inclusion of "enfolding literature" (Eisenhardt, 1989). For example, the formation of sub-codes *Brainstorming Solution Ideas* and *Brainstorming of Design* appeared independently in the cases.

The respondents described in each of their cases that their established application was reaching its limitations of principle of use. They used similar expressions that led into the direction of limitation of underlying concept, e.g., "pain" (Fernandez, 2009, p. 5), "problem" (Fernandez, 2009, p.20; Meya, 2009, p. 11; Gebhardt, 2011, p. 2). In comparing the cases, similarities were identified which led into uniform categories, i.e., and *Brainstorming Solution Ideas* and *Brainstorming of Design*.

Further comparison of the cases led to a major uniform category that describes sub-codes, limitation and solution finding, i.e., *Brainstorming*. This category with its sub-

codes was related to the management literature on innovation, i.e., technology and structure (Arthur, 2007). The repetition of the instances across the independent studies led into theoretical saturation of this example, so the main code *Brainstorming* was formed.

Once the main codes had been identified, the question that had to be addressed was concering the best way to name them. Because the main codes were stages in a process of innovation that had a practical interpretation, the name had to be connected to practice. An idea was to name them "actions", but the term was too unstructured and was not a good fit with the work undertaken in companies that is somewhat more organized. The term "routines" was closer to the correct name, but the main codes were identified in only a few companies, so not all had them included in the procedures or implemented. The main codes were more like a set of recommended routines that, if implemented, could support information acquisition, knowledge conversion and the innovation process. The term "activities" was chosen as the most suitable, as it had a practical interpretation and sounded more structured than simply "actions". The main codes are thus called the activities of the innovation process in this research. They are also called the activities of information acquisition and knowledge conversion as they are carried out at the beginning of an innovation and support the initial segment of the process.

3.4.3.1 A comparison with the knowledge spiral

The theoretical framework has included Nonaka and Konno's (1998) knowledge spiral, giving it a central role, because it served as a starting idea and an inspiration for this research.

The activities used in this study: brainstorming, structuring problem, collecting data, reflecting on information, exchanging knowledge, filtering knowledge and feedback have some similarities with the activities described by Nonaka and Konno (1998). The activities are the main codes obtained with an inductive approach. They are the results of inductive coding and summarize very well the variables that are researched. The main codes and the relations between them can illustrate how the collection of information is carried out and used for innovation.

There are four main concepts that compose the knowledge spiral. The first, socialization, is sharing tacit knowledge between individuals through informal ways, rather than written or verbal instructions. Externalization refers to the process of turning tacit knowledge to explicit knowledge in a way to formalize it and make it accessible to a group or organization.

Combination turns explicit knowledge into more complex sets of explicit knowledge and can be done through meetings, reports or other methods. Internalization converts explicit knowledge into tacit knowledge, so that the individual chooses relevant knowledge from organizational knowledge.

The knowledge spiral is based on the concept of ba (Nonaka and Konno, 1998). This is a shared space for emerging relationships with the purpose of knowledge creation. It derives from the Japanese word "basho", which means place. It can be physical, virtual or mental and provides a platform for advancing individual or collective knowledge.

Without ba, knowledge is simply information, because knowledge is intangible and needs individuals to apply it. The concept of ba exists at many levels: for individuals, it is the team, for the team it is the organization, and for the organization it is the market. The use of knowledge requires a concentration of resources in the place consisting in the organization.

The knowledge spiral of Nonaka and Konno (1998) has led to the idea of using feedback loops in an emerging model about innovation. The model is based on the theory of the knowledge spiral as it is an iterative approach but is new because it considers the activities of information collection for obtaining innovation. In identifying the factors that are responsible for innovation in an organization, simple causal relations such as links are not sufficient. The new knowledge that determines innovation is not produced simply by accumulating different materials, documents or records, it is a cycle of converting tacit to explicit knowledge and then back to tacit.

The process of concentrating knowledge assets in the company is an organic process and can be compared with an ecological process of a cyclical cultivation of resources. The feedback loops allow a suitable representation for these processes that are more similar to ecology than economy and that, through numerous iterations, tend towards a balancing state. The feedback that takes place in a system can determine increased returns or production outputs in companies. The knowledge a company has increases by receiving feedback from the market and produces even higher growth.

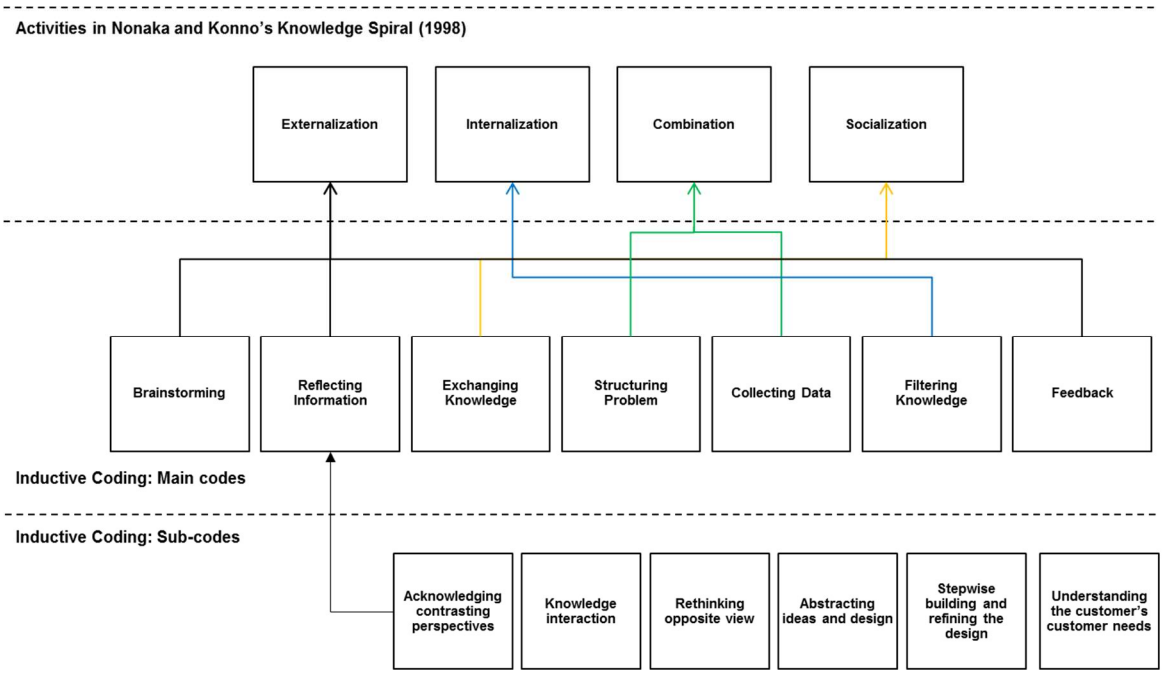

Figure 3-1: Hierarchy of coding scheme

The Figure 3-1 provides an example of how sub-codes form main codes, and how these main codes are compared to the activites in Nonaka and Konno's (1998) knowledge spiral. Brainstorming can be interpreted as a form of externalization because it relies

on the ideas or tacit knowledge of several participants in order to produce a real and tangible solution to a problem. Structuring the problem is a form of internalization at the individual level, as it consists of making a plan and choosing the steps necessary for it to be successful. However, at a company level it is a form of combination because choices are being made to construct a plan to be followed by different individuals in the organization.

Collecting data is a form of combination, as formal knowledge is turned into a more complex knowledge that is better indexed. Reflecting information is a form of internalization, as an individual chooses the information most relevant to him from other individuals. Exchanging knowledge is a form of socialization, as knowledge is tacit and intangible.

Filtering knowledge is a form of internalization as an individual chooses from a set the information most relevant to him. Feedback is similar to externalization, as tacit knowledge from consumers is made known to the company.

3.4.4 System dynamics

System dynamics includes a set of principles to conceptualize models and to study research and development processes (Sterman and Repenning, 1997; Sterman, 2000). This purpose was apparent from the initial days of the field and has developed since then to be an active area of research and also a significant influence on management practice (Wheelwright and Clark, 1992; Cusumano and Nobeoka, 1998). This allowed to shift the focus from individual projects to the product development process.

The term system dynamics was coined in the sixties by Jay Forrester at MIT (Forrester, 1961), replacing the term of industrial dynamics. It is a way to understand a system and its feedback structure by tracking responses to changes within or from outside the system. It also deals with the mathematical representation of the mental models, but this is not an objective in this research, as the focus is on the methods, activities and practices of the organizational actors that contribute to innovation. The field of system dynamics was initially quantitative, but this research is in line with the work of Senge (1990) who introduced a more qualitative approach to system dynamics.

In addition to system dynamics, this research is also based on the system analysis approach. System analysis is about understanding the components and feedback relations of a phenomenon. It sets out to discover the feedback structures of systems within organizations and creating insights into the organization of causalities.

Causal loop diagrams or qualitative models usually have an inherent system-thinking structure because they are constructed according to certain logic and reasoning. A model that does not describe its structure is essentially useless. A model is successful when the thinking behind it can be conveyed from the modeler to the reader (Haraldsson and Sverdrup, 2003). This is the true purpose of the models in this research, namely, to be able to clearly illustrate the principles, activities and practices that support the process of obtaining innovation.

Traditional education has taught us that reality is made of linear relations, but it can also be interpreted as a series of events arranged in a feedback pattern. A linear view

is indicative of a simple locus of causality, so we are looking for something that must be responsible (Senge, 1990). The linear view tends to put the individual at the center of attention rather than take a more neutral approach. System thinking does not simply look for an individual or cause that is solely responsible for a problem or phenomenon in a system, it searches instead for a set of influencing factors.

Simulation and modelling are important methods that can describe processes in economics and management. The modelling techniques have evolved as they had to address how variables change over time (Cloutier and Rowley, 2000).

Simulation and modelling techniques in economics and management have developed over three periods. The first period was focused on modelling business cycles and incorporating causal linkage determination between variables. The second period was characterized by the introduction of nonlinear models that could describe the dynamic properties of economic systems. In the third period computer hardware and software was used for simulation purposes.

Many of the empirical models introduced in this way have failed to answer fundamental questions about the social, economic and environmental interactions and the behavior of relevant agents. A way to succeed in answering these questions is to include complexity as a characteristic of modern organizations. Complexity means that there are factors with feedback interactions that influence management processes (Ford, 1999). The most important ones have to be considered for a specific process because they have the greatest potential for describing it and its complex dependencies, dynamics and feedback interactions.

System dynamics makes it possible to understand and characterize the underlying structure of an organization. This is accomplished by considering a greater range of information sources and mental models of decision-makers to obtain knowledge about changing systems (Forrester, 1994). This approach allows using both quantitative data and qualitative relations between variables depending on what is more suitable to a specific research.

Understanding business systems is made difficult by complexity that is a significant challenge for researchers and requires new tools for theoretical and empirical inquiry. System dynamics is a way to address complexity when researching complex systems (Forrester, 1975; Ford, 1999; Sterman, 2000). These authors mention that behavioral patterns in an organization are undeniably linked to its structure. The complexity and behavioral patterns in an organization have to be well conceptualized as they are the key to describing important activities such as the innovation and diffusion process.

Systems and organizations have been increasingly affected by accelerated change and uncertainty (Sterman, 2000). Structural change and uncertainty are sources of complexity that also influence organization behavior and the actions of individuals. Complexity is caused by systems that are constantly evolving and in disequilibrium. Systems have several characteristics that determine complexity as they are dynamic, governed by feedback, nonlinear, history-dependent, policy resistant and adaptive.

System dynamics models can have up to four components: feedback loops, stock and flow structure, time delays and nonlinearities (Sterman, 2000; Wolstenholme, 1993).

Management and economic systems can thus be considered as nonlinear, interconnected and reinforced by feedback loops that are indicative of their structure (Forrester, 1994). This means that actions, symptoms and solutions that belong to such systems are not isolated linear cause and effect processes, rather, they are circular and interlocked.

Both system dynamics and other modeling techniques do not contest the cause and effect relations between variables as these are accepted by all approaches. The difference between system dynamics and other modeling techniques is that cause and effect relations are considered distant in time and space and difficult to be determined with certainty. Policy resistance and bad decisions of economic agents arise because they do not know the full range of feedback and causalities that operate in the whole system.

In system dynamics models, the behavioral patterns in an organization can be caused by the organization structure itself, such as the production processes, policies and traditions. The structural framework of an organization can contain sources of amplification, information feedback, time delays and flow diagrams that represent modeled relations (Sterman, 2000; Wolstenholme, 1993). The feedback processes that include both quantitative and qualitative information can determine the dynamics of an individual system.

In the conceptualization stage of the model, the researcher has to determine the purpose of the model, the model boundary, the shapes of the reference modes and the nature of the basic mechanisms that consist of feedback loops and form the dynamic hypothesis. A dynamic hypothesis is an explanation of the behavior of interest and should be consistent with the model purpose. Feedback loops can be drawn and tested with the help of the previously identified dynamic hypothesis.

The first step in the modelling process is problem articulation and the next is constructing a dynamic hypothesis (Sterman, 2000). Problem articulation means focusing on a problem and narrowing down the model's audience. A well-defined purpose helps the researcher to find the relevant components to be included and structured.

A feedback system has a closed boundary within which the behavior of interest is created. The model boundary is defined by identifying the components that are included in the system. The components must be necessary so that nothing excluded from the model can determine and properly represent the behavior of interest. The components should also be aggregated if this does not change the nature of the problem being modeled or the model purpose because fewer components prevent any unnecessary complications. To further specify a model boundary, the components should be separated into endogenous and exogenous groups. The endogenous components are involved in the feedback loops of the system. The exogenous components are not directly influenced by the system, but influence, in turn, the other variables.

The reference mode has to be specified after the model purpose and the model boundary. It is simply another name for a plot of the behavior of key variables in a system. The reference mode graph has time on the horizontal axis and units of the

chosen variables on the vertical axis. The reference mode illustrates the change in variables and historical data, offers clues on the correct model structure and can check plausibility once the model is constructed and tested.

The reference modes can be historically observed or simply hypothesized. A historically observed reference mode usually exists when a modeler is given a problem and wants to find possible causes and solutions. Historical reference modes also use historical data.

If no historical information is available, a modeler must create a hypothesized reference mode. This consists of a simplified curve, usually drawn by hand, that illustrates the key features and behavior pattern of the system's components. The components can register growth or decay that can be linear, S-shaped, convex or concave and the oscillations can be damped, sustained or increasing. The hypothesized curve abstracts the relevant features of a variable in a system.

Formulating a dynamic hypothesis helps to construct feedback loops in the system dynamics modelling (Sterman, 2000). A dynamic hypothesis is a theory and, more specifically, a provisional explanation of the dynamics of a problem in terms of the feedback and stock and flow structure of a system. The goal is to represent a dynamic hypothesis and to obtain an endogenous explanation of the problem. This can describe the dynamics of a system through the interaction of the variables and agents.

A dynamic hypothesis provides a preliminary view of the dynamics of a specific problem in terms of its structure. It allows to identify the patterns of behavior created by the structure and rules of the system and to determine how this behavior might change when altering the structure and the rules of the system. A dynamic hypothesis can be used to represent feedback loops in management processes such as innovation (Homer, 1996; Senge, 1990). Innovation is also determined by the patterns of behavior of its developers and it is important to note how they can be changed by modifying the structure and rules of an organization or simply of a department tasked with researching and obtaining it.

The conceptualization stage is usually followed by a formulation stage where the feedback diagrams are converted in level and rate equations; however, this is beyond the purpose of this research. This can be accomplished in a physics system such as the flow of a dam. It can also be accomplished in a system concerning the course of a disease in a population to help city officials develop a plan of action. One of the difficulties of stating level and rate equations in management is quantifying the variables. Information and knowledge are also abstract concepts that cannot be translated in pages of text or in results to a test. In a management system it is important to see the underlying principles and the behavior of variables that influence each other and function in such a way to attain a purpose.

3.4.4.1 System dynamics models describing the innovation process

Innovation is a complex problem for managers to solve because of short product life cycles, extensive competition and costly research and development. Because of this complexity and the links between the constituent elements, a suitable way to model innovation in organizations consists of system dynamics (Milling, 2002).

At the industry level, consisting of the company and market, feedback loops have been used to define the dynamics of the industry (Kunc, 2010). Here, different types of feedback loops are used to describe the system. A balancing feedback loop is considered to be between actual customers and potential customers, while a reinforcing feedback loop is between resources, actual customers, revenues and, again, resources. However, in this model innovation is not specifically modelled, being grouped together with investment in research and development, which is not the only factor that influences innovation. This is because of the nature of System Dynamics at the industry level, where innovation is one of several functions pertaining to companies in the industry. The examination is performed at the macro level without going into detail in the innovation development that goes on within companies.

There have been models at the product level, also, and one such is the Bass Diffusion Model (Bass, 1969). This describes new markets by means of an S-shape growth curve. It is a stock and flow model with two feedback processes and uses the adoption rate of a product. Potential adopters, adoption from advertising and the adoption rate are considered a balancing loop, while the adoption rate, adopters and adoption from word-of-mouth are considered part of a reinforcing loop. However, this model has some limitations as it considers the diffusion process independent from the strategy of the companies and that the consumers are a heterogeneous group. The type of product is also a consideration when using this model, as in the durable goods industry, the number of potential adopters is quickly depleted, so the dynamics are different. System dynamics have also been used in the fast-moving consumer goods industry (Kunc and Morecroft, 2007). The product is clearly defined to be liquid soap and the adoption is represented as a competition between three companies. Stocks and flows are used to represent customers of different products and feedback processes of companies can make customers switch brands. This model is concerned with the operational elements of innovation and not with the development of innovations.

There is also an analysis of innovation at the process level, where new product development is illustrated as a sequence of tasks and interactions between resources, project scope and targets (Ford and Sterman, 1998). Product development is modelled as a network of stock and flows. All flows depend on the amount of resources assigned to each task. System dynamics models have been used to determine resource allocation policies that influence reaching targets of quality, timing and budget under various conditions. System dynamics at process level is based on conceptualizing innovation during development. Stocks are used to reflect the stages needed to develop a new technology, such as rework, test and release. Flows are indicative of the speed at which tasks are performed and the movement between stages. This way of modeling has similarities with our present study. However, there are also significant differences, as innovation is not necessarily viewed as a production process, but as the result of human interaction in the company during changing routines such as brainstorming and exchanging knowledge.

3.5 STEPS OF ANALYSIS

This section presents the stages that had to be completed to go from the initial data to results (Table 3-25). The first stages were concerned with inductive coding and the later ones focused on constructing and refining the diagrams of innovation and of knowledge conversion. The first step of analysis consisted of coding the transcripts and marking the important sections. This was done in order to help identify the codes and these preliminary data were used to choose the possible research directions that could be followed.

Table 3-25: Steps of analysis

STEPS OF ANALYSIS			
Steps	**Actions**	**Result**	**Goal**
First step of analysis	▪ Inductive coding ▪ Develop tentative assertions	▪ Separating data or text	Coding the transcripts and flagging important sections
Second step of analysis	▪ Labelling the codes ▪ Identify sub-codes for the seven main codes to make them more robust ▪ Cluster main codes from the sub-codes	▪ Seven activities	Identifying the activities of customer involvement
Third step of analysis	Vensim PLE ▪ Coding and transferring the seven activities into Vensim PLE ▪ Modelling a first emerging causal loop diagram with Vensim PLE ▪ Constructing the dynamic hypothesis model version 1.0 ▪ Improving the dynamic hypothesis model to obtain version 1.1 that has slight adjustments	▪ Obtaining the relations between the activities ▪ Generating the dynamic hypothesis innovation model ▪ Improving the model	▪ Answering research questions ▪ Including employee involvement
Fourth step of analysis	▪ Testing dynamic hypothesis model structure with two specialists in the field and three innovation managers	▪ Creating a revised dynamic hypothesis model version 2.0	▪ The revised model contains significant adjustments

In the second step of analysis the codes were labeled, and it was important to determine the sub-codes and the main codes from the transcripts. By looking over the interviews, it was helpful to note how often some of the codes were mentioned and what relation they had with others.

The interviews were different from each other, but some common trends could be identified concerning the collection of information. Theoretical saturation was reached once no further concepts could be developed from the transcripts. This concluded with finding the sub-codes that were very indicative of the main codes. It was also important to have an idea of how these main codes contribute to information acquisition and are supportive of innovation.

The third step of analysis concerned building the initial theoretical model. This was done by interpreting the main codes as activities, identifying how they influence one another and constructing the feedback loops between them. The feedback loops were

used to illustrate how the output from a later stage of the information collection process could influence an earlier stage and in what conditions. The dynamic hypothesis model did not try to specify the steps needed to obtain innovation but, rather, was indicative of how to collect information and how to improve the organizational processes for this purpose in order to create many supporting factors. The model was improved with a banking case that was carried out after the other cases. This resulted in slight improvements to the information collection model of innovation.

The fourth step of analysis had the purpose of undertaking revisions to the initial model due to interviews conducted with specialists, researchers and innovation managers. The changes were significant as they determined adjustments and included the influence of context on innovation and generative mechanisms in line with critical realism. The context has a lot of influence in determining what information is valuable and how knowledge conversion is carried out.

This data analysis procedure is illustrated in Figure 3-2 (page 134).

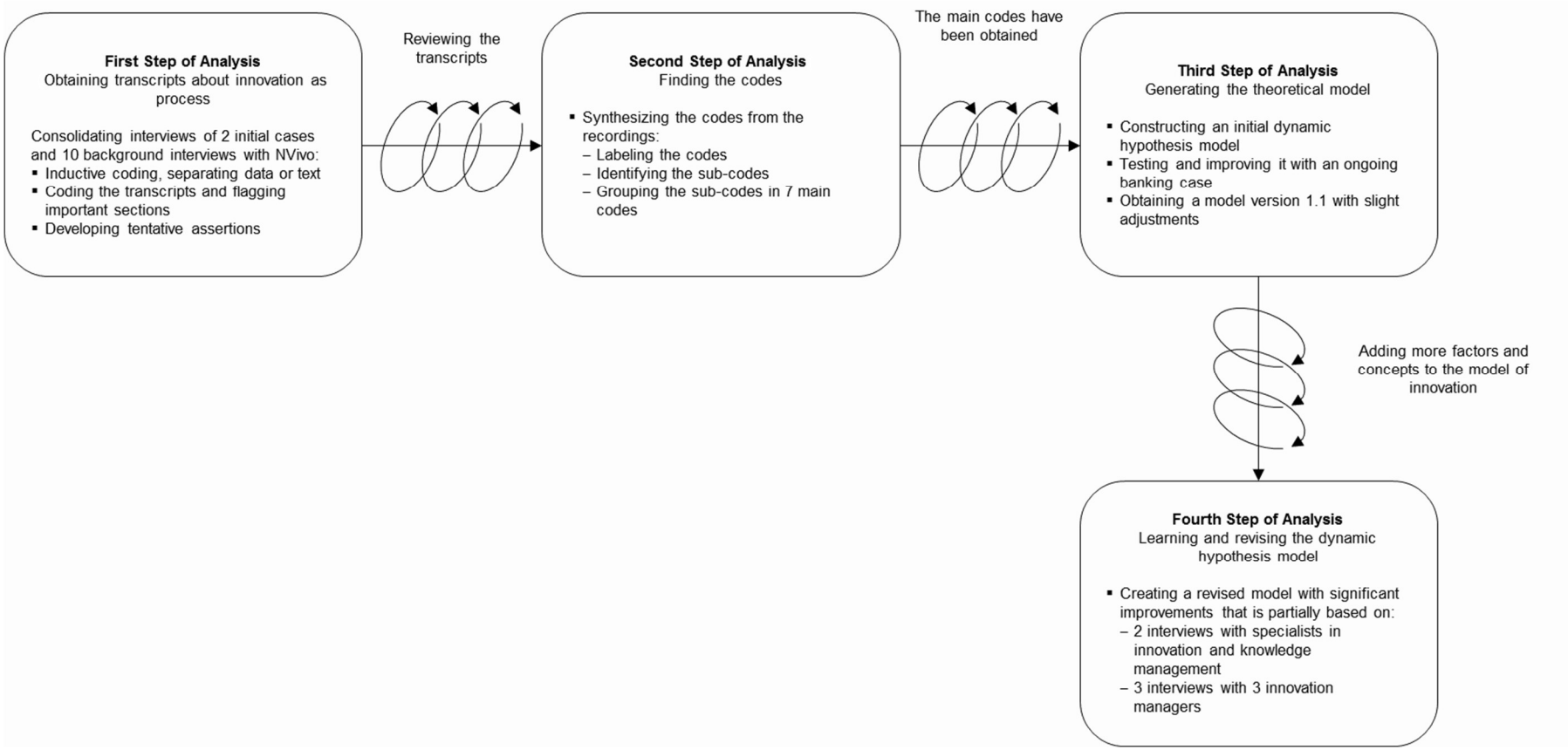

Figure 3-2: Data analysis from interviews to a dynamic hypothesis representation

3.6 VALIDITY AND RELIABILITY

Reliability and validity are important criteria for assessing methodologies. Research is deemed reliable if its findings can be replicated (Ritchie and Lewis, 2003) because "reliability of the findings depends on the likely recurrence of the original data and the way they are interpreted" (p. 271).

Validity has internal and external aspects. Internal validity refers to how well the collected data conform to the reality they presumably reflect (Ritchie and Lewis, 2003). The instruments they suggest for internal validity are "sample coverage", "capture of the phenomena", "identification or labelling" and "interpretation and display" (p. 274). In this study, the sample coverage is assured by avoiding bias through having historical events explained by respondents directly involved in innovations. Relevant codes were "identified and categorized and named" in line with stories of the respondents (p. 274). This study made sure the findings displayed remained faithful to the original data and reflected "analytic constructions" (p. 274). Given that the cases in this study are historical events described through recollections of key participants, it should be possible to replicate them (Ritchie and Lewis, 2003). Such description of historical events is stable, unobtrusive, and exact (Yin, 1994). Therefore, others who repeat this research would likely draw similar conclusions.

Triangulating from different sources of data is one way to improve internal validity (Yin, 1994). Therefore, this study employs interviews with managers and customers as different sources of information. In this research, such triangulation is followed because the cases emerged from similarities among those different sources and were confirmed through follow-up interviews with other participants. Internal validity was, therefore, enhanced. Comparing and contrasting data with existing literature also increases internal validity (Eisenhardt, 1989).

Interacting with key participants during the case studies mitigated selection and respondent bias (Flick, 2006). Respondents were asked to review transcripts to validate accuracy and context. Except for the modeling sessions, interviews were recorded, and notes transcribed by unaffiliated persons, enhancing the reliability of information and data. In some cases, non-disclosure agreements and promises of anonymity assured that interviewees could express opinions without repercussions.

Among the sources consulted in addressing interactions between customer and employees were representatives from companies. They were the suitable object of inquiry because this study investigates how the information acquisition process supports the innovation developed by a company. It might have been worthwhile to document the customers' perspectives as well, but that would have been time consuming and would have involved a great number of interviews and responses, reducing the possibility to generalize the findings.

External validity refers to the possibility of drawing general conclusions from the research conducted (Miles and Huberman, 1994). Since little is documented about the effect of the information acquisition process on innovation, the existing theories about the mechanism seem inadequate and the study seeks to develop new theory

rather than extend or test existing theory, case studies are an appropriate research strategy (Eisenhardt, 1989).

Generalizations may inform the researcher and prompt further research in the same or other areas. The causal loop method of qualitative inductive coding and modeling "may also uncover some unique variance which otherwise may have been neglected by single methods" (Jick, 1979, p. 603). Triangulation functions to "examine the same phenomenon from multiple perspectives but also to enrich our understanding by allowing for new or deeper dimensions to emerge" (Jick, 1979, pp. 603-604).

External validity is increased by relating cases to theory, in order to reach more general conclusions. Themes discovered during inductive coding contribute to developing new theory by synthesizing established theory, concepts, and observations from other articles and studies.

3.6.1 Testing the structure of the models by interviewing innovation specialists

A number of interviews were carried out to test the innovation models after developing them. These interviews were conducted with professors performing research in innovation and also practitioners or innovation managers.

The academic respondents were:
- Professor Dr. Fanny Simon, Université de Rouen, Institut d'Administration des Entreprises, France
- Professor Dr. Martin Cloutier, École des Sciences de la Gestion, Université du Québec à Montréal (ESG UQAM), Canada

The practitioner respondents were:
- Ruth Mojentale, CEO & Co-Founder, Fintune AG, Switzerland
- Frederik Gregaard, Head Digital Financial Services, PwC Switzerland
- Frederik Arns, Director Digital Strategy, Cognizant Technology Solutions, Germany

The interviews are important, in order to determine whether the models reflect and conform to the reality of the people who are researching the concept or are trying to obtain it. It is also possible to identify new directions or relations between concepts from the transcripts.

3.7 SUMMARY

This chapter has provided a comprehensive description of the methods by which the data presented in this chapter were collected and analyzed. The opening section of the chapter provided the philosophical approach from which the methodology worked in terms of the ontological and epistemological positions assumed. Critical realism is chosen as the philosophy of this research, combining a realist ontology with a relativist epistemology. This approach reflects the exigencies of the project itself, in terms of trying to develop a model for practical use, while recognizing that the literature review and conceptual model described in preceding sections set out the imprecise nature of any given objects of analysis.

The data collection and analysis component of this methodology was set out as follows. The opening stage of data collection was designed to locate a set of potential components of innovation through two exploratory case studies, which provided a set of data that were then subject to a process of inductive coding. This was done according to the principles of case study research. The interview process and the ways to contact the respondents were presented.

The Research Design section outlines the steps taken to choose the concepts, collect the data and analyze it. After that the findings were compared with the relevant literature and the theory was developed. The two main ongoing cases used were those of Avaloq and Synosia. A case that was subsequently added for improving the causal loop diagram was the banking case, bringing the total to three cases. A series of interviews was conducted with several employees from those companies in order to ascertain the factors that support innovation, customer involvement and employee involvement. From the first interviews, lessons were gained that were useful in modifying subsequent interviews.

A series of concepts were then presented which have been used throughout the thesis, such as the case study method and inductive coding. All the methods used to collect the data were presented and the companies used in the study were listed.

In total, there were three main cases and ten background interviews. The questions used for each of those interviews are provided. Based on those cases, an emerging innovation model was built. The model was improved by conducting interviews with employees from a large bank and a chemical company. Based on those interviews, seven main codes were chosen from 30, each of which illustrates an activity. Each of these codes contained several sub-codes in order to present the activities with a higher level of detail and to show the implications.

The chapter provided comprehensive detail on each of the case studies, and the technical composition of each phase of the data collection, in terms of the style and approach of interviews, the software and supporting tools used, and the style of coding methodology used. The methodology is reflexive, in that it had to be adapted through the process in order to ensure that the data being generated were sufficiently robust to be able to offer insights on deep-level connections; therefore, the chapter described the use of NVivo and Vensim PLE to allow for a much more robust examination of interview data than was allowed by the question format itself. The chapter also reflected on the ethical implications of conducting research in this manner. The following chapter presents the data and the model generated through the interviews and the inductive coding procedure in terms of the seven components of innovations identified through case studies.

4 RESEARCH FINDINGS

4.1 INTRODUCTION

This chapter develops an inductive empirical model with which identified codes, or the seven recurring activities, are modelled to reveal the influences of these activities on the information acquisition process that supports innovation.

The chapter starts with presenting an initial causal loop diagram based on the seven main codes or identified activities (*Brainstorming*, *Structuring Problem*, *Collecting Data*, *Reflecting Information*, *Exchanging Knowledge*, *Filtering Knowledge* and *Feedback*) that includes feedback loops.

The activities of information acquisition were entered into the Vensim PLE software for qualitative modeling. This model was then further improved with a banking case study and its interviews. The longitudinal case studies from Avaloq and Synosia have also been used for improving the model and its structure.

The findings use qualitative System Dynamics (Mayo et al., 2001; Mass, 1974; Sterman and Repenning, 1997; Sterman, 2000) to illustrate the process of information acquisition and knowledge conversion that supports innovation. It is possible to map this process by using diagrams that can also be considered dynamic hypotheses (Sterman, 2000). The diagram of the innovation process has gone through two stages of adjustments, so there are three versions: emergent, improved and revised. The terminology of causal loop diagram had been chosen as opposed to a qualitative model, as it offers a starting point for modeling.

This research includes a system thinking approach (Gharajedaghi, 2006), as it follows a process of formalizing and studying feedback loops and their iterative nature. The system thinking approach helps to understand the patterns of interaction and the underlying structure of complex systems (Gharajedaghi, 2006; Senge, 1990). The process of innovation can be conceptualized as a complex system that consists of many activities contributing information and knowledge in an iterative way.

All of the innovation diagrams presented below are based on the seven recurring activities of information acquisition. The activities can be carried out with customers and employees, but some are more focused on just one group or category of individuals.

4.2 EMERGENT INNOVATION DIAGRAM

The emergent innovation diagram or dynamic hypothesis obtained in this study is based on the interview sessions conducted with the representatives from the Synosia and Avaloq companies. It is based on the inductive coding presented in the previous section. Together with the codes from the case studies, codes from the background information interviews were also used, in order to benefit from greater generalizability, multiple viewpoints and construct validation. This illustrates the mechanism of the

"information acquisition process" (Greer and Lei, 2012, p.74) that is considered a starting point for innovation.

Unlike the previous models of innovation, this diagram considers the actors of the market, the customers, but not the market itself. The process of involving customers is also more iterative and this involvement takes place at multiple stages of the innovation process, starting with information acquisition.

The emergent innovation diagram is similar to the fifth-generation model, the network model, which illustrates the relationships between the company and its customers, its suppliers and other companies (Galanakis, 2006). The similarity is that both representations state that sharing information with customers has the potential of making them co-developers of new products. Both representations state that enabling larger volumes of information to be shared is a key aspect in innovation. In line with Trott (2005), new product development can be considered a knowledge accumulation process that requires a wide variety of sources.

The presented diagram focuses on open innovation because it considers the contribution of external actors. A common theme is the requirement of both internal and external input for innovation (Chesbrough, 2008). Innovation is also seen as a culture, based on a free circulation of ideas, rather than a technical process that can be fully controlled (Huizingh, 2011). There are also differences, as the company is focused on involving the customer to a great extent, but not on open sourcing. The company uses a number of external channels to obtain information, but any knowledge that is created becomes proprietary.

This research thesis's diagram uses feedback loops. This is in line with Schmoch (2007), who states that innovation models should include feedback loops and non-linear characteristics which presents the dynamic unfolding of innovation development and its interconnectedness. Each of the innovation activities of customer involvement and employee involvement has a role in collecting, organizing or filtering knowledge. The feedback loops make it clear that these are iterative processes. Once the information is collected and assimilated by the company, it has a role in enhancing the knowledge conversion process and creating an environment that supports innovation.

Data from Synosia and Avaloq were used, as these are the first cases considered in the study. A banking case has been added more recently and will be used for improving the model of innovation. The data obtained this way allows identifying the links between routines, rather than only identifying the codes. Whenever the empirical nodes or codes were unclear, the preceding data were reviewed to clarify the content related to that code. This section presents the routines that occur related to an innovation and explains them through associated coding and sub-coding.

There is a distinction made between customer and employee involvement as both groups contribute to the routines of innovation or the seven main codes presented in the study. The routines are focused on one group or can be realized by individuals involved in both groups. The employees can contribute indirectly, by collecting and managing data from customers, or directly by specifying their own opinion, based on their knowledge and skills. There are four interviews from Avaloq, with Francisco Fernandez. There are also five interviews from Synosia, the first three were carried out

with Uwe Meya and the fourth was with Ian Massey. The fifth interview was conducted with Christoph Sarry, from Roche, a company that is collaborating with Synosia.

4.2.1 Brainstorming

Customer involvement
Through brainstorming, ideas are collected in meetings (Osborn, 1953) and stand at the basis of future studies and implementations:

> *"...the study design it was a brainstorming process which took a period of time; once we had gone through that process then we moved into the implementation of the study..." (Interview Synosia 3, p. 9)*

4.2.2 Structuring problem

Customer involvement
The interviews with the customers can be in the form of structured discussions (Zalot and Lussing, 1983). This is a relevant approach because it allows the interviewer to concentrate on what is relevant and the answers will also be more to the point and concise:

> *"… we would have all kinds of structured discussions with customers to understand what their needs were." (IBM Token Ring, 2011, p. 9)*

Employee involvement
Structuring the problem is a way to better manage the complexity and to present solutions in an iterative manner, with the purpose of making improvements and refinements as soon as they are required:

> *"You go process step for step... with a methodology that you start interviews with the customer, you go back, you design, you code, you prototype, you test, you show the customer, you come back to the understanding, you redesign, you recode, you retest in some step-wise refinement loops until you think you have, again, a new automation step within the process and then you go to the next step, etc." (Interview Avaloq 2, p. 4)*

> *"Design has to be reduced to a reasonable max... just to master the complexity." (Interview Avaloq 3, p. 4)*

A suitable problem structuring will identify priorities that need to be addressed in a reasonable timeframe, while also leaving open the possibility of future development and improvements:

> *"You can't specify everything in total because time is moving. So, if you would design a 200 floor thing... the 200th floor will be designed and specified differently than the first three because time is moving so complex long projects have to be split up and built in an evolutionary method with lots of prototyping." (Interview Avaloq 3, p. 4)*

Structuring the problem in a detailed and suitable way will make it easier to solve. An adaptive methodology will provide a number of benefits, such as increased flexibility and an iterative method of problem solving that is centered on the problems as they appear:

> *"...you take a little step, you learn something; then you react to that, you adapt your design, your methodology and test it again. Then it may confirm what you believe. That's much faster, much more cost efficient." (Interview Synosia 1, p. 6)*

The development team structures the problem by summarizing it into facts, making it more approachable:

> *"...we summarize the need and we turn it into, I would say, facts, because usually the problem is not well defined and usually the problem is not based on facts." (Interview JC, p. 7)*

> *"...we try to reduce the customer's problem, as I said, in some facts. Clearly defined because, again the customer, and that will lead to identifying the root cause of the problem." (Interview JC, p. 7)*

4.2.3 Collecting data

Customer involvement

Collecting data is accomplished by examining the market as a whole and the customer as an individual:

> *"In the beginning you gather information about the market, about the customers..." (Interview Avaloq 3, p. 11)*

> *"What can the customer contribute to innovation and, as I said, if he starts a little bit understanding what you can do with software he might contribute by having his own ideas of what we could change. But I said it's in addition to this, it's not given or automatic..." (Interview Avaloq 2, p. 8)*

The information obtained from customers is valuable especially if it's indicative of the preferences of an entire segment of customers, if it allows the company to see the general in the particular case:

> *"[Innovation was created] by understanding the market opportunity. So, by understanding the problem and understanding that problem is a market opportunity because that problem doesn't arise at one customer but every customer, or a whole market has that problem." (Interview Avaloq 2, p. 11)*

The customers can be individuals or businesses and in both cases they can help the company with useful information:

> *"… in terms of market insight we had direct contacts with end users, or potential clients like Nokia or Sony…" (Interview Millipede 2011, p. 11)*

Employee involvement
The data that can be collected concerns the demands existing on the market, as these stand at the base of new solutions:

> *"But as an engineer you want to build things so probably an inventor or an engineer is more out looking for demands than he's out looking for solutions because solutions come from competitors, from other engineers..." (Interview Avaloq 1, p. 17)*

> *"[You collect data] later on from the engineers, does the... function prevent design or design prevent the functionality or does it induce peak production costs..." (Interview Avaloq 3, p. 11)*

The purpose of collecting data is also to see what has already been tried and does not work or what works and can be improved. A consideration is also how to use existing technologies in a new way:

> *"So, the innovation, I would say, from the process perspective was recognizing the deficiencies of existing drug development processes, recognizing these imaging tools and what they could be used for and putting these together to apply these tools to the early phases of drug development." (Interview Synosia 3, p. 3)*

4.2.4 Reflecting information

Customer involvement
Reflecting information is done by discussing with the customer and ensuring the data collected is suitable, because he needs to be comfortable with the output of the company:

> *"...you want the end customer to decide because he's going to buy, he must become happy with the product, therefore you use him still for evaluating the options." (Interview Avaloq 3, p. 10)*

Another way of interpreting reflecting information is to discuss with the customers about a problem they have and to see if the technology or products of the company can solve it or they need to be adjusted to do so:

> *"… we had sessions with customers where we tried to solve their problem and figure out a solution to their problem using this technology … we had the technology but we had to figure out how to apply it to their problem and to make it work." (Internet Telenet 2 2011, p. 8)*

After data are collected, possible solutions are discussed with the customer in order to understand his opinion. Discussing with the customer is also important for confirming that the sales department understood all the requirements:

> *"...we enter discussion with having in mind one product, one feature or one application and talking with the customer we realize that what they really*

need is not what we thought or assumed. And what they really need is something different for which we might have a ready solution or for which we can develop something." (Interview JC, p. 4)

"We may, of course, discuss with the customer possible solutions but we never propose something firm and definitive but of course we have also to look internally if it fits, if it's feasible." (Interview JC, p. 7)

"So, we ask the customer to validate our understanding of the problem and our understanding of what is needed, really." (Interview JC, p. 11)

"...we discuss what we need because the customer needs to know what he will use or what he will get." (Interview JC, p. 12)

4.2.5 Exchanging knowledge

Employee involvement

Having people with different backgrounds and specializations greatly enhances the process of exchanging knowledge:

"...if you ask a banker to specify an IT solution he will just copy what he knows... If you have an engineer rethinking banking you get something different, so the dialogue of universities, bankers, physicians, software engineers will lead to new ideas." (Interview Avaloq 1, p. 5)

"A dialogue can also be a virtual dialogue, an intellectual dialogue of different skills. When I was speaking to bankers I tried to rethink [their] world and [they] tried to understand and rethink my world and that dialogue brought new concepts. The innovation is then the way or what emerged out of that dialogue of our engineers dialoguing or discussing with the bankers having the new technologies in mind." (Interview Avaloq 1, p. 7)

"[Innovation is obtained with] diverse thinking people. So, if you only have a dialogue with the same skilled people you have less innovation than if you start mixing cultures, skill sets..." (Interview Avaloq 1, p. 8)

Exchanging knowledge is important even in the early stages of setting up a company. Finding people with relevant backgrounds, capabilities and interests is one of the best ways to exchange knowledge, as it the most efficient:

"Here the initial concept of setting up a ready company that is already having a portfolio of fairly mature molecules so that came from the investor. He was lucky enough to find out CEO who had the same idea and who was then keen and willing to implement that new concept." (Interview Synosia 1, p. 18)

"Then, of course, in the second step our CEO carried that new idea, that new paradigm into the company and he tried to hire people with the mindset to do that." (Interview Synosia 1, p. 18)

Collaboration with universities and research institutes is a form of exchanging knowledge as the company can keep up with recent developments in a field of science:

"... what happened to us a lot was the collaboration with research institutes... For us, this new perspective from the outside helped us a lot..." (Dacuda Mouse Scanner 2011, p. 3)

"... it was a joint project between the lab here and the university group in Aachen. I think those guys interacted probably weekly..." (IBM Token Ring 2011, p. 11)

4.2.6 Filtering knowledge

Customer involvement
Information obtained from customers is filtered and also the answer for them. This is done so that a possible solution is understandable, clear and communicated efficiently to the customers:

"We try to summarize what the customer tells us to make sure we have well understood and to avoid noise, so to focus on what really is the problem… Then we are of course filtering the answer we provide, so this is filtering our knowledge…" (Interview JC, p. 14)

Employee involvement
Filtering knowledge can be accomplished with people from different departments and industries in order to identify what is important:

"But it's not enough to be a good engineer if you don't talk a little bit the bankers' language you won't be able to ask the right questions, to understand their answers, so there is a big transfer." (Interview Avaloq 2, p. 3)

4.2.7 Feedback

Customer involvement
Feedback is considered while interacting with customers, as solving a problem for one customer can be translated into knowledge to be applied for future customers. Feedback is obtained from the customer, sometimes simply from using a product over a long period:

"...trying to solve a customer problem leads us to learn about this problem and also to create, generate knowledge that will be useful for solving other problems with other customers." (Interview JC, p. 15)

"...people learn from their day to day work; they learn every day, especially research and development people; every day they discover new things working on projects for our customers." (Interview JC, p. 17)

"...we start selling, the customer is happy, he's using the product and he keeps on using the product which means it's a solution on the long run. ...So, this is sort of an indirect solution, indirect feedback." (Interview JC, p. 16)

Employee involvement

Through meeting with external partners, feedback can be obtained, following the advice and opinions stated by specialists:

> *"Then we are discussing and some people from our side who were attending these discussions who are specialists in this area, they are giving their opinion and this is an open discussion." (Interview Synosia 4, p. 6)*

The emergent innovation model (Figure 4-1) is focused on customers and examines them in more detail along with the customer activities that support innovation.

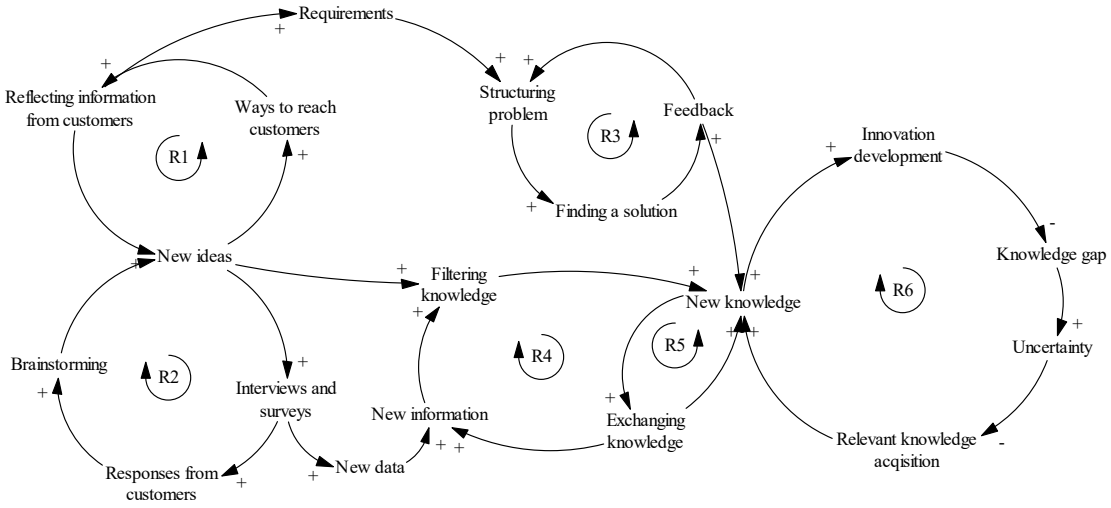

Figure 4-1: Emergent innovation diagram

These activities are routines and have a duality of stability and change. The potential for change is explained by routines being the product of organizational learning (Argote, 1999). Learning is considered to be a process that takes place across levels of hierarchy within an organization (Nonaka & Takeuchi, 1995). In contrast, Feldman (2000) sees it as a process that happens within organizational routines. The study agrees with this interpretation, as a company learns by changing its routines.

Routines can be considered as patterns of knowledge of the company. They are repertoires of actions and the rules that govern which action to take in a specific situation. A routine can change because of external factors. It can also change in order to attain a specific target or solve a problem in the company. A routine can also remain stable if no external factor or reason exists for it to change. A company can exchange knowledge in order to obtain new knowledge, but it requires a willingness to share some amount of information while, at the same time, keeping detailed knowledge about its own processes confidential.

The activity of brainstorming is a way in which the company can collect ideas in the course of sessions with participants who can be employees or customers. The ideas of the customers can be useful as it allows the company to obtain market knowledge and

to ascertain how a product will be received after launch by the public. The ideas of the employees can result in technical knowledge corresponding to design, implementation and production. It is important to note that the ideas of the employees are not automatically collected by the company if there is no process that accomplishes this and if they are not motivated to come up with innovative solutions.

Ideas collected through brainstorming are filtered to identify what is relevant and applicable (R2). It is possible that the company must collect a lot of ideas to find one that can be put into practice, but the reward can compensate for the effort if something innovative is identified. A successful idea that is implemented contributes the most to new knowledge, but even ideas that don't work can contribute to a lesser extent, as the company knows that a type of solution does not work and can concentrate on others.

The activity of structuring the problem is carried out after the requirements of the customers have been obtained (R3). A problem can also consist in implementing an idea obtained through brainstorming, from an innovation group or from an individual. If a company can structure a problem suitably, then the solution becomes apparent. The stages needed to complete the solution also become visible and the innovators know what must be done.

Structuring a problem (R3) is usually done in the design stage and, if done correctly, helps the development of innovation. The activity of structuring a problem does not happen only once, rather, it is part of an iterative process and is adjusted as new information and feedback is collected: *"… you start interviews with the customer, you go back, you design, you code, you prototype, you test, you show the customer, you come back to the understanding, you redesign, you recode, you retest…" (Interview Avaloq 2, p. 4)*. What is interesting is that in the second case study that was conducted with a company from another industry, the interviewee referred to the same process with similar wording: *"… you take a little step, you learn something; then you react to that, you adapt your design, your methodology and test it again" (Interview Synosia 1, p. 6)*. This was the reason for drawing the loop that starts with structuring a problem and continues with finding a solution and feedback, thus illustrating a process that is iterative.

Interviews with customers and surveys completed by them are a way for the company to obtain and collect data. These data describe a quantity or a quality of a product or process. It is a sum of discrete, objective facts or observations that are unprocessed and have no meaning until they are given an interpretation. In the context of customer involvement for innovation, data in the form of text can be more valuable than numerical data. This is because the company wants to know what customers are thinking about a particular product or service. Organizing and structuring this data is the way of turning it into information that is more useful for the purpose of innovation.

Reflecting information (R1) is done by discussing with the customer and making sure the requirements are correct. The requirements and the solutions proposed by the customer are repeated to make sure that the interviewer has properly understood them and they are suitable. It has to be determined if the offerings of the company can address the customer's problem as they are or if a customized solution is required

and they need to be adjusted. Reflecting information is a way to verify that the requirements obtained from the customers are correct and so it is illustrated in the causal loop diagram as having a positive influence on them.

The activity of exchanging knowledge can be carried out internally with employees of different backgrounds and specializations because having a diverse innovation team is a good approach (R5). It can also be performed externally with business partners or research institutes: *"… the collaboration with research institutes offered us a new perspective that helped us a lot…" (Dacuda Mouse Scanner 2011, p. 3)*. In both cases exchanging knowledge can result in new knowledge if it can be immediately integrated by the company, but this is rare. Usually, exchanging knowledge can result in new information that has to be filtered by the company in order to become new knowledge. This proprietary knowledge is more valuable to the company than knowledge that has been obtained from another source. The company selects from discussions with partners the knowledge that is applicable and can be implemented. In the causal loop diagram, it is illustrated that exchanging knowledge has a positive influence on both new knowledge and new information because of this reasoning.

Filtering knowledge is the process of selecting from the available information what is the most relevant, recent and applicable. The way to obtain knowledge is to apply information to a given context and see how practice compares to the theoretical expectations and planning. Filtering can also be carried out with ideas in order to choose those that are most promising, valuable and have the greatest potential to turn into profit. Filtering knowledge is a part of the process of converting information to knowledge that will be outlined and discussed in detail later in the chapter. Feedback (R3) is offered by the customer that concerns new products, new services or simply initial versions of those that are shown in meetings, interviews or trade fairs. Feedback from customers is a good opportunity for learning and improvement: *"… people learn every day, especially research and development people; every day they discover new things working on projects for our customers" (Intervew JC, p. 17)*. Feedback is part of the iterative process that starts with design and structuring the problem. Customers give more specific feedback as better and better product versions are shown to them and they decide if they conform to the requirements.

4.3 COMPARING ROUTINES TO THE ACTIVITIES IN THE KNOWLEDGE SPIRAL

The role each activity has in knowledge management is also presented. The seven routines of customer involvement are constructs or abstractions and the relationships between them help understanding. They can be compared to the variables in Nonaka and Konno's (1998) knowledge spiral. However, this comparison can be interpreted as mentioning a list of similarities, as there is no equivalence relationship to be stated.

Brainstorming
In the model, brainstorming is a way in which a company can collect ideas by having sessions with groups of customers or employees. This activity can allow customers or employees to identify solutions to problems that can be useful to the innovation development team.

The main focus is to convert tacit to explicit knowledge regarding problems and solutions or the externalization of conceptual knowledge (see details in Table 4-1, page 150). The tacit knowledge customers or employees have can be converted into explicit knowledge because, during a brainstorming session, participants offer ideas and support them with plenty of descriptions and explanations, so that many ideas, some of which can translate into new knowledge for the company, are collected.

Structuring Problem
This concept focuses on translating a "set of conditions into a set of problems, issues and questions sufficiently well-defined to allow specific research action" (Woolley and Pidd, 1981). Structuring a problem in a better way can be accomplished with the ideas obtained during a brainstorming session. These can provide a better perspective on a problem that has not yet been considered or organize the steps needed to solve a problem in a different way. It can be compared to a combination of operational knowledge (see details in Table 4-1, page 150). Explicit requirements obtained from customers are converted into an initial design where the steps of solving a problem are agreed. The design is explicit knowledge as it has to be understood by the innovation team.

Collecting data
"Collecting data" explains how the development team, the supplier with or without the customer, can "acquire explicit and tacit knowledge from external sources" (Messa and Testa, 2004) regarding problems and solutions. In the model, collecting data allows the company to obtain data from reports and surveys, and from individuals and groups within customer involvement. However, for this data to be useable by the company, it has to go through the filtering process in order to obtain new knowledge.

It can be compared to the combination activity in Nonaka and Konno's Knowledge Spiral (see details in Table 4-1, page 150). Explicit knowledge is combined in different ways to obtain different sets of explicit knowledge. The result is not implicit knowledge, as is not yet in a form customized for the company.

Reflecting information
The focus of this concept is "learning by example" either on an organizational or group level regarding problems the development team faces, more often than not with the customer. Reflecting information consists of how the customer views the internal processes and development stages of the company. It is expected the customer will have a different perspective than the development team and, in this way, new ideas are obtained that can translate, to some extent, to new knowledge. It can be compared with the externalization of operational knowledge (see details in Table 4-1, page 150). The implicit knowledge of customers is externalized in the form of transparent and clear requirements that are explicit in nature.

Exchanging knowledge
In the model, exchanging knowledge is a way for the company to obtain new knowledge by trading existing knowledge. This activity is realized with external partners, such as other companies, experts and also with customers who can be individuals or organizations. By discussing with a more advised party, the knowledge obtained is

of a better quality. However, the customer's opinion remains the most important, the company simply has to know how to interpret it.

Knowledge exchange can be compared with a socialization of systemized knowledge (see details in Table 4-1, page 150). This can be explained by the company changing implicit knowledge into other implicit knowledge. Because the information obtained is more elaborate, it can be considered to be knowledge. When the company is willing to share more information, more information can be received in return. However, this can be in conflict with the policy of the company, as some of its internal processes are confidential and it may consider the downsides to outweigh the benefits.

Filtering knowledge
Filtering knowledge serves to separate the important from the unimportant, based on reasonable interpretations and argumentation. This is an activity that allows a better organization of knowledge, as new ideas from brainstorming and new data obtained from collecting data are converted into a format the company can use and base its decisions upon.

Filtering knowledge can be compared to an internalization of operational knowledge (see details in Table 4-1, page 150). It is internalization for the company because the knowledge obtained is customized for the company. Different companies can have different ways to organize and store the same data, depending on their field of activity and their internal processes.

Feedback
In this concept, the main focus is to understand the arguments and ideas of the customers or the participants and to learn and adapt to their point of view. The feedback obtained from customers allows a company to learn more about the market. The knowledge obtained by the company through different methods allows it to learn more about the environment in which it pursues its activity and about the perceptions of the customers.

Feedback can be compared to an externalization of conceptual knowledge (see details in Table 4-1, page 150); it is an externalization as the tacit information of the customer is converted into explicit information as it reaches the company. Feedback is an important source of information for the company as it can be offered quickly and by multiple participants in response to a public statement of a company or to a new product that was launched by it.

Table 4-1: Comparing activities with variables of the Nonaka & Konno Knowledge Spiral (1998)

Activities	Focus/ References	Involvement	Information for variable	Knowledge Spiral (Nonaka & Konno, 1998)	Explanation	Agents
Brainstorming	Tacit becomes explicit knowledge	Individual and group	Problem, Solution	Externalization (Conceptual Knowledge)	Externalization, in turn, refers to the way in which an individual transfers knowledge to others through a process of identification that leaves the personal self behind and embraces a group identity, which may refer to a team, a business unit or an organization (Nonaka & Konno, 1998). Through externalization the personal aspects of tacit knowledge are left behind, allowing for knowledge to transcend individual purposes and intentions and to be used for shared objectives (Nonaka & Konno, 1998).	Customer and employee involvement
Structuring Problem	Translate a set of conditions into a set of problems, issues and questions sufficiently well-defined to allow specific research action (Woolley and Pidd, 1981)	Individual, group and organization	Problem, Solution	Combination (Operational Knowledge)	Combination involves the conversion of explicit knowledge into more complex sets of explicit knowledge. In this stage, the key issues are communication and diffusion processes and the systemization of knowledge (Nonaka & Konno, 1998).	Customer and employee involvement
Collecting Data	Organizations can acquire explicit and tacit knowledge from external sources (Messa and Testa, 2004)	Organization, group	Problem	Combination (Systemic Knowledge)	Combination involves the conversion of explicit knowledge into more complex sets of explicit knowledge. In this stage, the key issues are communication and diffusion processes and the systemization of knowledge (Nonaka & Konno, 1998).	Customer and employee involvement
Reflecting Information	Obtaining customer requirements in an applicable form	Individual and group	Problem, Solution	Externalization (Operational Knowledge)	Externalization, in turn, refers to the way in which an individual transfers knowledge to others through a process of identification that leaves the personal self behind and embraces a group identity, which may refer to a team, a business unit or an organization (Nonaka & Konno, 1998). Through externalization the personal aspects of tacit knowledge are left behind, allowing for knowledge to transcend individual purposes and intentions and to be used for shared objectives (Nonaka & Konno, 1998).	Customer involvement
Exchanging Knowledge	Sharing language, tacit knowledge becomes meaningful	Individual, group and organization	Problem, Solution	Socialization (Systemized Knowledge)	Creating and sharing language, tacit knowledge becomes meaningful to other team members. Socialization also enables critical readings to emerge; interpretations and argumentation to become part of the knowledge creation process, and for tacit to become explicit knowledge (Nonaka & Konno, 1998).	Employee involvement
Filtering Knowledge	Separate the important from the unimportant; interpretations and argumentation	Individual	Problem, Solution	Internalization (Operational Knowledge)	Internalization refers, on the contrary, to the transformation of explicit knowledge into implicit knowledge (Nonaka, Konno, 1998). Internalization is a process in which the individual realizes that explicit knowledge can be relevant to advance her own objectives within the firm; learning by example, training and exercises are changing routines which allow for individuals to access and appropriate explicit knowledge (Nonaka & Konno, 1998).	Customer and employee involvement
Feedback	Absorbing and providing arguments of participants to reflect, understand and learn, adapt or change point of view	Individual and group	Problem, Solution	Externalization (Conceptual Knowledge)	Externalization, in turn, refers to the way in which an individual transfers knowledge to others through a process of identification that leaves the personal self behind and embraces a group identity, which may refer to a team, a business unit or an organization (Nonaka & Konno, 1998).	Customer and employee involvement

A factor that makes knowledge transfer difficult is the size of the company, as a large size might be translated into substandard communication between departments. If mentors are responsible for guiding large numbers of employees, the knowledge transfer process may be hindered or inefficient. It is unreasonable to assume that knowledge will circulate naturally through organizations that have numerous departments and hierarchical levels, as innovators might find themselves to be administrators or too busy with operational assignments, as mentioned in the Synosia interviews; therefore, specific innovation groups and meetings are a company's best option when pursuing this objective.

When a group of individuals start to solve a common challenge, each of them uses the mental schemes and patterns he or she understands best. Such multiple perspectives produce intellectual conflicts and energy to be used for new ideas. The more possibilities offered, the more likely it is that an overarching perspective encompassing the most relevant viewpoints will be selected in order to produce an idea.

If individuals who have tacit knowledge important for innovation are discouraged from sharing it, they will do so. In companies where expertise is highly regarded, but mentoring and helping others is not, people will be inclined to hoard their knowledge and not give up the power that comes from having it, especially because sharing knowledge has a cost. That is why our diagram or qualitative model is centered on rewards for exchanging knowledge. This is especially important for activities that are not mandatory, such as informal communication between employees. In mandatory activities, however, such as training programs and workshops, sharing knowledge is at least expressly stated. A wider circulation of knowledge throughout the company is beneficial, because solutions can come from a greater number of places.

4.4 IMPROVED INNOVATION DIAGRAM

The causal loop diagram is improved by considering additional interviews from an ongoing innovation banking case study that was carried out after the two main case studies and background interviews. Interviews NL and RH are the discussions with employees from the banking case.

4.4.1 Banking case study quotes

The quotes from the interviews are used to determine whether the emergent theoretical model can be improved because of the new information available. The respondents were shown an initial version of the causal loop representation.

4.4.1.1 Brainstorming

Employee involvement
In the examined banking company, a way to accomplish brainstorming is through an innovation day:

"...was this innovation day, a full... a whole day with our main stakeholders, and of course the team, our product management team was involved, and some front stakeholders, too, and that was really important, to understand the client needs and the client, yes, the client view." (Interview 1 NL, p. 4)

"...we had this innovation day, and we have a best use group, called, this is an inside... a meeting that we have only every six or eight weeks, with front employees, say, or relationship managers, etc., and they give us, of course they give us also insights of what is missing, for example, in our bundle. What are... what the client would like to have in it, and so on." (Interview 1 NL, p. 10)

"And then we decided to run an innovation day to get some ideas." (Interview 1 RH, p. 3)

Brainstorming is realized at workshops, in which the development team tries to address potential problems customers may encounter:

"[In the workshops] ...we bring some client problems where we will highlight some problems, for example. Maybe sometimes we have some ideas so it can be both. Maybe I've raised an idea; or sometimes I say 'Okay, the clients will have the following problem; maybe you have a solution for the problem.'" (Interview 3 RH, p. 4)

In addition, brainstorming is also realized in meetings with participants from several departments:

"Also other colleagues... are working in this project, customer satisfaction project, and they had some insights from this study. ...we had several briefing sessions, and several brainstorm sessions." (Interview 1 NL, p. 11)

There is also "the voice of the business", which are meetings with employees that are easy to organize:

"...another idea is just to make, for example, a voice of business. I will invite, for example, 12 or 20 relationship managers over lunchtime." (Interview 2 RH, p. 3)

4.4.1.2 Structuring problem

Employee involvement

Structuring the problem is a way to better arrange the information obtained through brainstorming:

"And after the innovation day we tried to bring the ideas to innovation so then we had to analyze the ideas and started to divide the ideas into different categories." (Interview 1 RH, p. 3)

It is an important step as proper structuring will convince the management of the company to approve the planning:

"First was the planning, project planning, to get the buy-in from the management. Project planning with roadmaps." (Interview 1 NL, p. 4)

"Okay first we have to get our basis if you want, the basis of our product so we asked internally the product management and then they sent us a list with every product we have in our payment and savings department." (Interview 2 NL, p. 10)

However, the structuring process does not have to be too extensive as formal structuring may make the problem simpler than is actually the case:

"I don't want to make the solution by myself. If I do too much structuring, then maybe I will create an implicit solution." (Interview 3 RH, p. 4).

4.4.1.3 Collecting data

Customer involvement
This step is accomplished by the research department, by conducting individual interviews by phone and formally assessing customer satisfaction:

"...we were working together with our research department. They are doing analysis, every year they are questioning our clients and non-clients, and they ask us every year are there particular questions you have, and we can give them some particular questions." (Interview 1 NL, p. 7).

"And we had the second study, which was called customer satisfaction, so Bonviva customer satisfaction study, we wanted to know how happy are the clients with our products, especially our products, Bonviva and yes, that was also interviews with the clients." (Interview 1 NL, p. 9)

"Simply because when they are calling the people, when they make outbound they want to sell Bonviva, they explain it on the phone and then ask existing client 'do you want a contract, do you want to sign it?' They say okay and then they have to send the contract and there is a huge gap between sending the contract and then getting them back." (Interview 2 NL, p. 2)

Employee involvement
The marketing department also has a contribution to make in collecting data:

"[The banking study was done by] The inside client management. ...it's in marketing but in a separate department." (Interview 2 NL, p. 6)

"[Collecting data was accomplished by the] Client insight management of [the bank]. ...That's a team and they buy analyzers or they give the mandate to some other companies to run external market analyzers" (Interview 1 RH, p. 8)

Prototyping is a more elaborate way to collect data; however, the information obtained is quite customized and of high quality, as it concerns an early version of a product or service that the company will implement:

"The next step was, because we had the meeting with our senior management, and we wanted not only to show a paper based prototype, we wanted to show something real, on a screen, on an iPad, and we looked inside, in our bank, we have an IT department,

and we had some good contacts there, and so we could, we had a meeting with the IT guys, which provided us a really... a prototype on an iPad." (Interview 1 NL, p. 6)

"Okay; the IT did a lot in a really short time, first prototype, a good one, a good basis." (Interview 2 NL, p. 12).

"We started to summarize our knowledge in our team so I'm responsible for the product management bandwidth so for the package solutions and, yes, we ran several workshops with the product managers and then we had one external consultant with us. ... And then we had to design a prototype because without any prototype I was not able to discuss the idea from the beginning with my line management or with other managers in the bank." (Interview 2 RH, p. 1)

4.4.1.4 Reflecting information

Customer involvement
Reflecting information is accomplished by involving the customer to a greater extent, by showing him the product and asking his opinion. In this case, these meetings are called "the voice of the customer":

"So in former days we had a department doing voice of customer, and this voice of customer was basically usability tests. ...Usability tests with iteration to understand if the client is happy with the user interface and did he understand what he has to do and so on." (Interview 1 NL, p. 17)

"Voice of customer session is you have your end user, your client sitting with you in a room. Give them some duties to do; for example, you give them a duty, you have to buy a Bonviva bundle, you have to… how would you do it? ...We call them Use Labs." (Interview 2 NL, p. 15)

"[Customer involvement provided] ...improved product model, features, feature services and processes." (Interview 1 NL, p. 20)

4.4.1.5 Exchanging knowledge

Employee involvement
External experts can provide the company with a lot of high quality and unbiased knowledge. They can examine different sectors of the market and report back to the company:

"[External experts provide us with] Trends, Internet trends, trends on... Internet and also client behavior trends, in financing." (Interview 1 NL, p. 10)

"We had an external speech from an expert in innovation and online banking, and then we had several working groups with questions we had, and they worked then on these questions." (Interview 1 NL, p. 14)

"Yes we have lots of external analyzers. ...We have research, market competitor intelligence, market intelligence and voice of business, voice of customer analyzers." (Interview 1 RH, p. 5)

Exchanging knowledge can also be accomplished with internal colleagues:

"We exchanged knowledge with our colleagues from the front." (Interview 3 NL, p. 3)

4.4.1.6 Filtering knowledge

Employee involvement
In this company, filtering is done in a group and its importance is recognized:

"[Filtering is done] ...more in a group level during meetings or workshops." (Interview 4 NL, p. 4)

"I just received a white study from GFK and I get 160 pages in Excel so the thing is I have too much information and it's very important to have an idea what should I do with the 500 pages?" (Interview 1 RH, p. 7)

"It's like prioritization. Sometimes I have minus points and everyone gets, for example, three green points and three red points. And then everyone can make his point, make the point of what is important or what is not important." (Interview 3 RH, p. 3)

4.4.1.7 Feedback

Customer involvement
Feedback can come from the customer, after the voice of customer activity during reflecting information:

"I can prepare, of course, voice of customer with some feedback. But then it's more a workshop because voice of customer really means I present a problem and I get feedback." (Interview 3 RH, p. 8)

Employee involvement
Feedback can also be obtained from management:

"[We had meetings with management] two times a week ...and presented the progress and of course they gave feedback." (Interview 2 NL, p. 10)

Filtering knowledge can be realized after feedback, thus creating an iterative process:

"That's right and after the learning and feedback maybe I will enhance the solution, but change it a little bit. I will adapt, maybe, learning and feedback." (Interview 3 RH, p. 7)

The improved theoretical model that resulted from interpreting the quotes and codes from the interviews held with representatives from the banking company is presented in figure 4-2 (page 156) and the changes are described and discussed.

The improved causal loop diagram has another path toward new knowledge and innovation, and it consists in prototyping. The new ideas are used to create a prototype that is a preliminary version of a product or service. The reason why this is a new path is because it does not start with the requirements of the customers that are addressed and thus the company has new offerings with incremental or substantial changes based on market acceptance. Instead, a prototype is

presented that has to convince management to agree to release the product and customer involvement is carried out after that.

The prototype allows showing management an idea that has been developed and will be put into practice soon. The prototype can help management form an opinion of a product and service that is to be released, clarify misunderstandings and communicate possible concerns: *"And then we had to design the prototype because without any prototype I was not able to discuss the idea from the beginning with my line management or with other managers from the bank" (Interview 2 RH, p. 1)*. The feedback from managers can determine some improvements in the offering or they can accept it as it is. The difference between the initial and improved causal loop diagram is adding the prototyping loop (R7) that is placed between obtaining new ideas and implementing a solution.

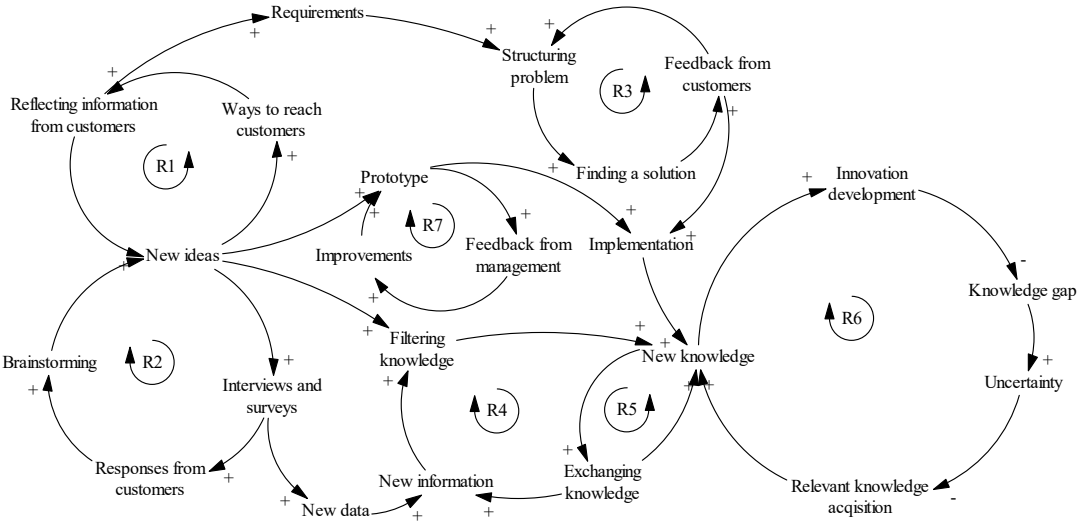

Figure 4-2: Improved dynamic hypothesis diagram

The banking case confirms the relation between new ideas and interviews and surveys from the original causal loop diagram that was, until now perhaps, too ambiguous. The ideas obtained through brainstorming can also be about how to interview customers and what to ask: *"… we were working together with our research department. They are doing analysis, every year they are questioning our clients and non-clients, and they ask us every year are there particular questions you have, and we give them some particular questions" (Interview 1 NL, p. 7)*. The output from the interviews and surveys is in the form of data that can be stored by the company.

The banking company has two specific ways to obtain information, the "voice of the business" and the "voice of the customer". The "voice of business" consists of informal meetings with employees and is represented in the model by brainstorming: *"… another idea is just to make, for example, a voice of business. I will invite, for example, 12 or 20 relationship managers over*

lunchtime" (Interview 2 RH, p. 3). The "voice of customer" is done by showing the customer an initial version of the product and asking him to give his opinion: "*So in former days we had a department doing voice of customer, and this voice of customer was basically usability tests… Usability tests with iteration to understand if the client is happy with the user interface and did he understand what he has to do and so on" (Interview 1 NL, p. 17)*. This is represented in the model in the form of feedback and this is a more complex response than completing a survey or stating a requirement because the customer can already know the look and functionality of the product with the help of an initial version and give his advised opinion by mentioning possible changes based on that.

4.5 KNOWLEDGE FLOW

Knowledge is an important determinant of innovation and the way it circulates through the company must also be considered and interpreted. The type of organizational structure also influences how knowledge flows and is distributed to departments and innovators. A company can be organized in numerous ways, but mechanistic and flat structures are considered the most representative cases and can illustrate the knowledge flow.

This interpretation of the knowledge flow addresses the statement in the SECI model of Nonaka and Konno (1998) that knowledge flows from middle management both upwards and downwards.

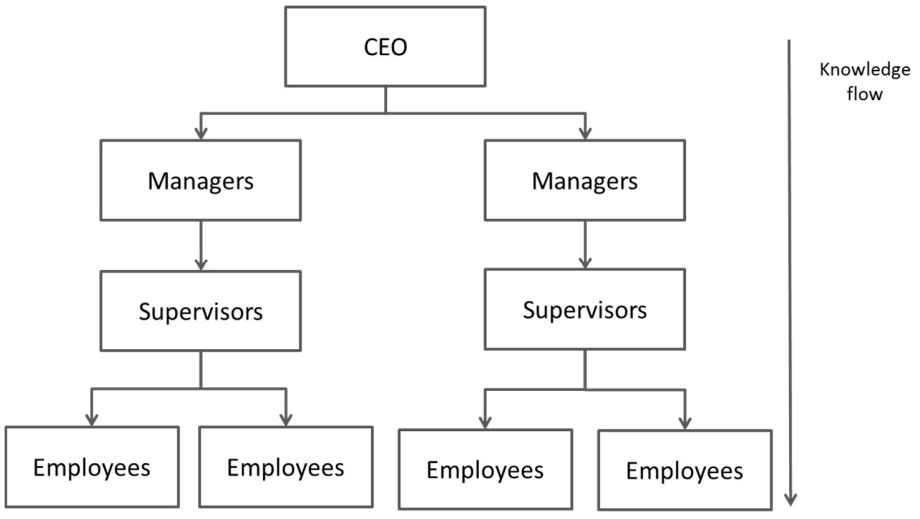

Figure 4-3: Mechanistic organizational structure

This is not true in all cases, as most companies have mechanistic structures where knowledge flows from top to bottom. In these organizations it is hard for individuals at the bottom of the

hierarchy to contribute with their own knowledge, or externalize it, as they have to follow the set routines and procedures of the company.

The activities of employee involvement such as brainstorming are a way to improve knowledge flow by making it possible to obtain knowledge from many sources. Mechanistic structures (Figure 4-3, page 157), or bureaucratic structures as they are also called, have narrow spans of control and high centralization and specialization. The departments are designed and permitted to undertake specific assignments regardless of choice.

The business operates based on standards and routines that determine all decisions and activities. This structure makes employees more accountable for their work, but introduces some obstacles for creativity, innovation and flexibility of the organization.

Flat structures (Figure 4-4), also called organic structures, have wide spans of control, decentralization and low specialization. The organizational structure is less formal than the mechanistic one but makes the hierarchy in the company difficult to identify. A positive aspect is that employees are allowed to try new things, develop as professionals and contribute to innovation.

This organizational structure can usually be found in start-ups, as they try to gain brand recognition and their success depends on the new offerings they introduce.

It cannot be said that one type of organizational structure is correct and another is wrong; this depends on the development and type of the company. A big company will not usually have a flat structure, as this makes control difficult. A mechanistic structure will make it clear who has the decision power. A company develops by scaling its business and making its growth sustainable, so this will require some routines and policies. A start-up will usually have a flat structure that will allow leaders to assemble a team and give a green light to projects quicker. Companies such as start-ups depend on innovations that can get them off the ground and a flat structure allows all team members to give their opinion and contribute.

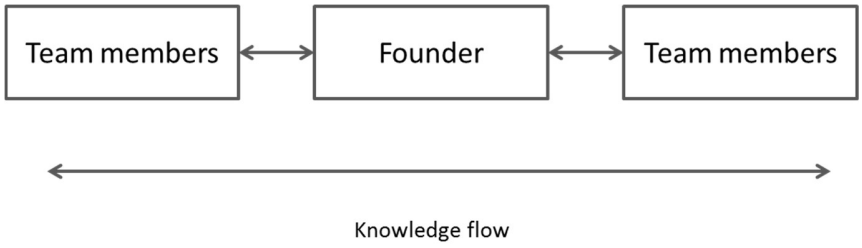

Figure 4-4: Flat organizational structure

In the mechanistic organizational structure that corresponds to big companies, knowledge flows from top to bottom. Employees have to use the knowledge of the company that is contained in organizational practices, procedures and routines. If the company has no innovation activities that include employees, it is most likely they will not work toward and contribute creative solu-

tions. In the flat organizational structure that corresponds to start-ups, the knowledge flows horizontally so that all participants are informed about the challenges the company is confronted with and they can contribute to the innovation process.

The company can involve employees in the innovation process by introducing some activities. As previously described, this consists of creating an innovation group that is separate from the rest of the company (Benner and Tushman, 2003) or developing processes and tools to support more novel ideas (Kelley, 2009). In the banking case some innovation activities were implemented in the form of an innovation day or "voice of the business" that considered the feedback from employees and used it for specific changes.

Companies with mechanistic organizational structures have a high degree of knowledge specialization that determines boundaries between departments and individuals. The boundaries can be surpassed with knowledge integration that is the interaction and recombination of knowledge from different individuals, disciplines and functions (Berggren et al., 2011). Knowledge integration is required to create new knowledge and to develop advanced products and systems that can transform the base of competition and support the innovation process.

In some instances, companies are finding it difficult to innovate because of their size; as a result, they contact smaller companies to undertake research for them. This has been identified in the case of Synosia, where Roche approached them to study a molecule: "*Big pharma tells us 'we envy you for being so small, nimble, flexible and taking fast decisions' …in big pharma companies that gets stuck in 10,000 reviews and you are significantly slowed down*" (Synosia 1, p. 9). In companies that are very big it is difficult to conduct innovation activities, so the small companies are a solution: "*Let's say Roche, they could say 'we just give up on our own research, so all that we do is send out scouts to find highly innovative approaches outside, then we acquire the rights to that approach'*" (Synosia 1, p. 10).

It may seem counterintuitive that big companies have the most difficulties to innovate, because they have the most employees and the greatest resources. The interviews confirm that this is true, as big companies have inflexible organizational structures and strict procedures. Putting together an innovation team is more difficult than it appears if the company has never done it before and does not have the guidelines to do so. Implementing an innovation or a new process in a big company is also difficult because it requires a number of approvals from different individuals that may have distinct priorities.

Companies such as start-ups can obtain innovation much quicker; this is also demonstrated in the background information interviews. In the VOIP interview, a team is put together that has the objective of creating this new product: "*I founded the company with 15 people from my team in those days called Media Strings. We developed the new enterprise VOIP suite from scratch*" (VOIP Enterprise Solution, p. 1). In the Internet case, the interviewee is chosen to lead a new team: "*So I was talking with BBN and I was talking to FCC and I concluded that the only thing to do was to start it in Ontario because I had approached AT&T and they said they wouldn't take over. So, BBN thought about it and started a company to do that, Telnet. And they wanted me to run it*" (Internet Telenet 2, p. 2). This pattern confirms that individuals who wanted to obtain an innovation created new companies with flat organizational structures. Companies such as start-

ups do not have the knowledge specialization problem because the team members communicate well with others and are motivated to do so. Big companies have the knowledge specialization problem, but they can surpass it through knowledge integration. This can be carried out by forming teams with individuals from different departments, with distinct specializations and ways of thinking. This will improve the knowledge flow in the company by letting employees communicate what they consider to be important opportunities.

Obtaining innovation also requires knowledge integration that is carried out through specific innovation activities such as creating an innovation group or organizing an innovation day to collect feedback from employees and partners. This has been confirmed to be true in the case studies: "[*Innovation is obtained with] diverse thinking people. So, if you only have a dialogue with the same skilled people you have less innovation than if you start mixing cultures, skill sets…"* (Interview Avaloq 1, p. 8). This requirement must not be confused with a guarantee, as big companies can find it difficult to innovate, as identified in the Roche interview where some research was outsourced to Synosia because it was a smaller company.

It has been illustrated in this section that the organizational structure and the size of the company determine the knowledge flow and its visibility to individuals from different departments and partners. Changing the organizational structure results in changes in the knowledge flow and in the degree of knowledge integration. Companies such as start-ups have a suitable knowledge flow for obtaining innovation as they are motivated to achieve it. Big companies can surpass knowledge specialization and improve its flow by implementing policies and procedures that support communication and involve a diverse number of people with different functions.

4.6 Diagram of Knowledge Conversion

The process of knowledge conversion presented in Figure 4-5 (page 161) illustrates the transformation from information to knowledge. This is based on the principle of assimilating information that is useful and applying it to obtain solutions. The solutions can be about addressing a customer problem, improving a product or process or creating new offerings so they are conceptualized to be general in nature and they address a variety of situations.

The process of knowledge conversion starts with collecting information and filtering it based on the following criteria: relevant, recent and applicable information. The filtering is done in this specified order so, initially, the relevant information for an industry or market is chosen. From this amount of information, the second filtering step is to choose what is recent because old information can be obsolete and already implemented by competitors. This does not mean that old information is useless because a production process or service routine can be introduced even if it is old if it is of high quality. It can be said that at least most of the filtered information has to be recent. The third step is to sort the information based on applicability so it must be possible to put the information into practice and the company must be able to pay the cost to do so. Filtering will, predictably, result in applicable information that can be used at a later point. Individuals also filter information in this way as they better retain what is relevant, recent and applicable.

The applicable information is then used in the structuring problem activity (R3) that is like design and can also be interpreted as structuring a solution to a problem. The structuring will result in a sequence of stages that represent a solution to a problem. In order to illustrate this idea, we can make a comparison with a programmer who wants to write a code that can undertake a specific task. The programmer has the applicable information in the form of instructions, but he has to include them in a specific context to solve the task. To design a solution means to settle on an architecture of the program that has a sequence of stages. The structuring of a problem is conceptualized in the same way in the case of creating products, services and also processes.

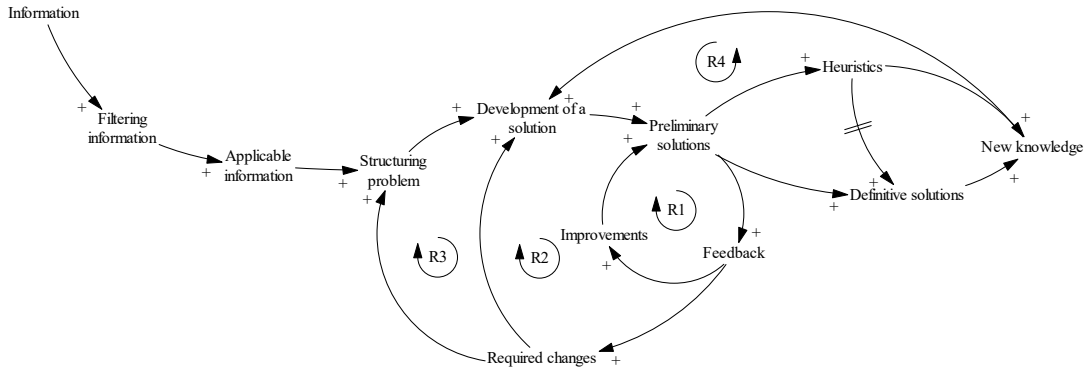

Figure 4-5: Knowledge conversion diagram

Once the design has been agreed upon the next step consists of development (R2) that can be carried out. Development is the step that takes the most amount of time as it can require significant work to complete the product or service. This step illustrates the importance of action in obtaining knowledge and agrees with the definition of Zeleny (1987): “Knowledge… brings forth from the background of experience a coherent and self-consistent set of coordinated actions”, so “knowledge is action, not a description of action.” Since knowledge is action, the best way to obtain it is through action and the model illustrates this by considering the step of developing products and services.

The issue of applicability is also mentioned by Ackoff (1989) who describes knowledge as the “application of data and information, which answers ‘how’ questions”. The model is consistent with this interpretation as it considers applicable information as a way to obtain knowledge.

If a preliminary solution has been found, it is shown to the customer and feedback is communicated. The process of improving a solution iteratively based on feedback has been discussed and it also applies to this model of knowledge conversion. The difference, here, is that the feedback can concern only small improvements (R1), or the offering can require significant changes until it is released (R2 and R3). In this second case, it is required to revisit the design and development step and make changes based on feedback.

Identifying solutions increases the knowledge store of the company. The solutions can be intermediary such as heuristics or definitive that can be difficult to change. A heuristic is any approach of problem solving that employs a practical method that is not guaranteed to be optimal but which is, nevertheless, sufficient for reaching an immediate short-term goal. Heuristics can be applied both by individuals and companies. The process behind creating products and services or organizational ones can be heuristic if they have potential for improvement and the company is actively pursuing this. A definitive solution can be a process or routine that is considered suitable and is not a priority to change.

The knowledge conversion model has been tested by carrying out the last round of interviews with professors and managers who were responsible for innovation. The responses were useful as they allowed the addition of variables and causal relations or adjustments to be made.

It was identified that "knowledge is not a static component, but translucent and keeps changing, it has different degrees and always depends on context" (Frederick Gregaard, p. 3). In that interview it was suggested to have arrows coming back from knowledge to the problem (R4). This was considered a valid approach as the internal knowledge of the company is used when designing or developing a solution. The causal link between New knowledge and Development of a solution was subsequently added (R4).

Some responses were helpful in adjusting the model structure: "…I think it's not as linear and sometimes you may have a problem and then try to find the applicable information" (Professor Fanny Simone, p.3). This is correct as employees search for information after they are presented with a problem, but the priority in this model is to illustrate how information is converted to knowledge, hence the reason for the linear approach.

Another contribution of this interview was to point out that "…boundary objects can have embedded knowledge. In the case of medication, you are testing your object without really knowing what knowledge it has" (Professor Fanny Simone, p.3). This is also true when the company uses external software, designs or processes, as it first has to obtain the embedded knowledge required for operating with such objects before creating a solution.

The interviews generally approve the iterative process of finding a solution through feedback: "In that process you will go to different steps, to receive feedback, to improve the idea, to make it evolve and to turn it into something that gets you closer to identifying the solution that you may want to put together" (Professor Martin Cloutier, p. 4). Another respondent had this to say on the subject: "You need to gather the feedback and you will need to change your initial thoughts, initial ideas or design of the solution" (Ruth Mojentale, p. 2).

The idea that the knowledge flow is influenced by the organizational structure has also received some support: "If you have several hierarchical levels that have to be overcome by an innovation team or by a great idea itself, of course it might get filtered out or blocked by one of the lower levels" (Ruth Mojentale, p. 6). This response also agrees with the differences between big companies and start-ups in developing new solutions that were identified in the initial interviews with respondents from Synosia.

The question “Is including heuristics an intermediary step toward knowledge?” caused some confusion and the respondents needed some clarifications before answering. This contributed to realizing that heuristics are not a step toward knowledge, but knowledge in itself. A heuristic is a practical solution that has to be created in a specific time interval and with incomplete information; it is, nevertheless, sufficient for answering a problem. Heuristics, thus, contribute to new knowledge and also to definitive solutions but, in this case, a lag indicator has been introduced to show that this functions in the long term only. This causal loop diagram illustrates that companies obtain knowledge from information by working on something real, concrete and identifiable, such as a product, service or process, as opposed to thinking in the abstract. This real solution allows the company to collect knowledge by adjusting it according to feedback and implementing it.

4.7 REVISED INNOVATION DIAGRAM

The revised innovation diagram (Figure 4-6, page 164) has been constructed by considering all the case studies, background information and specialist interviews to arrive at a greater and more comprehensive perspective. The reason behind constructing the model is to show that there is a longer process between new knowledge, invention and innovation. Obtaining an invention is an important step but is not an innovation until the company succeeds in distributing it, commercializing it and gaining the acceptance of the customer.

The loops in the innovation diagrams were originally labelled with a “+” but this was changed to an “R” for reinforcing feedback loops. This is in line with Sterman (2000) and enables numbering the loops individually and, thereby, to refer to them in the text.

The interviews with specialists made it possible to revise the model by adding the path between invention and innovation. However, by reading all the transcripts, quotes from older interviews were identified that also described this path; hence, the reason for including quotes from all interviews.

In this version of the causal loop diagram, knowledge flows have a positive influence on invention. This is consistent with the previous section, as knowledge flows are determined by the size and the organizational structure of the company. It is best if the knowledge flows are unrestricted and bidirectional. This is simple to achieve in the case of start-ups, but big companies can also have this transfer if they create innovation teams and good communication between departments and individuals.

Obtaining an invention that has the potential to be an innovation is often an interdisciplinary problem that requires a diverse team to address: “...basically our interdisciplinary approach enabled us to solve a problem which others couldn’t solve for over 30 years. Our approach comes from the combination of robotics with image processing…” (Dacuda Mouse Scanner 2011, p. 1). This is the reason why knowledge flows are important, as they allow communication between individuals with different ways of thinking and specializations who can achieve something new and valuable if they collaborate.

It can be argued that the organizational structure is the context in which innovation is carried out. It can support or ignore innovation depending on the objectives and priorities of the company. The generating mechanisms of innovation are the specialists working to attain it and the new knowledge and this is in line with Pawson and Tilley's (1997) equation: Mechanism + Context = Outcome. The interpretation also agrees with the critical realism that is the ontological and epistemological approach of this research.

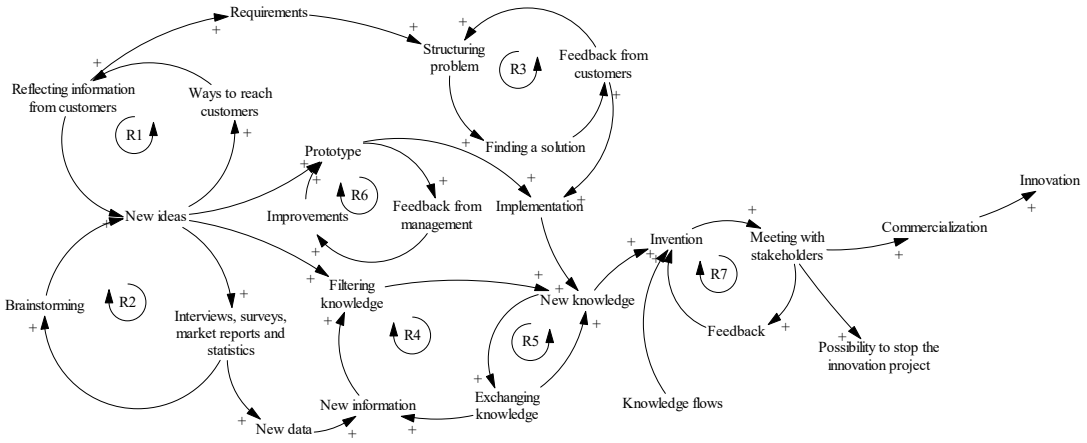

Figure 4-6: Revised innovation diagram

The revised innovation diagram adds to the previous versions the invention loop (R7) that is placed between new knowledge and the commercialization phase or launch. This allows a more comprehensive perspective of the innovation process as it includes the possible requirement of securing funding and meetings with stakeholders.

Once the prototype is complete the next important step is pitching it to investors with the hope to secure funding (R7). Investors can be from inside the company: "So, we tried, in IBM, we tried to find partners there. So, we presented, at that time we still had a division for PCs, they tried to sell it to the PC division..." (IBM Millipede 2011, p. 6). Investors can also come from outside of the company: "...we actually looked out for external partners that would be in the area. Eventually we found one." (IBM Millipede 2011, p. 7). The invention can still fail if the partners withdraw or if the market does not accept it: "The people were very proud of what they achieved but they also had to say it was good but not good enough for the market." (IBM Millipede 2011, p. 8).

Companies such as start-ups usually do not have the resources for a wide launch of their inventions, so they depend on investors to do so. The business context also has an influence: "It was a very difficult time to finance the company because after the end of 2000 it was very, very difficult to get start-up money for software companies." (Enterprise VOIP 2011, p. 2). The invention can be a functional version of a product but is not completely developed: "Start-up teams usually

don't have enough money and investor relationships to wait until they finally develop the product" (Enterprise VOIP 2011, p. 3). The invention must register some profit from a limited release in order to convince investors to join the venture: "In the software industry they do not believe in many years of pre-financing so you have to make some success in the market before you finally develop the product" (Enterprise VOIP 2011, p. 3).

The invention is a more advanced version of a product than a prototype because it has some functionality. It is preferable if the company can launch the invention through a limited release in order to convince investors that the product can turn a profit. If the investors do not join, they can still give some feedback that could be useful to adjust the product in order to increase its market acceptance. If the investors join, the company can prepare for a wide commercialization and see how the customers perceive it. The invention may not need investors if the company has the resources for manufacturing, distribution and promotion, but this case is less likely than the other one. If the invention is widely distributed, accepted by the customer and turns a profit, it is an innovation. The process that started with information, turned it into knowledge and continued with an invention concludes with achieving the innovation objective.

The revised innovation model was tested in a similar way to the knowledge conversion model to arrive at a definitive version. Five interviews were used to do this, two with university professors and three with innovation practitioners. The interviews allowed to adjust the structure of the model and the naming of the variables, in cases that were appropriate. The instances where changes were made because of the interviews are specified.

One respondent had this to say about the iterative nature of innovation: "You basically live by innovation and you give it away to somebody else and then they take care of it but if it's a product you own it should never be regarded as finished. It should be regarded as in constant motion" (Frederik Gregaard, p. 9). This is true in financial services, where modifications have to be made because of client companies or legislation. An argument can be made that there are also instances where a company has to release an initial version of the product to have a turnover and to pay stakeholders. The model has to show the most general case and its structure reflects this.

The responses also concerned the feedback received to an invention: "The impression that you only have feedback from investors is not true. When you try to develop your innovation you will have feedback from a lot of people, people who mainly have the industry to produce your product, feedback from sales persons, feedback from your marketing department trying to do your communication… "(Professor Fanny Simone, p. 8). This comment determined changing the variable Meeting with investors to Meeting with stakeholders to make the model more general and to include all relevant individuals.

The distinction between invention and innovation was interpreted as: "…you might have a good invention, but you might have a very unqualified marketing team and they are not able to commercialize the invention" (Frederik Arns, p .8). This comment requires some clarification to the terminology of commercializing an invention. In this model, commercialization does not refer to marketing, but to being able to secure funding and produce a solution and then having that solution accepted by customers. This sequence of stages allows an invention to become an innovation.

The comments also revealed that the feedback loop can stop if the invention is not accepted: "You think there is money to be made out of that and the answer is not always the same; sometimes yes so you will continue; sometimes, no, nothing will happen. So, therefore, you hit the wall and the feedback loop breaks down because there is no perceived commercial potential" (Professor Martin Cloutier, p. 18). This is true, as sometimes the invention is not good enough for the market, as the quality could be inferior to its competitors or the costs to produce it could be too high.

The question was, then, how to illustrate that the feedback loop can stop without using an ambiguous causal link. The relevant literature states that an ambiguous polarity usually means that there are multiple causal pathways that have to be represented separately (Sterman, 2000). This resulted in adding the unambiguous causal link between Meeting with stakeholders and Possibility to stop the innovation project. The model now shows that it is possible through meetings to obtain the feedback needed to improve an invention, but it is also possible that the invention will be shut down if the idea is not sufficiently good or it is difficult to implement it.

4.8 SUMMARY

Inductive coding with NVivo provided a generic diagram to explain the mechanism of customer involvement and employee involvement and that supports the development of innovation. This mechanism involved seven primary activities or routines that were identified through coding and interpreting the interviews: *Brainstorming*, *Structuring Problem*, *Collecting Data, Reflecting Information*, *Exchanging Knowledge*, *Filtering Knowledge* and *Feedback*.

Analyzing the interactions between customers and suppliers with NVivo through inductive coding involved transferring codes to the feedback loop model. The emergent diagram is based on these feedback loops. The customer involvement is noticeable because all seven routines, to a greater or lesser extent, involve the customer. The involvement of employees is also presented, either directly or indirectly, through the interaction with the customers. There are different ways in which these routines contribute to knowledge collection and innovation: some have a direct contribution, some offer data or ideas that have to be transformed into knowledge, while others improve the quality of the data acquisition process. This will close the knowledge gap between what is required and what is available for creating an innovation.

The seven routines of customer and employee involvement were compared to the variables in Nonaka and Konno's (1998) knowledge spiral. This was in order to examine how routines contribute to knowledge sharing. Some companies do not have incentives for sharing knowledge within the company, which makes the process even more difficult. It is important for information to be distributed throughout the company. This can be done through workshops, training sessions or other routines, in both a formal and informal way. Offering a significant amount of information to employees is risky, because companies have confidentiality policies, but this is also a way in which innovation can be attained.

An improved innovation diagram is presented that includes a banking case in addition to the other interviews. This illustrates prototyping as a way to obtain knowledge. The next section presents how knowledge flows through a company depending on its size and organizational structure. A model of knowledge conversion is then described that is based on filtering, assimilating and applying information in an iterative process of creating solutions.

A refined diagram that is constructed based on all the interviews is described. This has some changes in order to specify the path from invention to innovation that has some challenges that have to be overcome, such as wide commercialization and also securing funding for developing a product until being accepted by the market. How all the models have been constructed has been discussed; codes and quotes from the interviews have been indicative and helpful for this purpose.

The next chapter brings together the findings, hypotheses and models of this research and discusses how the information acquisition, knowledge flows and customer and employee involvement should be set up in order to support the innovation process.

5 DISCUSSION

5.1 INTRODUCTION

Businesses that understand the information acquisition process associated with innovations can have a better grasp of the process behind their successful development. Innovation provides promising business opportunities (Leifer et al., 2000; Morone, 1993) but, at the same time, entails high degrees of complexity. Information acquisition supports the development of innovations, regardless of the industry in which the company operates because it has a role in closing the knowledge gap. For the purpose of innovation, organizational advancements are just as important as technological ones. Therefore, the study sought to answer the following research question:

How does information acquisition support innovation?

In order to answer this research question, it was broken down into two supporting sub-research questions:

What are the main activities associated with customer and employee involvement that determine innovation as a process?

What are the routines and dynamics of customer and employee involvement?

Customer involvement manifests in a different way across industries. Employees also have a contribution to make in information acquisition, either directly or indirectly, by collecting, managing and improving the information from the customer. Including customers in the innovation process is a way to surpass the lack of information associated with uncertainty so that the company knows what it has to do and the requirements of the public.

The information defect, defined as the difference between the information required for innovation and the information available to the company, has been discussed in the literature review. This information defect can be solved by integrating the customer directly in the development of innovations (Spender, 1993; Mullins and Sutherland, 1998). In order to obtain meaningful information that can be applied and consulted, this customer involvement cannot be limited to telephonic interviews or surveys. Customers have to provide their own feedback or ideas about new products after examining them directly. Some companies have already begun to reach customers in this way, by means of workshops or changing routines called “the voice of the customer”. In this way, customers have a chance to involve themselves more extensively in improving a product or service they already use.

Seven routines related to gathering information and transforming it into knowledge were identified and chosen for inductive coding: Brainstorming, Structuring Problem, Collecting Data, Reflecting Information, Exchanging Knowledge, Filtering Knowledge and Feedback.

From these, an emergent innovation model was constructed. An improved innovation model is then illustrated that includes the banking case and adds the development of prototypes as a step

toward creating new products and services. A knowledge conversion model identifies the path from collecting information to obtaining knowledge. The revised innovation model is then presented that is constructed with the help of interviews with managers and innovation specialists. This includes a path that stretches from invention to innovation which can require investor funding, market acceptance and business knowledge so that a new offering can be called an innovation. Commercializing an invention and obtaining success on the market is the last step in the complex innovation process. The models have thus described the complete process that begins with information acquisition, continues with knowledge conversion and developing an invention and concludes with obtaining innovation.

Obtaining the routines through inductive coding, constructing the models and interpreting the findings are presented in more detail in the next sections. The individual routines will be discussed first, as they are the building blocks of what the study sought to accomplish. The findings will be discussed next, and consist of the models that include activities of customer and employee involvement for information acquisition and knowledge conversion.

5.2 DISCUSSION OF ACTIVITIES AND ROUTINES

This section describes the activities of customer involvement that determine innovation. The activities support information acquisition and knowledge conversion that are a part of the innovation process. Feedback loops are presented as they explain the dynamics between the activities.

Concepts and ideas from system dynamics such as feedback loops can be useful to understand organizational learning. Since organizations are complex and dynamic, ordinary cause and effect models cannot be applied to understand learning activities in companies. The organizational learning process and the social reality in which it is included contain circles of causality. The system dynamics perspective allows seeing organizational learning as the overarching and complex process it really is.

Information acquisition and knowledge conversion are part of the innovation process and are also a learning process. This is true because learning consists of the accumulation and storage of knowledge (Levitt and March, 1988). Organizational learning cannot be carried out without individual learning (Argyris and Schon, 1978). This is why employees are important in collecting information and converting it to knowledge. However, organizational learning is not the sum of the employees' individual learning. Organizational learning must be accepted by all the hierarchical levels and is included in the routines, procedures and practices of the company.

Learning also results in an adaptation capability that has to be discussed further as it is important in the context of this research. Learning in organizations is described as a process that allows individuals to successfully react to external and internal environment changes (Argyris, 1977). Thus, organizational actors detect and correct errors to ensure the normal functioning of the company. Contingency theory also views companies as open systems that adapt to environment changes. Organizational learning is usually viewed in the literature as an adaptation process. The adaptation component of learning is illustrated in this research as the possibility to change routines when the environment demands it or if there is an advantage in doing so.

The ability of a company to change its routines is commonly linked with dynamic capabilities. The concept of dynamic capabilities is theoretically fragmented as there are multiple definitions with separate approaches and interpretations. The most used definition unifies several diverging perspectives and states that a dynamic capability is a learned and stable pattern of collective activity through which the company systematically generates and modifies its operating routines (Zollo and Winter, 2002). This means that dynamic capabilities are activities obtained through learning that make it possible for a company to create and change its routines. Dynamic capabilities are thus comparable to knowledge if they are obtained through learning. This knowledge makes it possible for the company to act and be adapted to the environment changes by adjusting its operational routines for this purpose.

In the literature, the importance of involving the customer for innovation is already stated. Suppliers are not able to find the relevant knowledge in the market regarding the development of innovation, so they integrate the opinions of customers in order to close the knowledge gap (Spender, 1993; Mullins & Sutherland, 1998). This is in line with the results of this study, as the contribution of customers is expressed in knowledge that can help innovation. Customers can aid suppliers in the development or co-development of required solutions (Slater & Narver, 2000). Improving the processes of the company is also a priority which is why involving customers successfully allows the company to improve its organizational orientation (Tidd, 2001). However, the means through which the process of involvement is carried out are not explained and detailed. That is precisely the focus of this study, as it identifies the activities through which customer involvement appears.

Customers lack the knowledge needed for expressing problem statements in a usable way (Cohen & Levinthal, 1990) which is why a simplistic approach of simply asking for their opinion is not feasible, as it will not provide the company with the information needed. Common activities of interaction include exchanging information, group problem solving and testing (Laage-Hellman et al., 2014) and this study expands on these concepts. Customers must be involved throughout the development process, so that they can see both the reality of what happens in the company together with the reality of their preferences and seek to find some common ground. The following activities are ways in which customers can be involved, in order to obtain useful information from them that can be converted into the knowledge required to obtain innovation.

It is also important to describe how the main codes or activities were obtained from the transcribed interviews. The interviews were based on the case study methodology in order to locate the objects of analysis. This was undertaken by framing a set of questions that shed some light on the principles of customer involvement, employee involvement and innovation. It was expected that the answers to these questions would differ between respondents but, by collecting a large number of interviews, some common trends could be identified.

The background information interviews were of an exploratory nature and could be adapted along with the case study protocol and the interview guide. The two detailed cases, from the companies Avaloq and Synosia, were chosen on the basis of their relevance to the research area of interest, theoretical importance and geographical location. The objective of these two cases was to identify the influential effects of the main codes or activities. By interviewing individuals

from companies that had already achieved innovation, it was possible to find the principles that have supported and enabled it.

The study employs case-based research followed by qualitative modeling in the form of causal loop diagrams. The interviews were inductively coded. The purpose of sub-codes was to clearly state the notions the codes included.

Semi-structured interviews with executives involved in the innovation of their respective companies sought to identify precise information about innovation, the strategic context of innovative development and the characteristics of customer involvement. For Avaloq and Synosia, three interviews were carried out in order to obtain detailed information. The schedule and interviewees for these companies have been previously specified. The questions for each interview have also been specified.

The notions collected from the interviews were matched to the key concepts of innovation and knowledge management. The codes obtained were refined to identify similar repeating instances, until further refinement did not lead to any improved identification of instances. As soon as the final tree of pattern codes became stable and robust enough, the tree codes were named, forming the main codes. These codes contributed to the theoretical basis needed to explain the role of customer involvement and employee involvement in innovations.

After three interviews with each of these two companies, the main codes were found to be brainstorming, structuring problem, collecting data, reflecting information, exchanging knowledge, filtering knowledge, and feedback.

After the first cases were conducted and the first categories of codes with their coding strategy were defined, the interview questions were adjusted. The findings and lessons learned during interviews 1, 2 and 3 led to a revised interview format for the remaining cases.

The data were analyzed both within-case and cross-case. The advantage of single cases was that it allowed for the large amounts of data collected to be separated into more manageable units. The advantage of cross-case data analysis was that it allowed the comprehensive understanding of the phenomenon under study. It enabled selection and categorization of the data in order to identify the main aspects of the main codes. The purpose was to examine the proposed components of innovation and the potential of each component to determine and support it.

Information acquisition and knowledge conversion form a learning process that can be routinized. This learning process includes assimilating information from customers and using it to create new knowledge as opposed to acquiring it from another source. The learning process is the first part of the innovation process and it is possible to routinize this through the activities that have been identified.

The activities are first presented in a general way in order to broadly give a definition to them. The “Integrative discussion of identified activity with relevant literature” section states how they are related to the customer involvement and innovation literature. The “Placing the activity in the innovation process” section illustrates how each activity is positioned in the model and the

arguments for doing so. This positioning of the activities gave the first insights on model construction.

5.2.1 Brainstorming

Osborn (1953) presents a number of procedures that can be used for problem solving, including brainstorming for the creative collaboration of groups. Four guidelines are stated that are necessary for the brainstorming process to be efficient:

- There is no criticism until after the session;
- participants are free to suggest outlandish and wild ideas in order to enable creativity and because there are instances where it is possible to adjust these ideas to be realistic;
- there is an emphasis on quantity, as the more ideas that are presented, the likelihood of finding good ideas increases;
- participants are free to cooperate and build upon somebody else's idea.

Brainstorming was compared to an alternative group approach centered on group evaluation, in a study conducted by Meadow and Parnes (1959), and it was found that it enabled more quality solutions to be found, with respect to the other approach.

There is also a variation of brainstorming called the nominal group technique, in which participants write their ideas anonymously. Subsequently, all the ideas are collected by the group leader and each voted upon. The ideas that receive the highest number of votes can be sent back for further brainstorming. The idea can also be subdivided into segments for groups of participants to work on each segment.

An empirical comparison between nominal and real brainstorming groups has been made by Taylor, Berry and Block (1958) who found that if individuals work alone, they minimize the loss of ideas possible in real interacting groups.

Factors can also negatively affect the brainstorming process. One of these is social loafing, defined as a reduction in motivation and effort when individuals work collectively compared with when they work individually or coactively (Karau and Williams, 1993); this results when there is a loss of personal accountability for performance. If participants think they will not be held accountable for the results, they reduce their productive output. In this way, people can rely largely upon an individual out-performer in the group (Kerr and Bruun, 1983).

Another factor that can reduce the efficiency of brainstorming is the matching of effort. If participants feel that they are performing better than their teammates, they will reduce their contribution to match involvement in order not to carry any non-contributors. This is true even if under-performance is only perceived or if the teammates offer excuses or justifications.

Osborn (1953) specifies the attributes of a group leader or facilitator, to oversee activities before, during and after the meeting. The activities consist of making sure the guidelines are in place and encouraging all participants to play an active role. The group leader is also responsible for directing the conversation in productive and relevant areas, in order to maximize the number of ideas presented and to record them quickly and accurately.

5.2.1.1 Integrative discussion of identified activity with the relevant literature

In product development, the focus has changed from transactions to the relationships companies have with their customers and other interested parties (Gummesson, 1999). If these relations are managed properly, the company can mitigate its inadequate performance (Priluck, 2003). Innovation development based on relationship marketing goes beyond mere quantitative market research and recognizes the interaction between parties as the most important source for knowledge creation. Customers are the most frequent source of product ideas for business products (Hanna et al., 1995).

In short, understanding customers has proven to be critical for successful new product development (Lagrosen, 2001). The most useful tools for new product development have been identified by Nijssen and Lieshout (1995) as: generating ideas, optimizing products, optimizing the marketing mix and prediction. The first tool, idea generation, is based on brainstorming and other instruments, such as synectics and morphological analysis.

Brainstorming with customers or employees is a type of knowledge conversion and allows for tacit knowledge to pass through the continuum to become explicit (Nonaka and von Krogh, 2009). The customers' tacit knowledge about using a product for a long period can become explicit. The tacit knowledge of employees can also contribute to more explicit knowledge on which to base innovation.

Brainstorming with the customer is essentially a type of co-development, demonstrated to be the best choice for new technology products (Neale & Corkindale, 1998). However, in the case of products with a great number of consumers, involving them all in the development process is not a feasible way forward. A possible solution to this problem is to develop a close relationship with a select number of customers who can participate actively in the new product development process, while other customers provide information through market research.

5.2.1.2 Placing the activity in the innovation process

Brainstorming with customers is one of the main ways in which a company can improve innovation development. By obtaining information directly from customers, the company already knows how at least a part of the market will react when a new product is released. That is true if the sample of customers chosen for brainstorming is representative for the actual number of customers. However, issues can remain regarding problems or deficiencies the product or service might have before mass commercialization is viable. In this way, brainstorming is a source of new ideas that originate from employees or customers. Brainstorming is also influenced by feedback, as the ideas for solutions must address the problems identified through customer feedback.

5.2.2 Structuring Problem

Good problem structuring will be continued by planning. Planning and setting priorities are a means to integrate the values and judgments of the people concerning perceptions and importance, with raw data (Zalot and Lussing, 1983).

An approach towards structuring the problem is presented as the Strategic Choice Approach (Friend, 1989). This has been steadily gathering support among decision makers and has become widely taught in management, policy and planning schools. It consists of four basic principles:

- Shaping: the process of identifying the problem areas;
- designing: recognizing what can be done, looking at possibilities and drawbacks;
- comparing: making a comparison between different alternatives or paths, in order to reach the best possible way forward;
- choosing: one path to solve the problems, by constructing a plan of action and identifying any vagueness.

At the planning stage, there is an impetus toward designing, shaping and comparing modes. Exploring the decision space through mapping techniques is a way to develop the broad problem tree. At the strategy level, comparing and designing are explored, after ranking strategy areas and evaluating them at an area level in order to determine the best solution applicable for a certain situation.

5.2.2.1 Integrative discussion of identified activity with the relevant literature

A number of strategies are used to structure the problem and ensure that the right problem is being approached (Mitroff, 1998). These consist of selecting the proper stakeholders in order to ensure that a multitude of views are considered. The problem must be phrased correctly and examined many times from multiple points of view; it needs to be defined depending on what needs to be solved. A systemic approach is best, where the problem is examined together with the environment which causes it.

The findings are in line with the literature, as partial solutions and reductions of the model are sometimes considered a required step in order to solve a problem. For example, Vidal (2002) defines a problematic situation as a highly complex event, determined by many factors, with a lack of structure and interrelated objective and subjective aspects. It is characterized by a lack of transparency, determined by not knowing the actions of the participants. It also has several conflicting goals, because there is a lack of agreement about the mission of the organization. In this case, structuring the problem is the first step to solve it, as it can make it more approachable and clearer. It also contributes to knowledge conversion (Nonaka and von Krogh, 2009) because, as the problem is structured differently, the skills needed to solve it can also differ and specific elements of those skills can be identified.

5.2.2.2 Placing the activity in the innovation process

Structuring the problem is, together with filtering knowledge, a way to better organize the information in order to be of use to the company. It can also be compared with design, as the company chooses a way to solve a problem by determining the required stages. Structuring the problem can result in an intermediate solution that is presented to the customer to obtain feedback. This feedback is then used to restructure and redesign a solution, so it becomes viable through a process of iteration.

5.2.3 Collecting data

For companies, collecting data supports the planning of their work to become more fully inclusive. Once the type of information that has to be collected has been established, the approach used to obtain that information has to be carefully considered. The appropriate format for collecting data depends on what is being collected and from whom. It can consist of questionnaires, focus groups and telephone surveys.

The concept of gathering, coding and storing knowledge in companies is not new, as organizational policies, procedures, routines, reports and manuals have accomplished this function for years (Alavi and Leidner, 1999).

Interviews are one of the most common ways to obtain information and they can be one-to-one or group interviews. They should be planned ahead of time based on the information that is required. A good interview plan should start with open-ended and continue to more specific questions. Group interviews are useful when everyone is on the same level or has the same role, but they require more preparation and formality. Facilitated sessions are similar to group interviews but involve a larger number of participants for a common purpose. Interviews are not the best approach where a large quantity of information has to be collected.

In these situations, questionnaires are useful as they are more informal and can collect data from participants in remote locations or those who have only a minor contribution. Prototyping is a modern technique for collecting data which consists of building an initial version of a solution from initial requirements, called a prototype. After receiving feedback, the solution is changed, and this continues until the output meets the needs of the company or after a set number of iterations.

Collecting data can be enhanced by various forms of information systems. Those specifically designed for collaboration and communication can facilitate an individual's contact with others and with information. Intranets allow access to greater amounts of online organizational information than has been previously possible, both horizontally and vertically. The range and detail of information available to participants increases. The efficacy of technology on collecting data has been established in the literature (Alavi et al., 1997).

5.2.3.1 Integrative discussion of identified activity with the relevant literature

The role of collecting data in knowledge management is to provide capabilities for searching and retrieving information, so that individuals can expand their personal knowledge and apply it to the needs of the company (McQueen, 1998).

Collecting data from customers is also presented in the literature. Customers are interpreted as an information source, because they can provide information to the new product development team that uses this information for idea generation and for product conceptualization (Fang, 2008). If conventional research methods such as focus groups and marketing surveys are used, the role of customers may be passive. As a result of this passive role of customers, companies can find it difficult to collect specific data from them (Nambisan, 2002). However, there are other methods that involve customers to a greater extent. Collecting data is a first step in knowledge

conversion, as the tacit information from the customers is collected (Nonaka and von Krogh, 2009).

The customers as an information source approach can directly enhance new product advantage, by achieving higher product quality. These improvements require specific information on what customers want for a product, such as a higher quality standard or specific performance requirements. These can be accomplished by simply collecting data.

5.2.3.2 Placing the activity in the innovation process

Collecting data can contribute to knowledge creation but, to do so, it is first necessary for it to go through a long process. It must first be turned into information and then converted to knowledge. The data considered in the models were obtained mostly through interviews and surveys. The company is focused on the quantitative aspect if collecting data with interviews and surveys, as opposed to directly involving customers in the innovation process that is a more qualitative approach.

5.2.4 Reflecting Information

Reflecting does not consist of asking questions, introducing a new topic or directing the conversation in another direction. Reflecting not only allows speakers to feel understood, it gives them an opportunity to direct their thoughts and focus on their ideas (Agerfalk et al., 2006).

When reflecting, the user interprets messages that originate from other people. A participant interacting in a real or computer-based system is in a nexus of social actions and relationships. The social action cannot be understated, and this dimension has to be considered in an information systems environment in order to construct complex research in an organizational situation (Gasson, 1998).

5.2.4.1 Integrative discussion of identified activity with the relevant literature

By reflecting on information with customers, they can play a more active role in innovation development, as they take the role of co-developers (Fang, 2008). This can include consumer-idealized design and interactive company-customer design processes. There are also challenges, as this increased level of implication can lengthen the time needed for accomplishing innovation since it requires closer coordination between customers and company (Brockhoff, 2003).

In the literature, it is established that reflecting information and collaborative customer involvement contributes the most to new product innovativeness. It allows for closer interactions between the customers and internal development team, through which the information of the customers can be more effectively shared and combined with the knowledge of the employees. This closer interaction allows knowledge conversion to take place (Nonaka and von Krogh, 2009). The customers know details about product usage and their requirements, while the employees know the technology, manufacturing and design of the product.

Reflecting information with customers can determine collective creativity that is an important force allowing innovative ideas (Bissola and Imperatori, 2011). Customers are also exposed to the

specialized knowledge of the development team which permits them to have a better understanding of the technologies used and enhances their ability to develop innovative ideas (Nambisan, 2002).

5.2.4.2 Placing the activity in the innovation process

Reflecting information is a process of co-development that is more direct in involving customers than collecting data. Reflecting information is a way to make sure that the innovator has understood the requirements of the customers by asking them to confirm what they said. It supports customer involvement by improving communication and promoting a dialogue as opposed to a monologue or interview. It is a way for the company to obtain new ideas and to identify precisely the requirements of the customers.

5.2.5 Exchanging Knowledge

Knowledge exchange entails transferring knowledge between departments, in an organizational context. It is similar to knowledge management, as the purpose is to create, distribute and organize knowledge and to ensure that it is available for future users. It is not simply a communication problem as, if that were the case, it would have been easily solved through an email or meeting. Exchanging knowledge is a complicated process because of the nature of the knowledge itself, which is sometimes tacit or hard to articulate or resides in company members, subnetworks or tasks. Knowledge exchange is also defined as the process through which one unit, such as a group or department, is affected by the experience of another (Argote & Ingram, 2000).

Knowledge exchange in a company is discouraged by factors other than only a lack of incentives (Szulanski, 1996). The way in which knowledge about best practices remains broadly accessible to a company depends on the nature of that knowledge, where it originates and the organizational context in which the exchange is performed.

In much of the present innovation literature it is shown that there is potential for increased collaboration and knowledge exchange between industry and universities. The open innovation approach to developing business value supports the concept that universities are a vital source for accessing external ideas. They are a great, largely unknown and underexploited resource with the potential to contribute to the creation of wealth and economic competitiveness.

5.2.5.1 Integrative discussion of identified activity with the relevant literature

Companies have tried to involve customers; however, until recently customers did not usually play an active role, as they were simply the recipients of the company's innovation activities. Companies want to improve the fit between what they are offering and customer needs by not only surveying the customers, but by bringing quality knowledge from informed customers into the company (von Hippel, 1988). This is accomplished through exchanging knowledge and dialogue.

This exchange of knowledge is helped by an internet-based virtual environment that allows the company to engage with a much larger number of customers without compromising the richness of the interaction. Virtual environments produce three key benefits for knowledge exchange: the direction of communication, the intensity and richness of the interaction, and the size and scope

of the audience. Since the advent of the internet, companies have benefited from a greatly enhanced ability to communicate with customers for innovation (Dahan and Hauser, 2002). As a result of virtual environments, companies can tap into customer knowledge through dialogue (Sawhney & Prandelli, 2000). Exchanging knowledge with experts, other companies and customers can contribute to knowledge conversion, as the process allows for a part of their tacit knowledge to become explicit (Nonaka and von Krogh, 2009).

The internet allows customer relations to be transformed into consistent dialogue. The social dimension of customer knowledge is represented by a community of people with similar interests and companies can benefit from being aware of it (Kozinets, 1999). There is a varying level of involvement from customers who are members of a discussion group (Hagel & Singer, 1999). It is possible to involve the customers from these discussion groups by incentivizing them with rewards in order to find solutions to the problems of the company (Nalebuff & Ayres, 2003). A few examples of such marketplaces include Experts Exchange (www.experts-exchange.com) and NineSigma (www.ninesigma.com). This socially generated knowledge provides insights that complement the knowledge generated through individual customer interactions.

5.2.5.2 Placing the activity in the innovation process

This activity represents a straightforward way to acquire knowledge and is centered on the customer as a partner in the innovation process. Dialogue with the customer is continuous and focuses on social and experiential knowledge. It can be direct as well as consist of mediated interactions with prospects and potential customers. The result of conducting this activity with customers is market knowledge that is useful for innovation. If this activity is undertaken with outside partners the knowledge that is obtained is new from the perspective of the company but not new from an industry standpoint. This is why proprietary knowledge obtained internally is more valuable for the company. It is also rare to obtain knowledge directly by discussing with partners as it is more likely to obtain it with conversion from information.

5.2.6 Filtering Knowledge

Filtering allows converting information into knowledge. Knowledge assets are created by acquiring different types of information from the environment, making the information meaningful and useful to employees in such a way that it can be converted into procedures and expertise that will be useful for the organization (Phaneuf et al, 1996). Knowledge is valuable if there is a possibility to convert it into competencies and replicable knowledge.

Filtering or selecting knowledge identifies needed knowledge from a company's available knowledge resources and offers it an appropriately representative activity (Holsapple and Joshi, 1998). Filtering knowledge is different from knowledge acquisition, because acquisition is about identifying and collecting information that is available in the environment, while filtering is a systemic process which uses already available information.

Information becomes knowledge when it is retained and accepted by an individual to be an accurate representation of reality (Lehrer, 1990). In this way, organizational knowledge exists when it is accepted by a group of people. In order to be common knowledge, it is not required to be shared by all members; it is sufficient to simply be accepted among a group of people. Identifying

exactly when information becomes knowledge is difficult because individuals perceive knowledge through information because information is a kind of artefact of knowledge, a way through which a significant amount of knowledge is circulated, shared or transacted between individuals or companies.

Consequent to the increased amount of data and information, it is easy to see the value of an effective filtering process. It prevents employees from spending more energy sorting through information than making it useful for their job. The design of a formal filtering process usually requires two steps. The first is to conduct relevancy screening that will serve as a way to manage the amount of processed information. The second is knowledge appreciation to rank or select the information deemed relevant.

Even at an individual level, people use a filtering process to determine which information to retain (Plotkin, 1994). Choosing between accepting and rejecting the information depends on the relevance of the information in the immediate context. Relevancy means that individuals will be more attentive to information regarding their areas of interest. The relevance of the information is the result of appreciating the information (Kress, 1993). Individuals with varied interest will interpret more information as being relevant.

5.2.6.1 Integrative discussion of identified activity with the relevant literature

The literature documents well the influence that filtering knowledge has over knowledge management. Personalized knowledge filtering is now gaining increased attention because of an era of information with lots of information agents and personal assistants (Borghoff and Pareschi, 1997). A relevant example is the knowledge pump system, in which filtering is realized by a community and the information is disseminated according to user recommendations and an established trust between participants (Glance et al., 1999). In this way, a document is presented to a user if it is highly rated by another individual trusted by the user.

Another example is the knowledge sharing environment (KSE), a system that organizes, summarizes and shares knowledge from a number of sources, including the internet, a company's intranet and other users (Davies et al., 1998). Users add information to the system according to their profile. This information is distributed to users with similar profiles. A user receiving information can give feedback to the system and, in this way, refine his profile. This system can support most of the converting and connecting processes relating to knowledge, without formal representation. Filtering knowledge is related to the explicit part of knowledge conversion (Nonaka and von Krogh, 2009).

A knowledge management system should be able to provide an individual with all the relevant information to help him with the decision process by offering him new knowledge. However, these systems have certain disadvantages, because of inflexible formal representations of both the information entities and the needs of the user. Knowledge filtering can help with these disadvantages if it is based on a technology able to assess the relevance of information in the database, is able to minimize the interaction of the user with the system and is flexible enough to adapt to the requirements of the user.

5.2.6.2 Placing the activity in the innovation process

Filtering knowledge helps to create knowledge by ensuring that the most relevant information from a database of a company can be easily identified and accessed. It helps summarize the wealth of information obtained through collecting data, in the form of reports, surveys and transcripts. An effective process of filtering knowledge ensures that the participants are not encumbered with information overload at any stage of the decision process and that efficiency is attained. This activity allows selection of the most relevant information to be retained and accepted by the company.

5.2.7 Feedback

Incorporating customer feedback is a way to guarantee the creation of a product or service customers want to buy, as it solves a product or fulfils a need. The most innovative companies in the world are best at creating products that meet the consumers' needs and exceed their expectations. By intertwining development and customer feedback, companies can obtain strong competitive advantage, ensure customer loyalty and gain favorable publicity.

Customer feedback offers a way to communicate with customers to ascertain their satisfaction with a product or service before they choose another brand and the company loses valuable market share. Customer feedback surveys are a way for the company to be informed if a customer becomes frustrated or views a competitive offer to be a better alternative. This ensures that the company has sufficient information and instruments to ensure customer retention. Customer feedback also offers tangible data upon which the company can base their business decisions. This enables it to be informed about the market and general public perception, before starting a risky project or developing a new product.

5.2.7.1 Integrative discussion of identified activity with the relevant literature

The literature documents well the role that the customers have in providing feedback to the company. By listening carefully to what customers want, companies can respond with new products that can meet or even surpass their needs (Thomke & von Hippel, 2002). Customers provide direct inputs for learning and feedback, in the form of idea generation, product design and prototype modification (Nambisan, 2002).

There is a distinction between knowledge of the field and knowledge of the higher levels of the organization. Having knowledge of the field is important for organizations in order to increase their influencing power (Fowler, 1992). Information systems are useful to process information from the field quickly (Madon, 2000). Feedback is the activity that allows, to the greatest extent, knowledge conversion (Nonaka and von Krogh, 2009). Feedback supports knowledge conversion, as the tacit experience of the customer shapes explicit knowledge.

Agencies in the development sector are at a disadvantage because they are accountable to at least two different groups of people (Edwards, 1994). Companies in the business market have an advantage over NGOs, because their clients are both their target group and financial supporters and their ability to learn from the market is enhanced (Roche, 1998).

5.2.7.2 Placing the activity in the innovation process

Feedback from customers to the intermediate solutions obtained by the company is a way to improve them. This constitutes an iterative process as the feedback determines a redesign of the solution. Responding to feedback and creating a functional and accepted solution contributes to the knowledge of the company.

5.2.8 Feedback loops

Feedback loops, or causal loops, are closed sequences of cause and effect and can also be interpreted as a closed path of information (Richardson and Pugh, 1981). They offer an enhanced understanding about the functioning of a management system in a company. The feedback structures of the system can provide an accurate representation of the dynamics of a management system.

Without feedback, it is difficult for a company to distinguish whether the chosen course of action can lead to reaching its objective. If a problem must be solved and the problem is unstructured, considering feedback is a worthwhile alternative.

Feedback helps to formulate problems that are not well structured, and this is evident in the literature (Simon, 1973). In this type of case, a module is introduced which scans the external environment and long-term memory in order to find usable information for the present problem and adds it or replaces it with the information already in the process. For this purpose, the module can interrupt the ongoing process to add or modify information. It is not something that happens only once because the feedback process can take several iterations to completely formulate the problem, list alternatives and choose the one that is the most appropriate.

Testing for feedback at the right time will result in the subsequent choice of action being the right one. If this is not realized, the company may not identify the relations of causality and may continue or discontinue an activity for the wrong reasons.

5.2.8.1 Integrative discussion of identified activity with the relevant literature

Feedback loops have previously been used for knowledge management. Fact nets and measures represent the knowledge base of an organization. This, combined with environmental variables, is used by the verifiers and assessors to complement information in the immediate problem space. Information is passed between the problem space and these three components. During the design stage, information and knowledge is transferred continuously. If the objective is reached, the process ends. At that point, the desired state has become the present state and the process will repeat as a new desired state is specified.

The model is not fully automated as it depends, largely, on the decision makers who must understand, in detail, the knowledge base and the experiential knowledge existing in the company. The knowledge base depends on communication between organizational members, when some elements of tacit knowledge can become explicit in order to be stored. In this way, the system is not independent of human interaction as the desired state, environmental variables and checkpoints are determined by individuals. However, the individuals benefit from support from the system

and can act more effectively than usual. This system of individuals and advanced technology can determine progress for knowledge management, customer involvement and innovation.

5.2.8.2 Placing the activity in the innovation process

Feedback loops have been used in the past for knowledge management, but the present study constructed a new model that uses them. Feedback loops have been chosen for their versatility and ability to accurately represent a system that changes over time. They can illustrate the relations between the activities, how they contribute towards obtaining knowledge and how they allow a company to achieve innovation.

5.2.9 Overall contribution of the activities to theory and practice

The activities of information acquisition add to the literature by specifying precisely how to involve the customer in the complex process of innovation. The literature on customer involvement (Biemens, 1991; Leonard and Rayport, 1997; Ritter and Gemuenden, 2003; Tidd, 2001) agrees that interaction with customers is determinant of new product success, but does not detail the types of interactions needed through the innovation process.

Specifying the activities makes it simpler for organizations to carry out customer involvement as they know what the interactions should look like. This research thus provides a practical approach to customer involvement, as it removes the ambiguity and confusion surrounding it and clearly specifies how to implement it.

The activities also provide the information that is required to close the information defect (Spender, 1993; Mullins and Sutherland, 1998). The information defect is defined as the difference between the amount of information necessary to perform a specific task and the information that is available to the company. The activities can identify latent needs and learning opportunities that can help companies in the development of solutions (Huber, 1991; Slater and Narver, 1998). It thus becomes possible to reliably link technological possibilities to the needs of the market (Vercauteren and Vanhaverbeke, 2007).

The most technologically complex solution may not be the best for the market and the supplier helps to reduce development time by directly involving customers and obtaining information from them in different ways. Rather than going through the elaborate process of adapting an existing technology for the market the technology can be developed from the ground up based on the requirements of the market.

The literature on employee involvement for innovation (Benner and Tushman, 2003; Howell and Higgins, 1990; Sundbo and Gallouj, 2000) is more limited than that focusing on customer involvement, but this research considers employee involvement to have a similar contribution with customer involvement in the innovation process. The employees collect and interpret the information that comes from customers, but their role does not stop here, as they can also contribute with their own knowledge and opinions. The creative ideas of employees can be important for the process of organizational innovation (Zhou and Woodward, 2003).

It should also be stated that a company does not automatically benefit from the knowledge of employees if there are no activities in place for this purpose. In big companies with multiple organizational levels, employees are used to carry out the routines of the company and are not often tasked with creative assignments, regardless of their knowledge. Companies must counterbalance this by creating innovation teams and organizing activities such as brainstorming, meetings or workshops as was identified in some of the interviews.

The results show that customer involvement can enhance the information acquisition process that influences innovation. This supports what was written previously in the literature, such that customer involvement increases organizational effectiveness and performance. In addition, this research describes the activities through which customers and employees can be involved and contribute with information to the innovation process.

5.3 DISCUSSION OF THE MODELS AND THE GENERATIVE MECHANISMS

The interviews reveal repeating patterns, upon which the models are constructed. The interviews were the first step in constructing the innovation models illustrated in this research. It was possible to identify useful patterns and themes by reading the transcripts.

Several interviews were carried out and each focused on a different aspect: innovation, customer involvement and reducing the knowledge gap. After the interviews were transcribed, a case database was put together. By examining the transcripts, the objective was to identify the main codes and sub-codes. The frequency with which these codes were mentioned and what the interviewee was relating to the most was of importance. If the relationships between codes were known, the model would have been possible to be constructed. The theoretical concepts uncovered through inductive coding were compared with the literature in order to determine if the findings were presented in the literature or if the study was bringing something new.

The models were constructed with the help of feedback loops. A dichotomy in terminology can be identified as feedback has multiple interpretations in this research. The initial interpretation states that feedback is a response obtained from customers that concerns the quality and the features of a new product or service. The second presents feedback to be a part of the causal loop process. Feedback is the output that is used as an input for another iteration, so a cyclical process or loop appears. This clarification is intended to reduce confusion on the use of feedback.

This research introduces three innovation models and a separate model of knowledge conversion. The emergent innovation model is the first and is constructed based on the two main cases, Avaloq and Synosia, and the ten background information interviews. As more data were obtained, additions and changes were made that resulted in subsequent versions of the model of innovation. The improved model includes the banking case and the corresponding findings. The revised model includes all the data from the improved version and the interviews with professors and innovation specialists. The knowledge conversion model focuses on obtaining knowledge from information, rather than changing and moving through different types of knowledge. This is also a complex process as the applied information and intermediate solutions have a cumulative and steady contribution to obtaining knowledge.

5.3.1 The emergent innovation model (diagram)

The model presented in this study is more general than the first models of innovation, but more specific than later ones. It could be said that its generality is at the middle of the spectrum because it considers some stages such as brainstorming, but these are not arranged in a linear manner as their dynamics are illustrated in the form of feedback loops. The stages do not result in innovation directly, they merely create a setting in which it can appear. Once this setting is created, the model does not try to establish a fixed number of steps that result in innovation. If the company has the required knowledge, skilled employees and quality organizational processes, innovation will be achieved, but the time required for it is unspecified.

The activities can be interpreted to be a number of stages with the purpose of collecting information in a variety of ways, then converting it to knowledge. The part of the model until knowledge is collected is more specific as how the activities influence the others and in what direction is clearly stated. The part after knowledge is collected is more general, in order to be applied in a variety of contexts and in companies operating in different industries. An early consideration of the study included examining only innovations that were technology-based. However, this restriction was relaxed, as innovations have been examined regardless of their level of technology in this study. Improving a process or policy in an organization can be considered to be innovation in the same way as a product or service based on a new technology. The instruments with which employees' work are important, as more outdated equipment can impede their capacity to perform well. However, having state-of-the-art equipment does not guarantee innovation. Technological advancements are quickly incorporated into companies' practices. It is possible for multiple companies to undertake their activity while benefiting from the same technology, and some obtain innovation, while others do not. Organizing the activity of the employees can have a greater influence on innovation than only technology. The knowledge collected by the company has a role in reducing or closing the knowledge gap.

Once the relations between activities were clear, it was possible to construct the model by linking the explanatory case data to the empirically emerging theoretical model. The model was constructed with causal loops as it was a means to inquire about the processes that support innovation.

All the activities have a contribution toward obtaining new knowledge. The most obvious example is feedback, as new knowledge allows the company to learn from its past experiences with the market and customers. In other words, the company applies the information it has in order to turn it into knowledge and then it learns, over time, from each instance it has applied information to and engaged in an activity. Most of the activities are based on customer involvement and on employee involvement. New ideas are collected from reflecting information with customers and from brainstorming. New ideas allow the company to identify ways to reach customers and relevant questions to include in interviews and surveys that contribute to obtaining information. These ideas, along with what is obtained from collecting data, are filtered in order to result in new knowledge. As the activities were described together with placing them in the model, some overall considerations about the innovation process have to be discussed. The rea-

son why knowledge is an important step in this process is because it allows putting the capabilities, objectives and difficulties of the company into perspective. A significant amount of knowledge is required to obtain innovation as it has technical, industrial and market implications.

Simply producing and distributing an offering requires a lot of knowledge. This goes beyond planning and design as the company has to know the production lines, plants, type of workforce, management, storage, distribution channels and suppliers. This knowledge is obtained through action, by applying information (Ackoff, 1989) in a real context and solving the problems that appear. Introducing a new product requires more knowledge, as some of the production and distribution variables can change. Obtaining innovation requires even more information and knowledge. The company must be informed about the technological capabilities, what the market requires, what the competition is doing and what is possible to produce. It can then apply this information to design and produce a new offering. The response of the market, the required improvements and the reaction of the competition are now an opportunity for learning.

It is now possible to formulate the first proposition that gives a response to the main research question:

> *P1: Information acquisition supports innovation through knowledge that is obtained by applying information, developing new offerings and receiving feedback.*

This proposition supports the interpretation of knowledge that is obtained through action. Innovation should not be mistaken with developing new offerings as this is simply an initial step. The innovation process is finished when the development is complete, the offering is functional and accepted by the customers.

The relation between new knowledge and innovation development has to be dealt with carefully. However, the new knowledge is an expression of all the previous activities with customer involvement and employee involvement. These activities create a framework in which innovation is supported. New knowledge supports innovation development, but the opposite is also true. Innovation development supports learning through technological breakthroughs, addressing implementation problems and getting feedback from customers by involving them in this process. This reinforcing loop illustrates the iterative and complex nature of the innovation process as knowledge determines action and action, in turn, determines knowledge.

By following the activities, innovation will be obtained, but the time is not specified as it depends on the field of activity of the company. It is not feasible to create a schedule to obtain innovation, as even innovators do not know exactly when they will reach it but, regardless, they do.

5.3.2 The improved innovation model (diagram)

The improved innovation model was constructed by including a banking case study, conducting interviews with company representatives and then coding the transcripts to obtain findings. The most representative quotes for each activity have been specified. They allowed a more thorough understanding of each activity, as the respondents from each company stated how they collect information and the aspects important to them when contacting or meeting the customer.

The banking case confirms the importance of involving customers and employees in the innovation process. This is because the company has two activities called “voice of the customer” and “voice of the business”. In the former activity, the client was sitting with employees in a room and was shown new products and services to obtain his opinion. It also consisted of usability tests to ascertain whether the customer was happy with the user interface and if he understood it. The later activity consisted of informal meetings with employees to obtain information from them. This information is helpful for management to understand how the departments are doing, what problems they are confronted with and how they find a solution.

The improved innovation model adds prototyping as a way to show a preliminary version of an offering to management and obtaining a response. The initial model included presenting intermediate solutions to customers and getting feedback, but the acceptance and feedback of management are also important.

The management can accept the prototype as it is or give feedback to make changes and this is also an iterative process. The incremental changes to an intermediate solution or to a prototype are undertaken to make sure that the offering is well received by the customers and that management agrees with its characteristics.

It has been illustrated that customers and employees have an important role in the information acquisition and knowledge conversion process. The banking case study has confirmed this. Proposition 2 can now be formulated that answers the first sub-question as follows:

> *P2: Customers and employees support the information acquisition and knowledge conversion process through the activities of brainstorming, structuring problem, collecting data, reflecting information, exchanging knowledge, filtering knowledge and feedback.*

The activities listed above are routines for a company only if it has implemented them. The majority of companies do not have routines for information acquisition or simply use interviews and surveys without more complex activities of customer involvement for innovation. Involving customers in the innovation process requires the company to share a lot of information with them about products in development and organizing face-to-face meetings for that purpose. Not all companies are willing to do so or do not have procedures for this, so the activities are a recommendation of the routines to implement to have a good information acquisition process.

5.3.3 The knowledge conversion model (diagram)

This model presents a segment of the innovation process by illustrating how information is converted into knowledge. Obtaining knowledge is an iterative process that begins with filtering information to determine what is applicable. That information stands at the base of creating solutions that are presented to customers and improved because of the feedback. Finding a viable solution increases the knowledge of the company.

The knowledge spiral of Nonaka and Konno (1998) was an inspiration for this research, but that model assumes that knowledge is already collected so it can go through externalization and internalization. This does not work well with models of innovation that are focused on the creation of new knowledge.

The model of the knowledge spiral also assumes that knowledge flows from middle management both upwards and downwards. This has been addressed in this research so that big companies are considered to have a top-down decision process and start-ups have a horizontal knowledge flow as was stated.

Another shortcoming, identified by Harsh (2009), is that Nonaka does not consider a considerable part of the initial knowledge is flowing through the cycle many times so this requires a new way to model the process. This research has included feedback loops precisely to show the cyclical and iterative nature of the knowledge flow. Adding and improving the knowledge base of the company depends on its flow and if departments and individuals have access to it.

It should be noted that the distinction between different types of knowledge has been outlined in the literature review, but the innovation models and the knowledge conversion model do not have this distinction illustrated in the causal loop diagrams. The reason is that the focus is on obtaining knowledge from information and not on transferring it to different types such as individual knowledge and company knowledge.

The individual knowledge is intended to be transferred to the company and this is the reason for including employee involvement and giving it the same importance as customer involvement. The company can access the knowledge of employees through brainstorming, workshops and activities such as "voice of the business", as identified in the banking case. The company must be able to rely on the knowledge of its employees to obtain new product ideas, improve its design and development processes and update its routines to be in a good position to achieve innovation.

An additional categorization of knowledge is described by Garud (1997) as know-why, know-how and know-what. Know-why is created by the activity of R&D laboratories and consists mainly of discovering the principles under which technological systems operate. It is a highly technical kind of knowledge. Know-what refers to understanding the configurations and applications customers want from a product or service.

Know-how is similar to a process of learning by doing as knowledge on how to perform a task accumulates with experience over time (Arrow, 1962). This is the type of knowledge that is most likely to be obtained with the knowledge conversion model of this research. This know-how is customized for a specific business environment and for a specific market. It can be obtained through an iterative process of searching for a solution.

It is now possible to formulate proposition 3 that responds to the second sub-question corresponding to converting information to knowledge:

> *P3: Information obtained from customers and employees is converted to knowledge by applying it and creating solutions that are incrementally better suited to the requirements of the customers.*

The knowledge conversion has thus fulfilled its purpose of illustrating how information is filtered and applied to support knowledge creation. This knowledge is also the product of action and feedback that determines a change in that action to achieve a better result.

5.3.4 The revised innovation model (diagram)

This model has been constructed by including the transcripts from the interviews with professors and managers who are specialists in innovation. The reason for conducting these interviews was to test and validate the structure of the innovation models and also of the knowledge conversion model. The revised model adds to the path from knowledge to innovation by specifying that there is a segment from invention to innovation. An invention can have very good characteristics and technical specifications, but the company must be able to produce and distribute it and the customers have to accept it before it can be called an innovation.

An obstacle that has to be surpassed to commercialize an invention consists of securing funding. This is especially true for start-ups that do not have the resources to undertake the wide release of a product or service and must rely on external partners. Big companies can also contact internal partners or departments to obtain funding.

This revised model, as well as all the innovation models that have been presented, requires good communication and transparency both with internal and external actors. This will support the information and the knowledge flow. Companies already have workshops where employees from different departments exchange ideas and this is included in the identified activities and innovation models. It is possible that employees will exchange knowledge with others only if they are incentivized to do so. If they are rewarded for sharing knowledge, they will be motivated to complete more tasks. This, in turn, will allow them to obtain knowledge that can be of use to the company. Some employees have greater capacity to explain than others, but the knowledge they have accumulated during the time they spend working for the company is a valuable resource. Finding the best way to communicate that knowledge and present it in an easy to understand format is of paramount importance as it will enable an easier knowledge transfer in the company. The processes, policies and structure of the company are based on this knowledge.

Better work processes will support better employee collaborations, as they will have a clearer picture regarding what their responsibilities are and how their performance is monitored. They will not be quick to shift blame when something unexpected happens as they will all know who is responsible for each activity. If employees communicate better, then the potential for knowledge conversion increases. Shared knowledge will create a framework where innovation development is possible because it will allow a greater number of employees from the development team to approach a problem.

The distinction between information and knowledge is an important one to make, as information is fixed and specific, while knowledge is less specific and adaptable. For example, the contents of a report can be considered information if they are read and given meaning by an individual but knowing how to manage a company when the business environment changes is knowledge. In this case, it depends on some underlying principles that have been accumulated by a manager over a long period. There is nothing specific about these principles and it is possible that the manager could not express them in an explicit way even if he wrote a book about them. These principles, that can also be called individual or tacit knowledge, can be seen more easily while observing the manager doing his work. It is the mission of the company to try to obtain this knowledge through employee involvement so that is can be of use to the entire company.

Feedback loops can be compared to organizational routines as they have an iterative nature. However, they also illustrate the dynamics that underline routine evolution. If we consider routines to be the rules and procedures of the organization, they consist of a replicative part, but also an adaptive part. A company that has subsidiaries in many countries will use the routines that have proved to bring the most performance, but will also recognize the need to adapt these routines in order to face the challenges of a new economic environment. Routine theory has only, recently, begun to address routine dynamics, such as learning, change and adaptation (D'Adderio, 2008).

Feedback loops are a way to examine the dynamics between routines. The activities presented in this research can be considered to be routines that are recommended to be implemented by the company to support its information acquisition process. Converting knowledge from information to improve the organizational routines can be considered an adaptive process. New knowledge can help the company determine if it is required to adjust its routines and how to do so. This process can determine some routines to be changed, either in production, design or marketing departments. As markets and technologies change, companies must also change in order to be relevant, and they accomplish this by adapting their routines to new requirements, environments and conditions.

5.3.5 The generative mechanisms of the innovation process

Because the chosen research philosophy is critical realism a discussion concerning the generative mechanisms of innovation should be also included. The definition of Roy Bhaskar (1979) states that critical realism sees the universe as a stratified and open system of entities that has multiple layers: the empirical, the actual and the real. The emprirical is what we percieve, the actual is what events take place and the real is composed of mechanisms and structures that can determine events to appear. The generative mechanisms of innovation are thus situated on the real layer that is the most complex.

The generative mechanism also requires a setting or context that has other factors to produce an outcome. This is according to the equation of Pawson and Tilley (1997) that states: Mechanism + Context = Outcome. The generative mechanism is dependent on context when producing or failing to produce an outcome.

In the case of innovation, the generative mechanisms are factors that have the potential to support it if some conditions are met such as context. In this case the context is the organization, and more specifically, its structure. In literature there is some agreement on this, as creating an innovation group that is separate from the rest of the company is considered a good approach (Benner and Tushman, 2003). The innovation group is composed from individuals from separate departments that are tasked with finding innovative solutions collectively.

The innovation group represents a change in the organizational structure and a shift from an operational to a more holistic and complex objective. This is why the individuals from the innovation group should not be pressured to have the same efficiency as other departments and should be evaluated in a different way. The innovation group also has a flat organizational structure that is similar to start-ups and this is in agreement to that was said in the section Knowledge

Flow. This means that there is a reduced number of hierarchical considerations and all participants are incentivized to contribute equally regardless of their specialization or function.

Once the context that supports innovation has been described, the generative mechanisms themselves should be introduced. The first generative mechanism is creativity. A lot of employees can have creative potential, but the executives and managers should discover it and implement it. Big companies should realize that they have a vast potential to innovate in the form of their employees that often is untapped because the company does not have procedures for their involvement. This has proved to be true in the case of Roche that was slowed down by its complex administrative procedures and had to rely on smaller companies such as Synosia for innovation. The ability of a company to profit from the creative potential of their employees depends on how it can involve them in the innovation process. Some companies are unwilling or unable to do this as they have specialized departments and fixed responsabilities where change or creativity is not given a real priority. The role of context again is becoming relevant.

The second generative mechanism follows from this reasoning and consists in the flexibility of the company. This can mean creating new organizational structures such as innovation groups but also being able to change its routines. The change in routines is similar to dynamic capabilities that are the company's ability to integrate, build and reconfigure internal and external competences to address environments of rapid change (Teece, Pisano and Shuen, 1997). The difference is that, in the case of innovation, the company must be quicker in changing its routines. If the company changes its routines when the environment requires it, then this is already a slow response and it finds itself below the trend of other more flexible organizations. The company must be able to change its routines in response to the internally collected information to support customer involvement and employee involvement. A more proactive approach will allow the company a better position on the market and not be required to make sudden changes that can be detrimental to its performance. The change in routines is also illustrated in the diagrams as the company adjusts them according to the collected information from the employees and the customers.

The third generating mechanism of innovation is the communication. This primarily refers to the communication between employees as having a supporting influence on innovation. This is mentioned in the literature on employee involvement as processes and tools that support more novel ideas can be designed as communication vehicles (Kelley, 2009). An example is the Google company where they designed the offices to specifically enhance communication. This is a good example to follow, as this company considered the knowledge flow a priority and then created the workspace based on this principle. Some other companies with excessive specializations between departments and with strict hierarchical reporting may have difficulties when trying to implement such a change. Innovation groups also support communication especially when there is a diverse team. This is in accordance to the first Avaloq interview, where it has been stated that innovation is obtained with diverse thinking people that have distinct skills. The communication between employees should be improved by changing structures and processes as it is important for supporting innovation.

The last generative mechanism discovered in this research is feedback. The company can obtain the most detailed feedback through customer involvement, but there are other ways such as

interviews, surveys and reports that can fulfill this purpose. The preferred approach to collect feedback is through customer involvement, as it is possible for the customer to see the product or a prototype of it and voice his opinion on what should be added or changed. The process of designing a product with the customer or based on his feedback can improve its market acceptance and make it more probable to be well received. Feedback is a part of the information acquisition process of the company. A lot can be changed based on feedback such as outputs, routines, procedures and the way in which the company addresses to customers.

As stated above, these generative mechanisms rely on context to produce a specific outcome. Another way of saying it is that an entity can require a context to exercise its causal mechanisms. Some companies can ignore creativity, not accept flexibility, discourage communication and not implement changes based on feedback. Such companies are usually large, have fixed procedures in place, have a clear differentiation between departments and pursue operational objectives. If a company wants to obtain innovation, it should conform to the principles and values previously listed. The process of innovation can require changes that can seem unreasonable to some companies but tht are worthwhile to be implemented because of their potential and of the opportunities that will result.

5.3.6 Overall contribution of the causal loop diagrams to theory and practice

The causal loop diagrams contribute to the theory by mapping the innovation process and its corresponding activities, steps and iterations to provide a comprehensive picture. It has been stated that the innovation process illustrated, here, starts with information acquisition, continues with knowledge conversion and concludes with commercializing an invention. Information acquisition can have a series of intricacies, as it can be obtained in multiple ways, from different sources and with separate activities. The diagrams have tried to illustrate these multiple paths that allow the fast transfer of information. The generative mechanisms have been presented and they complement the mapping of the innovation process by stating what are the factors that can make a difference and support innovation if the context is suitable for this.

The diagrams also propose a new interpretation of knowledge conversion that describes how knowledge is obtained by applying information in a real context. The SECI model (Nonaka, 1991; Nonaka and Konno, 1998) provided inspiration for this research, but differences are apparent. This research is focused on converting information to knowledge, as opposed to cycling between different kinds of knowledge. A number of criticisms of the SECI model have also been addressed in this research. One is that organizational knowledge does not flow from middle management both upwards and downwards (Harsh, 2009). This research has illustrated that the knowledge flow in big companies is a top-down process and there is a possible counterbalance by implementing activities of employee involvement; the diagrams are based on this principle. Another criticism is that Nonaka's model does not explain how new ideas are produced (Bereiter, 2002). This has also been addressed in this research, as companies can implement activities of customer and employee involvement, resulting in new ideas through collaboration.

Knowledge played a key role in describing the innovation process. It has been stated that knowledge determines innovation and also innovation determines knowledge. Companies that

collect knowledge are in a good position to obtain innovation. This is because they know what the technical capabilities are, they know what the competitors are doing, and they know the requirements of the customers. This innovation is translated into new products and services that are suited to customer requirements. In this way, another interpretation that can be given is that there is a reinforcing feedback loop between knowledge and innovation, as each positively influences the other.

The causal loop diagrams presented in this study are less linear than previous models, as they use feedback loops in order to explain the dynamics between the activities of customer involvement. There are also some similarities with later models, as the external environment is considered. However, the diagrams presented in this study focus on a specific part of the external environment, the one that can offer the most information to the company, the consumers. Other external factors, such as distributors, legislation and infrastructure are not used, as they have a role in the everyday functioning of the company, but not a direct role in obtaining innovation.

New inventions must find a market segment and be accepted by the customers in order to be commercialized and successful. Both the market knowledge of the customers and the technical knowledge of the employees are important for obtaining innovation.

This may sound obvious, but an example is given in order to better explain it. The Apple Newton was considered innovative for its time. It was a personal digital assistant which featured handwriting recognition. However, the price and early problems limited its sales and production was discontinued. This product was innovative and ahead of its time, but it was not well received by the market. In the following years, other PDAs have been developed that met the needs of the market in a better way.

This research highlights the ways and the reasoning behind involving customers in the development of innovation. Companies can be in a position to obtain new technologies, by investing in research and by having a capable workforce. However, creating a new technology and distributing on a wide scale while meeting the requirements of the customers are two very different things. A company can invest in research development, create something new and then discover that what was produced has no place on the market. That is why involving customers and obtaining knowledge to address uncertainty is a requirement for innovation. By being certain about the state of the market and the customer requirements, the company can focus on developing the new technology knowing it is safe and worthwhile to do so.

5.4 SUMMARY

This chapter discussed the findings that were previously outlined. It is possible to separate the findings in two main categories: the activities of customer and employee involvement and the innovation models. The discussion chapter is also consistent with this approach.

The activities of customer and employee involvement have been identified as the following: Brainstorming, Structuring Problem, Collecting Data, Reflecting Information, Exchanging Knowledge, Filtering Knowledge and Feedback. The activities are considered as routines that are

recommended to be implemented as they have a role in supporting knowledge conversion and the innovation process. The activities have been individually presented. They were first described in general based on the literature about them. The "Integrative discussion of the identified activity with the relevant literature" section states how the activity is presented in the customer involvement and innovation literature. The "Placing the activity in the innovation process" section illustrates the reasoning behind including the activity in the information acquisition and innovation process.

The models were then discussed starting with the emergent innovation model that was the first version. The improved innovation model included the banking case. The knowledge conversion model focuses on converting information to knowledge and this is considered as a component of the innovation process, as innovation requires creativity and original knowledge. The revised innovation model included adjustments based on additional interviews with professors and innovation specialists. The generative mechanisms of innovation were discovered to be creativity, flexibility, communication and feedback. Discussion of the models includes propositions that give answers to the research question and the sub-research questions that were formulated in the Introduction chapter.

The next chapter concludes this research, identifies the theoretical, methodological and managerial implications and specifies avenues for future research that have the potential to contribute with additional findings to the customer involvement and to the innovation literature.

6 CONCLUSION

The research started with trying to determine how information acquisition supports the innovation process. The findings showed that information acquisition is composed of several activities that can be routinized. A company is thus able to routinize part of the innovation process that starts with information acquisition and continues with knowledge conversion. The integration and usage of this knowledge for innovation is no longer a routine process, as it requires creativity, critical thinking and a holistic approach. The information acquisition process presented in this research contains customer involvement and employee involvement. Customer involvement is useful to identify the market requirements. The component of employee involvement allows the company to obtain technical information, but also requires that the company knows how to include employees in the innovation process and benefit from their ideas by creating a framework that supports sharing information, collaboration and transparency.

Customer involvement has been stated to be a way to surpass the information defect and obtain useful information. The information defect lies in the inability of customers to disclose elaborate product requirements which, if known, lead to an improved understanding of innovations (Day, 2002; Leonard and Rayport, 1997; Veryzer, 1998). Customers do not possess the knowledge of what an innovative solution should look like, but they can recognize a suitable one if they see it and can comprehend it. This is the reason for involving customers in innovation development, as they can give an opinion on whether a solution is applicable and has innovative potential.

Customers do not usually have technological knowledge, but they can offer important feedback about their requirements. Customer feedback is a valuable resource for a company because if a company knows precisely what the customers want, it will develop an innovation that targets directly those requirements to gain market acceptance. Furthermore, by understanding the market requirements, the utility of the product is considered together with its technical complexity. It is important to know what characteristics of the products are the most important to customers and what characteristics can be safely left aside in order to focus on important ones.

To achieve innovation, specialists possessing the necessary competencies and skills define and develop solution designs. Innovations are said to hinder the supplier's ability to properly assess the customer needs, while making it difficult for the customer to understand the advantages offered by an innovation, causing reluctance to use any new technology (Leifer, 2000). The reasons for this are that, first, buyers are not automatically confident about the efficiencies, increased functionality and superior performance of innovations; potential customers may face too many alternatives when considering using a new technology, because innovations do not have a pre-established role in their past customer experience. This remains true even if a product exhibits improvement in the quality of multiple applications (Day, 2002; Leonard and Rayport, 1997; Veryzer, 1998). These same authors report the inability of customers to disclose potential unsatisfied product requirements, pointing, thus, to a lack of understanding about the development of innovations. Secondly, suppliers themselves can possibly be unaware of the performance, parameters, attributes and specific features of new technologies.

The empirical evidence suggests that appropriate customer involvement tends to reduce the information defect which, in turn, increases organizational effectiveness and performance (Gruner

and Homburg, 2000; Salomo et al., 2003; Medlin, 2004; Ritter and Ford, 2004). Hence, the problem of customer involvement for innovation is of particular interest in the literature and for this research.

The central research question of the thesis asked about the role of information in the development of innovation: "How does information acquisition support innovation?" This study's contribution to the literature can be summed up as a pattern of customer and employee involvement that consists of a series of interdependent activities. The feedback loop mechanism presented in the models describes the dynamics between these activities of agent involvement.

The reason for including employee involvement is that it has a significant influence on innovation such as customer involvement. It is true that employees work directly to achieve innovation if they are tasked to do so, but the company has to introduce new procedures to involve all of them and to benefit from their knowledge. Some companies already do so as they have brainstorming sessions or meetings such as "voice of the business". By identifying such procedures, it is possible to formulate a set of recommended routines that, if implemented, can incentivize employee involvement. In addition, big companies with mechanistic organizational structures have difficulties if setting out to innovate. Such companies need a new set of routines that support the sharing of information and the transparency of knowledge if they want to have a better chance to obtain innovation.

Despite the extensive literature arguing in favor of customer involvement in the development of innovations, (Dosi, 1982; Lundvall, 1992; Anderson et al., 1994; Dutta et al., 1999; Lukas & Ferrell, 2000; Callahan and Lasry, 2004; Hult et al., 2004; Atuahene-Gima et al., 2005; Zhou et al., 2005; Tajeddini et al., 2006; Herrmann et al., 2007), little empirical evidence regarding the mechanism that supports such arguments has been gathered (Leifer et al., 2000; Morone, 1993; Day, 1994; Galbraith, 1982; Maidique and Zirger, 1985; Rice et. al., 2002; Utterback, 1994). Along these lines, the literature (Dosi, 1982; Martin and Tan, 2007; Tajeddini et al., 2006; Vercauteren and Vanhaverbeke, 2007) also argues that the interaction between suppliers of innovations and customers enables innovation, yet this interactive mechanism is not detailed or presented. Promising analysis (Vercauteren and Vanhaverbeke, 2007) points, however, in the direction of customer involvement, yet, so far, no indication has been introduced on the best way to involve customers and how to proceed to do so.

The literature on employee involvement for innovation consists of fewer studies, however, they are sufficient to make an argument for its importance (Benner and Tushman, 2003; Howell and Higgins, 1990; de Brentani, 2001; Ordanini and Parasuraman, 2011; Zhou and Woodward, 2003; Tellis et al., 2009). By studying this literature, it is possible to identify some overall guidelines for obtaining innovation, such as creating an innovation group separate from the rest of the company (Benner and Tushman, 2003). Another guideline is to develop processes and tools to support more creative ideas (Kelley, 2009), however, what these new procedures should be is not specified. The process of employee involvement for innovation is not detailed and its activities are not stated.

The study is seeking to rectify this, by proposing a mechanism that starts with the information acquisition process consisting of customer involvement and employee involvement, continues

with knowledge management and ends with the development of innovation. This process is not linear and illustrates all the interdependencies and complexities of innovation. The holistic approach is used, so rather than focusing on individual pieces, it focuses on the feedback relations between the concepts presented in the study.

To answer the research question, qualitative research was implemented through inductive coding, generating an empirical model explaining the mechanism based on feedback loops and its variables: the activities, which describe customer involvement and employee involvement. The activities included in the innovation process can be considered as routines that are recommended to be implemented by companies who want to achieve innovation.

The emergent, improved and revised models recognize feedback loops to be a legitimate approach to understand the development process of innovation. The case studies identified and validated the stated seven activities: Brainstorming, Structuring Problem, Collecting Data, Reflecting Information, Exchanging Knowledge, Filtering Knowledge and Feedback.

Nevertheless, differences have been found between companies in different industries. One of the major differences observed refers to the duration of development and cost of innovations. The case study Synosia behaves differently from that of Avaloq. The duration of the molecule development process (Synosia), involving genes or proteins (active agents of living organisms), is longer and more complex because living organisms result in exponential variations of possible solutions, compared to IT innovations (Avaloq). The development of a molecule takes about 13 years, costs about $1 billion and requires FDA approval. In this case, the molecule development was carried out by a small and specialized firm called Synosia. The company, Roche, out-licensed the molecule SYN-115 to Synosia, because, as Sarry (2012) explains, “All these drugs and projects Synosia is working on [including the SYN-115] related to CNS, central nervous systems” (p. 3) were no longer in the focus of Roche’s research. On the other hand, Avaloq’s software innovation lasted six years in development, cost a few million dollars, and required only client and no agency approvals. Therefore, the time spans involved in the two innovations are substantially different.

The results of this thesis have relevant implications at the theoretical, methodological and practical levels. The subsequent sections will elaborate on these implications. Furthermore, the study’s limitations are presented and recommendations for future research provided.

6.1 CONTRIBUTION OF THIS RESEARCH

This research uses feedback loops to illustrate the mechanism of customer involvement and employee involvement that supports the information acquisition process and also the development of innovations. The present research is different from previous models as it specifies the feedback loops and activities that allow the company to collect information and convert it to knowledge. To obtain innovation, the company must have the best processes and procedures and a reasonable amount of knowledge, in order to have the best probability to do so.

This research is the first to use feedback loops, not simply links, for explaining innovation. The advantage of feedback loops is that a later step in the process can influence an earlier one, as the

company has collected information from the market that can be used to improve the development process. In this way, innovation becomes an iterative process; with each iteration, the company obtains new knowledge and is in a better position to achieve it.

Obtaining innovation sometimes requires a collective approach and companies need new routines for this. Big companies have mechanistic organizational structures to maintain authority and control, but innovation requires another framework where participants produce ideas and collaborate regardless of their position. This is why small companies have more success in achieving innovation. Big companies can also innovate if they introduce routines that incentivize sharing information and a free knowledge flow.

The supplier and customer are provided with mutual learning opportunities during the development of innovations. The "information defect" (Spender, 1993; Mullins & Sutherland, 1998) is solved by involving the customer in the problem-finding or solution-finding activities; customers are educated in changing their knowledge and lexicographic preferences in order to accept the new innovations. Research is combined with action to improve understanding for generating changes (Lewin, 1946). The supplier and customer are constantly learning during the development of the innovation to close the "information defect" (Spender, 1993; Mullins & Sutherland, 1998).

Another contribution of this study is that the dual role of knowledge is presented; both determining innovation and being determined by it. The models presented until now have illustrated that knowledge has the main role of reducing uncertainty and closing the information gap, therefore supporting innovation. Obtaining innovation also creates new knowledge, as the company sees how the new solution is received by the market and if it needs adjustments. These two relations combine in an iterative process that allows the company to better refine knowledge and adapt it for its business. This shows that companies willing to collect more knowledge receive more in return.

6.1.1 Theoretical implications

This research contributes to innovation management, as it provides a series of models which explain the mechanism of customer involvement and employee involvement in innovation development and how the information defect can be reduced. The new theories have been obtained with the help of inductive coding and by consulting interviews conducted with employees from companies that have achieved innovation. Some patterns of organizational behavior have been identified as relevant in describing the innovation process.

The main theoretical additions of the research are the innovation models and the knowledge conversion model that supports the innovation process. The findings also provide a theory about the activities of customer and employee involvement that support the information acquisition process. The gap identified in the literature review, where the ways to conduct customer involvement and employee involvement were not detailed or properly identified, is thus closed with activities and models that illustrate the innovation process.

The study extends the present literature on feedback loops and learning. The latter is examined from the perspective of the company and consists of collecting knowledge in various ways in order to address the information defect. Feedback loops have been chosen, as they illustrate the mechanism between participants, company and customers, the interaction and dialogue for identifying problems, establishing requirements and finding solutions. The study contributes to the field by emphasizing the need for continuous experimentation and dialogue between company and customer. This problem-solving learning process is explained in the best way by feedback loops, because of their iterative nature.

Learning occurs as a consequence of collecting knowledge. Within the feedback loops, both adaptive and generative learning is observed (Slater and Narver, 1995). Generative learning is encouraged by customer involvement and employee involvement and normalized by the presented activities. The iterative nature of the feedback loops and of the learning process allows detection of errors, failures or problems. Once identified, solutions can be found that may consist of changing the norms, policies and objectives of the company. The organizational learning process of collecting knowledge explains the potential and capacity of an organization to innovate and adopt and implement new ideas (Hurley and Hult, 1998). In line with Therin's (2002) research, this study corroborates the fact that organizational learning processes contribute to and support innovation.

In line with Dewar and Dutton (1986) the cases examined were successful in developing their innovations as a consequence of their high degree of knowledge acquisition and organizational transformation. In line with the studies mentioned, here, considerable importance is also placed on the policies, processes and organizational structure of the company as variables that can support or hinder learning. A company that is willing to undergo organizational transformation has many benefits to obtain, such as increased information acquisition or improved innovation potential.

6.1.2 Methodological implications

There were a number of advantages when using case studies as the principal methodological approach. This is a robust method, especially when a holistic investigation has to be carried out. Since case studies are better than quantitative methods when examining social or behavioral themes, they were chosen for this study. Innovation development had both a social and behavioral component. Knowledge conversion also depended on agency, as the actors were those who obtained knowledge by applying information to obtain solutions and used feedback to improve them in an iterative way. From this study, several methodological arguments can be suggested for use in future studies on this research area of interest. Case studies proved to be a good methodological approach as, by using both retrospective interviews and three longitudinal case studies, efficiency was balanced with the richness of data. This approach is similar to the one used by Leonard-Barton (1990). The interviews allowed observation of the general context of information acquisition and knowledge transfer for innovation, while the longitudinal case studies allowed for a more detailed perspective about the inner activities and mechanisms of specific companies.

From these interviews and case studies the main codes and sub-codes were obtained; this was the first step in describing the information acquisition process that involves customers and employees. The main codes were the seven activities of customer involvement and employee involvement. The relations between them and how they contributed to collecting knowledge were the basis of creating the theoretical models of the study. To generalize the results, further case study research is suggested (Yin, 2009), as well as adopting a holistic multi-case design (Yin, 2003) in an exploratory approach (Ragin, 1987). Due to the rarity of innovations (Tushman et al., 1986), a sample size of six to 12 cases proved to be reasonable in order to reach adequate results, in terms of specificity, diversity, and manageability (Stake 2006). The small number of cases in this research is compensated by the large number of interviews that made it possible to identify patterns of activities and organizational behavior.

6.1.3 Managerial implications

In practice, the diagrams generated by this research provide organizations with a framework that is suitable for handling innovations by profiting from the knowledge derived from customers and employees. The results from this research offer several implications for senior managers and entrepreneurs, when faced with the possibility or mission of developing an innovation. The study provides a meta-level framework with a new perspective about the market and a clear idea about the mechanism involved. The framework includes three diagrams of the innovation process and a diagram of knowledge conversion based on the principles and data outlined in the interviews. The concept of knowledge flow is also presented as an influence on innovation, as free knowledge circulation is supportive of creating new ideas and creating new products with distinguishing characteristics.

Therefore, to support the innovation objective of the managers, the following set of guidelines is presented:

Recommendation #1: Introduce the previously outlined activities of customer involvement.

The activities of customer involvement illustrate some practical ways of including customers directly in the innovation process. This direct interaction with customers allows identification of unanticipated or latent needs, by observing the problems encountered by customers when using products or services (Leonard and Rayport, 1997). It can also be added that this direct interaction can be particularly useful when the customer is presented with an initial version, or a prototype of a solution, as the feedback will concern a specific issue or problem that can be addressed before launch. By introducing the activities of customer involvement, the company can gain important market information from the customers that is used in the innovation process. Since the "unknown user needs" are required for creating and developing new technology (Rosted, 2005, p. 34) that contributes to a firm's competitive advantage and profitability, the presented diagram provides managers with an appropriate framework that is relevant for activities of customer and supplier interaction. Companies can with this framework see the intricacies and complexities of the innovation process and plan for them accordingly.

Recommendation #2: Introduce the previously outlined activities of employee involvement.

As stated, employees are an important source of technical knowledge and can also contribute with market knowledge by interacting with customers. That being said, employees do not automatically contribute to innovation if it is not a part of their normal responsibilities or if no organizational structures that support innovation are implemented. The company must change the paradigm from operational to more creative by introducing the activities of employee involvement if it has innovation as an objective. As documented, employees can produce ideas that are important for organizational innovation (Zhou and Woodward, 2003). The company must obtain these ideas and knowledge through activities of employee involvement and innovation groups. This will result in a framework that uses the knowledge of the employees obtained through operational routines as a starting point in the process of obtaining solutions that are creative, original and innovative.

Recommendation #3: Implement routines that are based on the activities of customer and employee involvement, in instances where it is possible to do so.

The activities can be interpreted as routines that are recommended to be implemented, as the best activities of customer and employee involvement have been included from all the interviews with the company respondents. If a company wants an organizational structure that is responsible for innovation in the long term, it should consider implementing these activities as routines, to gain from their repetitive nature. The activities indicate clear methods of involving customers and employees in the process of innovation. The result of this involvement is information that can be converted to knowledge. The stages to be followed that correspond to the innovation process are concretely stated and general in nature, as they focus on personal involvement and collaboration and not on technological advancements and capabilities. This makes the diagrams applicable in a wider range of cases, without specifying the technical processes depending on a specific industry. This is a way to address the variable character and inherent uncertainty that must be considered when developing innovations. The recommended routines provide management the opportunity of increasing customer retention as well as identifying potential customers with whom to work closely in diverse relevant activities. Hence, it allows a firm to build relationships, increase trust and put forward a two-sided learning platform for dialogue and information sharing in a transparent way that incentivizes feedback that can be used to improve an intermediate solution.

Recommendation #4: Have an implemented process that allows the company to create internal knowledge by acquiring and converting information.

The innovation process illustrated in this research starts with information acquisition and continues with converting it to obtain internal knowledge. This is a more detailed perspective of innovation that can hopefully change how managers view it. By stating that information is an initial step and that knowledge is obtained internally, the purpose is to modify the prevalent approach of management that knowledge has to be obtained from outside so that the company can innovate.

In the literature, it is stated that there are several paths toward innovation (O'Connor and DeMartino, 2006). One is with new capabilities by obtaining licenses for new technologies or by acquiring new companies that have them. The other approach is through organic growth by new

lines of businesses that are identified and developed within the organization by individuals and innovation groups. This research argues for the second approach.

The pursuit of new knowledge that is obtained internally advocates the need for originality in the innovation process. This can result in products and services that have significant differences from other alternatives and that can register market success. A series of issues can be identified with copying a business model or framework and bringing it to another country as there are diminishing returns for doing so. The competition can follow the same process and that leaves the company with nothing with which to differentiate itself. Another issue is that the possibilities for expansion are limited as the technology is borrowed and has no new characteristics. A technology that is licensed should be an instrument that supports obtaining innovation and not a part of that innovation.

It is also true that the company can obtain external knowledge by purchasing a technology or by contacting another company to outsource R&D. This is also an acceptable approach to collect knowledge, but it can be argued that internal knowledge is a better determinant of innovation. This is because internal knowledge influences the type of knowledge that can be assimilated through absorptive capacity (Liao et al., 2007), so it is possible that a company will not be able to integrate a new technology if it does not have sufficient internal knowledge. Internal knowledge also gives the company opportunities to differentiate itself through its solutions from the competition. The data that were collected were also indicative of this theory, as the interviewed companies had procedures for collecting information and obtaining knowledge, as opposed to borrowing it from the outside. Knowledge that is produced internally is usually specialized for an industry and context so it is difficult to imitate and transfer. Innovation is the result of originality and creativity so the knowledge that supports it also has to be aligned to such principles.

The diagram provides companies with a clear distinction between the stages of collecting information and supports the development of innovations in a systematic fashion. This helps managers to incrementally work and sign-off each stage, before continuing to the next. Thus, errors and redundant work can be avoided which increases, in turn, the overall efficiency. The increase in efficiency, entailed by individual innovations, means that a firm can allocate and manage its resources, such as labor, capital and infrastructure more efficiently and, therefore, increase its capacity to develop further innovations.

Recommendation #5: Have the flexibility to change the organizational structure and the knowledge flow, if the innovation so requires.

The interview resondents agreed that the organizational structure of the company influences the innovation process, so the need for new involvement activities or separate organizational structures becomes apparent. Big companies with complex hierarchies can inhibit innovation, while start-ups support it because they need it. Big companies also have fixed responsibilities for employees and cannot change easily as they require many procedures to function properly. The start-ups are more flexible and can incentivize the creativity and collaboration between all employees that is a requirement for innovation.

The difficulties that big companies have in developing innovations can be clearly seen in the Synosia case. Synosia is not a big company, but it was licensed a molecule for research from Roche, a much larger company, that could not be developed internally. The reason for this is because Roche had procedures working and required a lot of approvals before starting research, as is usually the case in big pharma companies. Synosia had a reduced size, was flexible and had the ability to make fast decisions, so it was chosen to develop the molecule because it was more aligned to innovation.

The activities of customer and employee involvement change the knowledge flow by allowing new ideas and knowledge to come from multiple sources and by adjusting routines to support innovation. Big companies have a top to bottom knowledge flow so that knowledge is sent downward in the hierarchy. This is because knowledge is embedded in the organizational routines that have to be followed by employees so the knowledge of the company becomes the law in that setting. The employees are not incentivized to contribute with their own ideas or come up with creative solutions if there are no procedures to support that. The company must incentivize a knowledge flow between all employees as is the case in start-ups, if they want to be in a position to innovate. A way to accomplish this is to find new ways to involve employees and to see if they hold relevant knowledge. The company can also introduce new routines that support collaboration and innovation.

Recommendation #6: The practice of changing solutions because of feedback can lead to innovation.

The feedback loops show the iterative nature of information acquisition and obtaining knowledge that are an initial part of the innovation process. The knowledge that is produced internally can allow the company to change its information acquisition routines or procedures and contact more customers thus making it possible for the process to proceed from the beginning and create a new loop. Knowledge allows the company to have a more detailed perspective on the customers from a market and on an industry.

The knowledge conversion diagram has important managerial implications, as it shows how a company can create its own knowledge through developing solutions in an iterative way. Here, information supports the designing and developing of an intermediate solution. Feedback from customers who see the preliminary solution is useful for redesigning it or for making improvements. This results in an iterative process with solutions that are incrementally better suited to the needs of the customers as their opinions are considered. The last iteration will be a finished solution that can be released. The knowledge the company has obtained consists of the solution that is accepted by the customers and in the production process.

Recommendation #7: Consider the opinion of all relevant stakeholders when setting out to commercialize inventions.

The revised innovation diagram illustrates the distinction between invention and innovation by considering them to be different but related concepts. The process from invention to innovation is also iterative, as the company pitches to investors or stakeholders and can use feedback to

change the presentation and be more convincing, but it is also possible that the innovation project can be shut down if the idea is not good for the market. Start-ups usually require funding from outside the company, as they do not have the resources needed to develop and commercialize an invention by themselves. Individuals who pursue innovation in big companies can try to obtain funding internally from departments inside the company.

The recommendations are also in line with the generative mechanisms of innovation: creativity, flexibility, communication and feedback. By making changes to its routines, procedures and structure the company modifies its organizational context and allows the generative mechanisms to produce a result and support innovation.

To sum up, this research contributes to management theory as it illustrates the complete innovation process and the supporting activities. The feedback loops show the iterative nature of the activities that constitute the innovation process. If the company carries out an activity or develops a solution, the feedback obtained from customers, employees, stakeholders or partners can help it to improve that action in an incremental way and obtain better results as it has new guidelines to follow and more nuanced objectives. This principle remains true during the whole innovation process as the company learns by obtaining feedback and develops new solutions that have the potential to be innovative.

6.2 LIMITATIONS OF THIS RESEARCH

The journey of this DBA thesis was accompanied by steady learning and various struggles to constantly redefine and refine the structure and argumentation with its logical flow reaching, ultimately, a thread throughout the thesis. This research considered the concept of innovation in detail by illustrating it as a process that incorporates a series of activities. Nevertheless, it is still natural for some limitations to exist that have to be stated together with some arguments on how to surpass them.

The first limitation is that this research was undertaken by one individual which provides a limitation in terms of having only one point of view regarding interpretation. The second limitation is that adopting a specific theoretical approach, such as case studies, limits the angle of interpreting a specific phenomenon. The third limitation of this research is derived from the sample number or size of cases used. However, Eisenhardt (1989) and Stake (2006) argue that a sample of ten cases is good enough to define a new construct and two detailed case studies is the minimum requirement in this respect. Still, in terms of corroboration and generalization, the sample can be considered insufficient. For the three case studies, Avaloq, Synosia and the banking case, the number is, itself, limiting, constituting a reduced cross case setting. Yet, detailed case studies do provide a rich pool of qualitative information, making the analysis of more detailed case studies impractical, due to time and resource constraints. In order to supplement this reduced number of cases and to ensure a macro perspective, a number of background information interviews were also carried out. To further corroborate the validity of this new construct, the author intends to conduct additional research, in order to contrast its results by examining more case studies from equally diverse industries, although still focused on the development of innovations.

The age of an innovation limits a study, too. For old innovations, respondents rely solely on their memories and notes, and cannot explain the innovation process in real time, so the information can be ambiguous. This limitation was partially addressed by interviewing respondents that have been directly involved in the innovation process so they have the most information. Another way to address this limitation is by including case studies and interviews that concerned an ongoing innovation.

6.3 AVENUES FOR FUTURE RESEARCH

Future research could focus on studying *how* the activities identified reduce the information defect, both in general and in concrete terms. In particular, further research can be valuable, in order to analyze the learning processes, in terms of negative and positive feedback loops for each individual activity that is said to influence the information acquisition process for innovation. Such analysis could also dive into single- and double-loop learning cycles and reveal whether and how they contribute to the dynamics between activities.

Another direction for future research is knowledge conversion and its underlying and complex process. Knowledge conversion is defined, here, as turning information into knowledge as opposed to cycling through different types of knowledge. This thesis illustrates the process of knowledge conversion as obtaining incrementally better solutions because of feedback, but it is possible that other interpretations can also be viable. Knowledge is situated at the intersection between theory and practice and the actions that help to obtain it warrant additional studies and approaches.

The modeled influencing relationships offer a number of interesting research opportunities to develop in the future. The model, with its influencing relationship effects, based on feedback loops, can be either used in future studies or further developed to achieve a series of different research objectives, such as greater verification, generalization, or comparison. In short, this study provides an array of opportunities for researchers to build upon in future studies. For example, a focus on the "presence of the activities" could explain why activities appear in different places in the model depending on the industry. For example, future studies could investigate the learning processes in terms of feedback loops. Looking at different "theoretical concepts", which apply for different innovations in various industries, could reveal the reason why those specific concepts change under different circumstances or settings. Investigating the feedback loops of innovations in different industries could identify the differences between them and result in different models that are applicable for specific cases. Furthermore, having more cases on biotechnology, related to "transaction cost theory" application for out-licensing/outsourcing molecules to smaller specialized firms, would provide greater insight and add to the generality of the theoretical findings on the phenomenon of innovations in that industry. Learning processes can be explored more within the context of this study and future studies should develop them.

Differences in industries can also be considered more extensively. For example, the biotechnology industry requires various and difficult FDA approvals, making the innovation development more complicated. To restate, the molecules development, resulting in an exponential variation

of solutions, also makes innovations in biotechnology more complex. Innovations in the IT industry depend mainly on the applicability and acceptance by customers, and do not have to pass agency approvals. Therefore, the development is more condensed and the appearance of the activities in each stage can be different, compared to the biotechnology industry.

The differing processing implies that differing contextual theoretical concepts apply**.** The reason for the above-mentioned variation in industry behavior, particularly that of Roche's out-licensing of the molecule SYN-115 to Synosia, shows that such innovations underlie different additional theoretical concepts, when compared to Avaloq's IT software innovation. Synosia's innovation is not only based on innovation theory, but also explained by transaction cost theory, whereas Avaloq's appears to be purely driven by innovation theory. The out-licensing from Roche to Synosia and the customer-supplier interaction reduces the drug development and cost by 50%, from approximately 12 years and $1 billion down to six years and $500 million. The higher costs are based on the fact that big players such as Roche and Novartis "are usually a bit more conservative, risk aversive" (Meya, 2010, p. 6), and "they were very inflexible, very conservative and it would take a big effort or be impossible to implement it in big Pharma" (p.6). Big pharma companies have high costs and have difficulties in organizing and convincing individuals to pursue something new. A solution for them to minimize risk and cost is to outsource molecule development to another company and then buy it back.

This outsourcing would be grounded in the rationale of transaction cost theory (Coase, 1960) and transaction cost analysis (Williamson, 1975; 1979), where big companies also have higher costs than specialized firms, such as Synosia, that make faster and more efficient decisions. More efficient decisions entail, therefore, shorter and less costly development times, compared to big players such as Roche and Novartis. In this respect, Roche identified that their costs would be lower when the development of the molecule SYN-115 was outsourced to Synosia. This is also an interesting perspective that tries to determine the cost of developing an innovation and it illustrates the paradox that big companies have greater difficulties in this case when compared to smaller companies. The high costs big companies have, in addition to complex hierarchies, unidirectional knowledge flows and reduced collaboration, is a factor that makes innovation difficult to achieve when compared to smaller companies. The cost of innovation and the practice of outsourcing to smaller companies is also a promising avenue for additional research.

1 REFERENCE LIST

Acemoglu, D., Aghion, P. & Zilibotti, F. (2006). Distance to frontier, selection and economic growth. *Journal of the European Economic Association*, 4(1), 37-74.

Ackoff, R. L. (1989). From data to wisdom. *Journal of Applied Systems Analysis*, 16, 3-9.

Adams, P., Brusoni, S. & Malerba, F. (2011). Knowledge, supply and demand in industrial development: A sectoral system perspective. *Innovation and Development*, 1(2), 167-185.

Agerfalk, P. J., Goldkuhl, G., Fitzgerald, B. & Bannon, L. (2006). Reflecting on action in language, organizations and information systems. *European Journal of Information Systems*, 15(1), 4-8.

Alavi, M. & Leidner, D. E. (1999). Knowledge management systems: issues, challenges, and benefits. *Communications of the AIS*, 2nd edition, 1-12.

Alavi, M., Yoo, Y. & Vogel, D.R. (1997). Using information technology to add value to management education. *The Academy of Management Journal*, 40(6), 1310-1333.

Anderson, J. C., Håkansson, H. & Johanson, J. (1994). Dyadic business relationships within a business network context. *Journal of Marketing*, 58(4), 1-15.

Anderson, J. C. & Narus, J. A. (2003). Selectively pursuing more of your customer's business. *MIT Sloan Management Review*, 44(3), 42-49.

Andreeva, T. & Kianto, A. (2011). Knowledge processes, knowledge-intensity and innovation: A moderated mediation analysis. *Journal of Knowledge Management*, 15(6), 1016-1034.

Ardichvili, A., Cardozo, R. & Ray, S. (2003). A theory of entrepreneurial opportunity identification and development. *Journal of Business Venturing*, 18(1), 105-123.

Argote, L. (1999). *Organizational Learning: Creating, Retaining and Transferring Knowledge*. Boston: Kluwer Academic.

Argote, L. & Ingram, P. (2000). Knowledge transfer: A basis for competitive advantage in firms. *Organizational Behaviour and Human Decision Processes*, 82(1), 150-169.

Argyris, C. (1977). Organizational learning and management information systems. Accounting, *Organizations and Society*, 2(2), 113-123.

Argyris, C. & Schon, D. (1978). *Organizational Learning*. Reading, MA: Addison-Wesley.

Arrow, K. J. (1962). The economic implications of learning by doing. *Review of Economic Studies*, 29(3), 155-173.

Arthur, W. B. (2007). The structure of invention. *Research Policy*, 36(2), 274-287.

Audretsch, D. B. (1995). Innovation, growth and survival. *International Journal of Industrial Organization*, 13(4), 441-457.

Atuahene-Gima, K., Slater, S.F. & Olson, E.M. (2005). The contingent value of responsive and proactive market orientations for new product program performance. *Journal of Product Innovation Management*, 22(6), 464-482.

Baldwin, C. & Von Hippel, E. (2011). Modelling a paradigm shift: From producer innovation to user and open collaborative innovation. *Organization Science*, 22(6), 1399-1417.

Bamberger, P. (2008). Beyond contextualization: Using context theories to narrow the micro-macro gap in management research. *Academy of Management Journal*, 51(5), 839-846.

Bansal, P. & Corley, K. (2011). The coming of age for qualitative research: Embracing the diversity of qualitative methods. *Academy of Management Journal*, 54(2), 233-237.

Bartel, C. A. & Garud, R. (2009). The role of narratives in sustaining organizational innovation. *Organization Science*, 20(1), 107-117.

Bass, F. M. (1969). A new product growth model for consumer durables. *Management Science*, 15(5), 215-227.

Bateson, G. (1972). *Form, Substance and Difference, in Steps to an Ecology of Mind*. University of Chicago Press, 448-466.

Becker, M. C., Lazaric, N., Nelson, R. R. & Winter, S. G. (2005). Applying organizational routines in understanding organizational change. *Industrial and Corporate Change*, 14(5), 775-791.

Becker, M. C. & Zirpoli, F. (2008). Applying organizational routines in analysing the behaviour of organizations. *Journal of Economic Behavior and Organization*, 66(1), 128-148.

Belbay, N. & Houze, E. (2007). Etude empirique de l'effet de la creation de connaissances sur le processus de developpement de nouveaux produits, XVI International Conference of Strategic Management, Montreal, 6-9 June.

Belkahla, W., Triki, A. & Mjahed Hammami, S. (2014). Developing a customer knowledge-based measure for innovation management. *European Journal of Innovation Management*, 17(3), 349-374.

Bell, G. G. (2005). Clusters, networks and firm innovativeness. *Strategic Management Journal*, 26(3), 287-295.

Benner, M. J. & Tushman, M. L. (2003). Exploitation, exploration and process management: The productivity dilemma revisited. *Academy of Management Review*, 28(2), 238-256.

Bereiter, C. (2002). *Education and mind in the knowledge age*. Mahwah, NJ; London: Lawrence Erlbaum Associates.

Berggren, C., Bergek, A., Bengtsson, L., Hobday, M. & Soderlund, J. (2011). *Knowledge Integration and Innovation: Critical Challenges Facing International Technology Based Firms*. Oxford: Oxford University Press.

Berthon, P., Hulbert, J. M. & Pitt, L. F. (1999). To serve or create? Strategic orientation toward customers and innovation. *California Management Review*, 42(1), 37-58.

Bhaskar, R. (1975). *A Realist Theory of Science.* Routledge.

Bhaskar, R. (1979). *The Possibility of Naturalism: A Philosophical Critique of the Contemporary Human Sciences.* Atlantic Highlands, N. J.: Humanities Press.

Bhaskar, R. (2008). *Dialectic: The Pulse of Freedom.* London; New York: Routledge.

Biemans, W. G. (1991). User and third-party involvement in developing medical equipment innovations. *Technovation*, *11*(3), 163-182.

Bilgram, V., Brem, A. & Voight, K. (2008). User-centric innovations in new product development: Systematic identification of lead users harnessing interactive and collaborative online tools. *International Journal of Innovation Management*, 12(3), 419-458.

Birkinshaw, J., Bouquet, C. & Barsoux, J. L. (2011). The 5 myths of innovation. *MIT Sloan Management Review*, 52(2), 43-50.

Birnholtz, J. P., Cohen, M. D. & Hoch, S. V. (2007). Organizational character: On the regeneration of camp poplar grove. *Organization Science*, 18(2), 315-332.

Bissola, R. & B. Imperatori. (2011). Organizing individual and collective creativity: Flying in the face of creativity clichés. *Creativity and Innovation Management*, 20(2), 77-89.

Boisot, M. H. (1998). *Knowledge Assets*. Oxford University Press: New York.

Booker, L. D., Bontis, N. & Serenko, A. (2008). The relevance of knowledge management and intellectual capital research. *Knowledge and Process Management*, 15(4), 235-246.

Borghoff, U. M. & Pareschi, R. (1997). Information technology for knowledge management. *Journal of Universal Computer Science*, 3(8), 835-842.

Bossink, B. A. (2002). The development of co-innovation strategies: Stages and interaction patterns in interfirm innovation. *R&D Management*, 32(4), 311-320.

de Brentani, U. (1991). Success factors in new developing business services. *European Journal of Marketing*, 25(2), 33-59.

de Brentani, U. (2001). Innovative versus incremental new business services: Different keys for achieving success. *The Journal of Product Innovation Management*, 18(3), 169 - 187.

Brockhoff, K. (2003). Customers' perspectives of involvement in new product development. *International Journal of Technology Management*, 26(5-6), 464-481.

Brockman, B. K. & Morgan, R. M. (2003). The role of existing knowledge in new product innovativeness and performance. *Decision Science*, 34(2), 385-419.

Brown, J. S. & Duguid, P. (1991). Organizational learning and communities of practice: Toward a unified view of working, learning and innovation. *Organization Science*, 2(1), 40-57.

Brown, S. L. & Eisenhardt, K. M. (1995). Product development: Past research, present findings, and future directions. *Academy of Management Review*, 20(2), 343-378.

Bryman, A. (1988). *Quantity and Quality in Social Research*. New York, NY: Unwin Hyman.

Bryman, A. & Burgess, R.G. (1994). *Analyzing qualitative data*. London: Routledge.

Burgelman, R. A. (1994). Fading memories: A process theory of strategic business exit in dynamic environments. *Administrative Science Quarterly*, 39(1), 24-56.

Burnes, B. (2005). Complexity theories and organizational change. *International Journal of Management Review*, 46(4), 26-34.

Byrne, S., Todd, D., Simpson, B., Woods, C. & Seidel, R. (2002). Inquiring into learning as system. In: G. Ragsdell, D. West and J. Wilby, eds. *Systems Theory and Practice in the Knowledge Age*, Kluwer Academic/Plenum Publishers, New York.

Calantone, R. & Cooper, R. G. (1981). New product scenarios: Prospects for success. *The Journal of Marketing*, 45(2), 48-60.

Callahan, J. & Lasry, E. (2004). The importance of customer input in the development of very new products. *R&D Management*, 34(2), 107-120.

Campbell, D. T. (1975). Degrees of freedom and the case study. *Comparative Political Studies*, 8(1), 178-191.

Campbell, D. T. & Stanley, J. C. (1966). *Experimental and Quasi-Experimental Designs for Research*. Chicago: Rand McNally.

Carley, K. M. (1996). Artificial intelligence within sociology. *Sociological Methods and Research*, 25(1), 3-28.

Caruso, H. M., Rogers, T. & Bazeman, M. H. (2009). Boundaries need not be barriers: Leading collaboration among groups in decentralized organizations. Crossing the Divide: Intergroup Leadership in a World of Difference, 113-125.

Cassell, C. & Symon, G. (1994). Qualitative research in work contexts. In: Cassell, C. & Symon, G, eds. *Qualitative Methods in Organizational Research*, A Practical Guide, London: Sage, 1-13.

Cefis, E & Marsili, O. (2003). Survivor: The role of innovation in firm's survival. Koopmans Institute, USE, Ultrecht University, 3-18.

Chandy, R. & Tellis, G. (1998). Organizing for radical product innovation: The overlooked role of willingness to cannibalize. *Journal of Marketing Research*, 35(4), 474-487.

Chandy, R. & Tellis, G. (2000). The incumbent's curse? Incumbency, size and radical product innovation. *Journal of Marketing*, 64(3), 1-17.

Chesbrough, H. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Press, Boston, MA.

Chesbrough, H. (2006). *Open Business Models: How to Thrive in the New Innovation Landscape*. Boston: Harvard Business School Press.

Chesbrough, H. (2008). Managing false negatives. *Harvard Management Update*, 13, 4.

Chesbrough, H. & Appleyard, M. M. (2007). Open innovation and strategy. *California Management Review*, 50(1), 57-76.

Choi, B., Poon, S. K. & Davis, J. G. (2008). Effects of knowledge management strategy on organizational performance: A complementarity theory-based approach. *Omega*, 36(2), 235-251.

Choo, C. W. & Bontis, N. (2002). *The Strategic Management of Intellectual Capital and Organizational Knowledge*. Oxford: Oxford University Press.

Clark, K. B., & Fujimoto, T. (1991). *Product development performance: Strategy, organization and management in the world auto industry*. Boston, MA: Harvard Business School Press.

Cloutier, L. M. & Rowley, R. (2000). *The Emergence of Simulation in Economic Theorizing and Challenges to Methodological Standards*. Working Paper.

Coase, R. H. (1960). The problem of social cost. *Journal of Law and Economics*, 3, 1-44.

Cohen, W. M. & Levinthal, D. A. (1989). Innovation and Learning: The two faces of R&D. *The Economic Journal*, 397(99), 569-596.

Cohen, W. M. & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1), 128-152.

Collier, A. (1994). *Critical Realism: An Introduction to Roy Bhaskar's Philosophy.* London: Verso.

Cooper, R. G., Easingwood, C. J., Edgett, S., Kleinschmidt, E. J. & Storey, C. (1994). What distinguishes the top performing new products in financial services. *Journal of Product Innovation Management*, 11, 281-299.

Cooper, R. G. (2001). *Winning at New Products: Accelerating the Process from Idea to Launch*. USA, NY: Basic Book.

Cooper, R. G. & Kleinschmidt, E. J. (1986). An investigation into the new product process: Steps, deficiencies and impact. *The Journal of Product Innovation Management*, 3(2), 71-85.

Corbin, J. & Strauss, A. (2008). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. Thousand Oaks: CA, SAGE Publications.

Corley, K. G. & Gioia, D. A. (2011). Building theory about theory building: What constitutes a theoretical contribution? *Academy of Management Review*, 36(1), 12-32.

Cormican, K. & O'Sullivan, D. (2004). Auditing best practice for effective product innovation management. *Technovation*, 24(10), 819-829.

Coviello, N. E. & Joseph, R. M. (2012). Creating major innovations with customers: Insights from small and young technology firms. *Journal of Marketing*, 76(6), 87-104.

Coyne, I.T. (1997). Sampling in qualitative research. Purposeful and theoretical sampling: Merging or clear boundaries? *Journal of Advanced Nursing*, 26(3), 623-630.

Creswell, J. W. (2002). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Upper Saddle River, NJ: Pearson Education.

Creswell, J.W. (2003). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. London: Sage Publications LTD.

Cusumano, M. & Nobeoka, K. (1998). *Thinking Beyond Lean*. Free Press: New York.

Cyert, R. M. & March, J. G. (1992). *A Behavioural Theory of the Firm*. Blackwell, Cambridge, MA.

D'Adderio, L. (2008). The performativity of routines: Theorising the influence of artefacts and distributed agencies on routines dynamics. *Research Policy*, 37(5), 769-789.

Da Mota Pedrosa, A. (2012). Customer integration during innovation development: An exploratory study in the logistics service industry. *Creativity and Innovation Management*, 21(3), 263-276.

Daft, R. L., Sormunen, J. & Parks, D. (1998). Chief executive scanning, environmental characteristics and company performance: An empirical study. *Strategic Management Journal*, 9(2), 123-139.

Dahan, E., & Hauser, J.R. (2002). The virtual customer. *Journal of Product Innovation Management*, 19(5), 332-353.

Dahiyat, S. E. & Al-Zu'bi, Z. M. F. (2012). The role of knowledge acquisition in facilitating customer involvement in product development: Examining the mediation effect of absorbtive capacity. *International Journal of Learning and Change*, 6(3), 171-206.

Damanpour, F. (1991). Organizational innovation: A meta-analysis of effects of determinants and moderators. *The Academy of Management Journal*, 34(3), 555-590.

Darroch, J. (2005). Knowledge management, innovation and firm performance. *Journal of Knowledge Management*, 9(3), 101-115.

Darroch, J., & McNaughton, R. (2002). Examining the link between knowledge management practices and types of innovation. *Journal of Intellectual Capital*, 3(3), 210-222.

Davenport, T. H. & Prusack, L. (1998). *Working Knowledge: How Organizations Manage what they Know.* Boston: Harvard Business School Press.

Davidow, W.H. (1986). *Marketing High Technology*. New York: The Free Press.

Davies, N. J., Stewart, R. S. & Weeks, R. (1998). Knowledge sharing agents over the World Wide Web. *British Telecom Technology Journal*, 16(3), 104-109.

Day, G. S. (2002). Winning the competition for customer relationships. *Sloan Management Review*, 51, 2-20.

Deeds, D. L. (2001). The role of R&D intensity, technical development and absorbtive capacity in creating entrepreneurial wealth in high technology start-ups. *Journal of Engineering and Technology Management*, 18(1), 29-47.

DeMaio, A., Verganti, R. & Corso, M. (1994). A multi-project framework for new product development. *European Journal of Operational Research*, 78(2), 178-191.

Denzin, N.K. & Lincoln, Y. S. (2005). Introduction: The discipline and practice of qualitative research. In: Denzin, N. K. & Lincoln, Y. S. eds. *The SAGE handbook of qualitative research*. 3rd ed., pp. 1-32, Thousand Oaks, CA: Sage.

Dewar, R. D. & Dutton, J. E. (1986). The adoption of radical and incremental innovations: an empirical analysis. *Management Science*, 32(11), 1422-1433.

Dey, I. (1993*). Qualitative Data Analysis: A User-Friendly Guide for Social Scientists.* London: Routledge.

Deszca, G., Munro, H. & Noori, H. (1999). Developing breakthrough products: Challenges and options for market assessment. *Journal of Operations Management*, 17(5), 613-630.

Di Stefano, G., Gambardella, A. & Verona, G. (2012). Technology push and demand pull perspectives in innovation studies: Current findings and future research directions, *Research Policy*, 41(8), 1283-1295.

Dosi, G. (1982). Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technical change. *Research Policy*, 11(3), 147-162.

Dougherty, D. (1992). Interpretive barriers to successful product innovation in large firms. *Organization Science*, 3(2), 179-202.

Dougherty, D. (1995). Managing your core incompetencies for corporate venturing. *Entrepreneurship, Theory and Practice*, 19(3), 113-135.

Dougherty, D. (2008). Bridging social constraint and social action to design organizations for innovation. *Organizational Studies*, 29(3), 415-434.

Drazin, R., Glynn, M. A. & Kazanjian, R. K. (1999). Multi-level theorizing about creativity in organizations: A sense-making perspective. *Academy of Management Review*, 24(2), 286-308.

Drucker, P. F. (1994). *Innovation and Entrepreneurship: Practice and Principles*. London: Heinemann.

Du Plessis, M. (2007). The role of knowledge management in innovation. *Journal of Knowledge Management*, 11(4), 20-29.

Dutta, S., Narasimhan, O. & Rajiv, S. (1999). Success in high-technology markets: Is marketing capability critical? *Marketing Science*, 18(4), 547-568.

Easingwood, C. J. & Storey, C. (1992). Service success and the service offering. In: Proceedings of the Marketing Educators Groups Conference, University of Salford, 544-554.

Easterby-Smith, M. Thorpe, R. & Lowe, A. (2002) *Management Research: An Introduction*. London: Sage Publications LTD.

Edmondson, A. C., Bohmer, R. M. & Pisano, G. P. (2001). Disrupted routines: Team learning and new technology implementation in hospitals. *Administrative Science Quarterly*, 46(4), 685-716.

Edwards, M. (1994). NGOs in the age of information. *IDS Bulletin*, 25(2), 117-124.

Eisenhardt, K.M. (1989). Building theories from case study research. *Academy of Management Review*, 14(4), 532-550.

Eisenhardt, K. M. & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of Management Journal*, 50(1), 25-32.

Ellis, H. C. (1965). *The Transfer of Learning*. New York: MacMillian.

Engen, M. & Holen, I. E. (2014). Radical versus incremental innovation: The importance of key competences in service firms. *Technology Innovation Management Review*, 4(4), 15-25.

Essers, J. & Schreinemakers, J. (1997). Nonaka's subjectivist conception of knowledge in corporate knowledge management. *Knowledge Organization*, 24(1), 24-32.

Estes, W. K. (1970). *Learning Theory and Mental Development*. New York: Academic Press.

Eveleens, C. (2010). Innovation Management: A Literature Review of Innovation Process Models and their Implications. Nijmegten, NL: Lectoraat Innovatie Publieke Sector. Available at: http://www.lectoraatinnovatie.nl/wp-content/uploads/2011/01/Innovation-management-literature-review-.pdf.

Eysenck, H. J. (1976). Introduction. In: Eysenck, H. J. ed. *Case Studies in Behaviours Therapy*, 1-15. London: Routledge.

Fang, E. (2008). Customer participation and the trade-off between new product innovativeness and speed to market. *Journal of Marketing*, 72(4), 90-104.

Feldman, M. S. (2000). Organizational routines as a source of continuous change. *Organization Science*, 11(6), 611-629.

Feldman, M. S. & Orlikowski, W. J. (2011). Theorizing practice and practicing theory. *Organization Science*, 22(5), 1240-1253.

Feldman, M.S. & Pentland, B.T. (2003). Reconceptualizing organizational routines as a source of flexibility and change. *Administrative Science Quarterly*, 48(1), 94-118.

Feldman, M. S. & Rafaeli, A. (2002). Organizational routines as sources of connections and understanding. *Journal of Management Studies*, 39(3), 309-331.

Feng, T., Sun, L. and Y. Zhang (2010). The effects of customer and supplier involvement on competitive advantage: An empirical study in China. *Industrial Marketing Management*, 39(8), 1384-1394.

Fernandez, F. (2009). Avaloq CEO. Interview.

Fleetwood, S. (2005). Ontology in organization and management studies: A critical realist perspective. *Organization*, 12(2), 197-222.

Flick, U. (2006). *An Introduction to Qualitative Research*. 3rd edition. London: SAGE Publications.

Fontana, R. (2000). Determinants of innovation and competition of component system technologies in the Local Area Network industry. KITeS Working Papers 117, KITeS, Centre for Knowledge, Internationalization and Technology Studies, Universita Bocconi, Milano, Italy, revised Sep 2000.

Ford, C. M. & Gioia, D. A. (2000). Factors influencing creativity in the domain of managerial decision making. *Journal of Management*, 26(4), 705-732.

Ford, D. & Sterman, J. (1998). Dynamic modelling of product development processes. *System Dynamics Review*, 14(1), 31-68.

Ford, D. (1999). A behavioural approach to feedback loop dominance analysis. *System Dynamics Review*, 15(1), 3-36.

Forrester, J. (1961). *Industrial Dynamics*. MIT press, Boston.

Forrester, J. (1975). A national model for understanding social and economic change. *Simulation Today*, 24(4), 125-128.

Forrester, J. (1994). Policies, decisions and information sources for modelling. In: Morecroft, J. D. W. and Sterman, J. D. eds. *Modelling for Learning Organizations*. Portland: Productivity Press.

Fowler, A. (1992). *Prioritizing Institutional Development: A New Role for NGO Centres for Study and Development*, IIED Gatekeeper Series No. 35. London: International Institute for Environment and Development.

Franke, N., von Hippel, E. & Schreier, M. (2006). Finding commercially attractive user innovations: A test of lead-user theory. *The Journal of Product Innovation Management*, 23(4), 301-315.

Frenken, K. (2006). Technological innovation and complexity theory. *Economic Innovation and New Technology*, 15(2), 137-155.

Friend, J. (1989). The strategic choice approach. Chapter 6. In: Rosenhead, J. ed. *Rational Analysis for a Problematic World*. Chichester: John Wiley & Sons.

Galanakis, K. (2006). Innovation process. Make sense using systems theory. *Technovation*, 26(11), 1222-1232.

Galbraith, J. R. (1982). Designing the innovating organization. *Organizational Dynamics*, 11(1), 5 -25.

Gamble, P. R. & Blackwell, J. (2002). *Knowledge Management: A State of the Art Guide.* London: Kogan Page.

Garud, R. (1997). On the distinction between know-how, know-why and know-what. *Advances in Strategic Management*, 14, 81-101.

Garud, R., Gehman, J. & Giuliani, A. P. (2014). Contextualizing entrepreneurial innovation: A narrative perspective. *Research Policy*, 43(7), 1177-1188.

Garud, R. & Van de Ven, A. H. (1992). An empirical evaluation of the internal corporate venturing process. *Strategic Management Journal*, 13(1), 93-109.

Garvin, D. (1993). Building a learning organization. *Harvard Business Review*, 71(4), 78-91.

Gasson, S. (1998). A social action model of situated information systems design. *Proceedings of IFIP WG8.2 & WG8.6 Joint Working Conference on Information Systems: Current Issues and Future Changes*. Helsinki, Finland.

Gebhardt, E. (2011). VoIP Enterprise Solutions. Interview.

Gersick, C. J. (1991). Revolutionary change theories: A multilevel exploration of the punctuated equilibrium paradigm. *Academy of Management Review*, 16(1), 10-36.

Gersick, C. J. & Hackman, J. R. (1990). Habitual routines in task-performing groups. *Organizational Behaviour and Human Decision Processes*, 47(1), 65-97.

Gharajedaghi, J. (2006). *Systems thinking, managing chaos and complexity: A platform for designing business architecture*. Burlington, MA: Elsevier.

Gioia, D. A., Corley, K. G. & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods*, 16(1), 15-31.

Glance, N., Arregui, D. & Dardenne, M. (1999). Knowledge pump: Supporting the flow and use of knowledge. In: Borghoff, U. and Pareschi, R. eds. *Information Technology for Knowledge Management*. Springer Verlag.

Glaser, B. (1992). *Basics of Grounded Theory Analysis*. California: Sociology Press.

Glaser, B. & Strauss, A., (1967) *The Discovery of Grounded Theory*. Hawthorne, NY: Aldine Publishing Company.

Glesne, C., (1999). *Becoming Qualitative Researchers: An Introduction*. 2nd edition. New York: Longman.

Gnyawali, D. R. & Stewart, A. C. (2003). A contingency perspective on organizational learning: Integrating environmental context, organizational learning processes and types of learning. *Management Learning*, 34(1), 63-89.

Goh, A. L. S. (2005). Harnessing knowledge for innovation: An integrated management framework. *Journal of Knowledge Management*, 9(4), 6-18.

Gopalakrishnan, S. & Bierly, P. (2001). Analyzing innovation adoption using a knowledge-based approach. *Journal of Engineering and Technology Management*, 18(2), 107-130.

Grant, R. M. (1996). Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. *Organization Science*, 7(4), 375-387.

Greenacre, P., Gross, R. & Speirs, J. (2012). Innovation theory: A review of literature, ICEPT Working Paper.

Greer, C.R. & Lei, D. (2012). Collaborative innovation with customers: A review of the literature and suggestions for future research. *International Journal of Management Reviews*, 14(1), 63-84.

Gruner, K.E. & Homburg, Ch. (2000). Does customer interaction enhance new product success? *Journal of Business Research*, 49(1), 1-14.

Gummesson, E. (1991). *Qualitative Methods in Management Research*. Newbury Park, CA: Sage Publications Inc.

Gupta, A. K., Tesluk, P. E. & Taylor, M. S. (2007). Innovation at and across multiple levels of analysis. *Organization Science*, 18(6), 885-897.

Hagel, J., III & Singer, M. (1999). *Net Worth: Shaping Markets when Customers Make the Rules*. Boston: Harvard Business School Press.

Hakansson, H. & Snehota, I. (1989). No business is an island. *Scandiavian Journal of Management*, 22(3), 187-200.

Hamel, G. and Prahalad, C. K. (1994). *Competing for the future*. Boston, MA: Harvard Business School Press.

Handfield, R. B. & Melnyk, S. A. (1998). The scientific theory-building process: a primer using the case of TQM. *Journal of Operations Management*, 16(4), 321-339.

Hanna, N., Ayers, D.J., Ridnour, R.E. & Gordon, G.L. (1995). New product development practices in consumer versus business products organizations, *Journal of Product & Brand Management*, 4(1), 33-55.

Hannan, M. T. & Freeman, J. R. (1983). Structural inertia and organizational change. *American Sociological Review*, 29, 149-164.

Hansen, N. K. & Vogel, R. (2011). Organizational routines: A review and outlook on practice-based micro-foundations. *Economics, Management and Financial Markets*, 6(3), 86-111.

Haraldsson, H. V. & Sverdrup, H. U. (2003). Finding simplicity in complexity in biogeochemical modelling. In: Wainwright, J. and Mulligan, M. eds. *Enviornmental Modelling: Finding Simplicity in Complexity*. New York: Wiley.

Harsh, O.K. (2009). Three dimensional knowledge management and explicit knowledge reuse. *Journal of Knowledge Management Practice*, 10(2), 1-10.

Hart, J. A., Reed, R. & Bar, F. (1992). The building of the Internet: Implications for the future of broadband networks. *Telecommunications Policy*, 16(8), 666-689.

Hayes, M. & Walsham, G. (2003). Knowledge sharing and ICTs: A relational perspective. In: Easterby-Smith, M. & Lyles, M. eds. *The Blackwell Handbook of Organizational Learning and Knowledge Management*. Malden, MA: Blackwell.

Henderson, R. & Clark, K. (1990). Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. *Administrative Science Quarterly*, 35(1), 9-30.

Henry, N. L. (1974). Knowledge management: A new concern for public administration. *Public Administration Review*, 34(3), 189-196.

Herrmann, A., Gassmann, O. & Eisert U. (2007). An empirical study of the antecedents for radical product innovations and capabilities for transformation. *Journal of Engineering and Technology Management*, 24(1), 92-120.

Herstatt, C. E. & von Hippel, E. (1992). From experience: Developing new product concepts via the lead user method. A case study in a "low-tech" field. *The Journal of Product Innovation Management*, 9(3), 213-221.

Higginbottom, G. M. A. (2004). Sampling issues in qualitative research. *Nurse Researcher*, 12(1), 7-19.

Hoeve, A. & Nieuwenhuis, L. F. (2006). Learning routines in innovation processes. *Journal of Workplace Learning*, 18(3), 171-185.

Hoffman, E. (1997). NASA project management: Modern strategies for maximizing project performance. *Project Management Journal*, 28(3), 4-6.

Holsapple, C. W. & Joshi, K. D. (1998). In search of a descriptive framework for knowledge management. *KIKM Research Paper*, 118, Kentucky University.

Homer, J. (1996). Why we iterate: Scientific modeling in theory and practice. *System Dynamics Review*, 12, 1-19.

Hoonsopon, D. & Ruenrom, G. (2012). The impact of organizational capabilities on the development of radical and incremental product innovation and product innovation performance. *Journal of Managerial Issues*, 24(3), 250-276.

Horwitch, M. (1982). *Clipped wings: The American SST conflict*. Cambridge, MA: MIT Press.

Howell, J. M. & Higgins, C. A. (1990). Champions of technological innovation. *Administrative Science Quarterly*, 35(2), 317-341.

Huang, C., Su, J., Xie, X., Ye, X., Li, Z., Porter, A. & Li, J. (2015). A bibliometric study of China's science and technology policies: 1949 - 2010. *Scientometrics*, 102(2), 1521-1539.

Huber, G. P. (1991) Organizational learning: The contributing processes and the literature. *Organization Science*, 2(1), 88-115.

Huizingh, E. E. (2011). Open innovation: State of the art and future perspectives. *Technovation*, 31(1), 2-9.

Hult, G. T. M., Hurley, R. F. & Knight, G.A. (2004). Innovativeness: Its antecedents and impact on business performance. *Industrial Marketing Management*, 33(5), 429-438.

Hurley, R. & Hult, T. (1998). Innovation, market orientation and organizational learning: An integration and empirical examination. *Journal of Marketing*, 62(3), 42-54.

Jansen, J. J., Van den Bosch, F. A. & Volberda, H. W. (2006). Exploratory innovation, exploitative innovation and performance: Effects of organizational antecedents and environmental moderators. *Management Science*, 52(11), 1661-1674.

Jelinek, M. & Schoonhoven, C. (1993). *The Innovation Marathon*. San Francisco: Jossey-Bass.

Jick, T. D. (1979). Mixing Qualitative and Quantitative Methods: Triangulation in Action. *Administrative Science Quarterly*, 24(4), 602-611.

Jones, O. & Craven, M. (2001). Expanding capabilities in a mature manufacturing firm: Absorbtive capacity and the TCS. *International Small Business Journal*, 19(3), 39-55.

Kanter, R. M. (1997). *Innovation: Breakthrough thinking at 3M, DuPont, GE, Pfizer and Rubbermaid*. New York: Harper Business.

Kaplan, S. M. (1999). Discontinuous innovation and the growth paradox. *Strategy & Leadership*, 27(2), 16-21.

Karau, S. J., & Williams, K. D. (1993). Social loafing: A meta-analytic review and theoretical integration. *Journal of Personality and Social Psychology*, 65(4), 681-706.

Kauffman, S. A. (1993). Origins of Order: Self Organization and Selection in Evolution. Oxford: Oxford University Press.

Kaulio, M.A. (1998). Customer, consumer and user involvement in product development: a framework and a review of selected methods. *Total Quality Management*, 9(1), 141-149.

Kazanjian, R. K. & Drazin, R. (2012). Organizational learning, knowledge management and creativity. *Handbook of Organizational Creativity*, 547-568.

Kazanjian, R. K., Drazin, R., & Glynn, M. A. (2002). Implementing strategy for corporate entrepreneurship. In: Hitt, M. A, Ireland, R. D, Camp, S. M. and Sexton, D. L. eds. *Strategic entrepreneurship: Creating a new mindset*, pp. 173-192. Oxford, UK: Blackwell Publishers.

Kellehear, A. (1993). *The Unobtrusive Researcher: A Guide to Methods*. St Leonards, NSW: Allen and Unwin.

Kelley, D. (2009). Adaptation and organizational connectedness in corporate radical innovation programs. *Journal of Product Innovation Management*, 26(5), 487-501.

Kerr, N. L. & Bruun, S. E. (1983). Dispensability of member effort and group motivation losses: Free-rider effects. *Journal of Personality and Social Psychology*, 44(1), 78-94.

Kim, D. (1993). The link between individual and organizational learning. *Sloan Management Review*, 37-50.

Kim, G., Shin, B., Kim, K. K. & Lee, H. G. (2011). IT capabilities, process-oriented dynamic capabilities and firm financial performance. *Journal of the Association for Information Systems*, 12(7), 487-517.

Kline, S. J. & Rosenberg, N. (1986) An overview of innovation. In: Landau, R. and Rosenberg, N. eds. *The Positive Sum Strategy*. Washington: Academy of Engineering Press.

Koerber, A. and McMichael, L. (2008). Qualitative Sampling Methods. *Journal of Business and Technical Communication*, 22(4), 454-473.

Kozinets, R. (1999). E-tribalized marketing? The strategic implications of virtual communities of consumption. *European Management Journal*, 17(3), 252-264.

Kress, G. (1993). Turning information into knowledge. IM Magazine.

von Krogh, G., Roos, J. & Slocum, K. (1994). An essay on corporate epistemology. *Strategic Management Journal*, 15(2), 53-71.

Kunc, M. (2010). Revisiting Porter's generic strategies using system dynamics: When taking book recipes conduces your organization to dysfunctional behaviour in a competitive environment. In:

Mollona, E. ed. *Computational Analysis of Firms' Organization and Strategic Behaviour*. Routledge.

Kunc, M. & Morecroft, J. (2007). System dynamics modelling for strategic development. In: Dyson. R. and O'Brien, F. eds. *Supporting Strategy: Frameworks, Methods and Models*. Wiley & Sons.

Laage-Hellman, J., Lind, F. & Perna, A. (2014). Customer involvement in product development: An industrial network perspective. *Journal of Business-to-Business Marketing*, *21*(4), 257-276.

Lagrosen, S. (2001). Strengthening the weakest link of TQM – from customer focus to customer understanding. *The TQM-Magazine*, 13(5), 348-354.

Lagrosen, S. (2005). Customer involvement in new product development: A relationship marketing perspective. *European Journal of Innovation Management*, 8(4), 424-436.

Langley, A. (1999). Strategies for theorizing from process data. *Academy of Management Review*, 24(4), 691-710.

Lawer, C. (2005). On Customer Knowledge Co-Creation and Dynamics Capability, Working Paper, Granfield University.

Lee, S. M., Olson, D. L. & Trimi, S. (2012). Co-innovation: Convergenomics, collaboration and co-creation for organizational values. *Management Decision*, 50(5), 817-831.

Leiblich, A. (1998). *Narrative Research: Reading, Analysis and Interpretation*. Thousand Oaks, CA: Sage.

Leifer, R., McDermott, C. M. & O'Connor, G. C. (2000). *Radical Innovation: How Mature Companies can Outsmart Upstarts*. Boston, Massachusetts: Harvard Business School Press.

Lehrer, K. (1990). *Theory of Knowledge*. San Francisco: Westview Press.

Leonard, D. (1998). *Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation*. 2nd edition. Boston, MA: Harvard Business School Press.

Leonard-Barton, D. (1990). A dual methodology for case studies: Synergistic use of a longitudinal single site with replicated multiple sites. *Organization Science*, 1(3), 248-266.

Leonard, D. & Rayport, J.F. (1997). Spark innovation through empathic design. *Harvard Business Review*, 75(6), 102-113.

Lettl, C. (2007). User involvement competence for radical innovation. *Technology Management*, 24(1), 53-75.

Lettl, C., Herstatt, C. & Gemuenden, H. G. (2006). Users' contributions to radical innovation: Evidence from four cases in the field of medical equipment technology. *R&D Management*, 36(3), 251-271.

Levitt, B. & March, J. (1988). Organizational learning. *Annual Review of Sociology*, 14, 319-340.

Lewin, K. (1946). Action research and minority problems. *Journal of Social Issues*, 2(4), 34-46.

Li-Ying, J. (2016). Dual boundary spanning: Toward a typology of outside-in open innovation reflected by the Canadian context. *Canadian Journal of Administrative Sciences*, 35(3), 429-443.

Li-Ying, J., Mothe, C. & Nguyen-Thi, T. U. (2018). Linking forms of inbound open innovation to a driver-based typology of environmental innovation: Evidence from French manaufacturing firms. *Technological Forecasting and Social Change*, 135, 51-63.

Liao, J. J., Kickul, J. R. & Ma, H. (2009). Organizational dynamic capability and innovation: An empirical examination of internet firms. *Journal of Smart Business Management*, 47(3), 263-286.

Liao, S. H. (2003). Knowledge management technologies and applications: Literature review from 1995 to 2002. *Expert Systems with Applications*, 25(2), 155-164.

Liao, S. H., Fei, W. C. & Chen, C. C. (2007). Knowledge sharing, absorptive capacity and innovation capability: An empirical study of Taiwan's knowledge-intensive industries. *Journal of Information Science*, 33(3), 340-359.

Liaw, S. S., Hatala, M. & Huang, H. M. (2010). Investigating acceptance toward mobile learning to assist individual knowledge management: Based on activity theory approach. *Computers & Education*, 54(2), 446-454.

Liew, A. (2007). Understanding data, information, knowledge and their inter-relationships. *Journal of Knowledge Management Practice*, 8.

Lilien, G. L., & Yoon, E. (1989). Determinants of new industrial product performance: A strategic re-examination of the empirical literature. *Engineering Management, IEEE Transactions on*, *36*(1), 3-10.

Lilien, G. L., Morrison, P. D., Searls, K., Sonnack, M. & von Hippel, E. (2002). Performance assessment of the lead user idea-generation process for new product development. *Management Science*, 48(8), 955-1101.

Lin, M-J. J. & Huang, C-H. (2013). The impact of customer participation on NPD performance: the mediating role of inter-organization relationship. *Journal of Business & Industrial Marketing*, 28(1), 1-19.

Lippman, S. A. & Rumelt, R. P. (1992). Demand uncertainty and investment in industry specific capital. *Industrial and Corporate Change*, 1(1), 235-262.

Liu, M. S. & Liu, N. C. (2008). Sources of knowledge acquisition and patterns of knowledge-sharing behaviours - and empirical study of Tawanese high-tech firms. *International Journal of Information Management*, 28(5), 423-432.

López-Nicolás, C. & Meroño-Cerdán, Á. L. (2011). Strategic knowledge management, innovation and performance. *International Journal of Information Management*, 31(6), 502-509.

Luethje, C. (2003). Customers as co-inventors: An empirical analysis of the antecedents of customer-driven innovations in the field of medical equipment. *Proceedings of the 32nd Annual Conference of the European Marketing Academy (EMAC)*, Glasgow.

Luethje, C., Herstatt, C. & von Hippel, E. (2005). User-innovators and "local knowledge": The case of mountain biking. *Research Policy*, 34(6), 951-965.

Lukas, B. A. & Ferrell, O. C. (2000). The effect of market orientation on product innovation. *Journal of the Academy of Marketing Science*, 28, 239-247.

Lundberg, C. (1995). Conceptual issues in organizational learning. *International Journal of Organizational Analysis*, 3(1), 7-19.

Lundvall, B. A. ed. (1992). *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London: Pinter Publishers.

Lynn, G. S., Morone, J. G. Paulson, A. Q. (1996). Marketing and discontinuous innovation: The probe and learn process. *California Management Review*, 38(3), 8-37.

Madon, S. (2000). International NGOs: Networking, information flows and learning. *Development Informatics Working Paper Series 8*. Manchester: Institute of Development Policy and Management, University of Manchester. Available at http://idpm.man.ac.uk/wp/di/index.html.

Maidique, M. A. & Zirger, B. J. (1985). The new product learning cycle. *Research Policy*, 14(6), 299-313.

Majchrzak, A., Cooper, L. P. & Neece, O. (2003). Knowledge reuse in radical innovation process at the jet propulsion laboratory. In: Leibowitz, J. & Holm, J. eds. *Knowledge Management Technologies and Applications in NASA*. Government Printing Office, Washington, D.C.

Maniak, R. & Midler, C. (2008). Shifting from co-development to co-innovation. *International Journal of Automotive Technology and Management*, 8(4), 449-468.

Manrodt, K. B. & Vitasek, K. (2004). Global process standardization: A case study. *Journal of Business Logistics*, 25(1), 1- 23.

Mansfield, E. (1968). *Industrial Research and Technological Innovation: An Econometric Analysis*. New York: Norton.

Martin, B. R. & Tan, P. (2007). The benefits of public funding. Science and technology working papers. University of Essex, paper 161.

Mass, N. (1974). *Readings in Urban Dynamics*, vol. 1. Waltham, MA: Pegasus Communications.

Massey, I. (2011). Biotie and Synosia to combine to create a leading CNS developing company. Conference call Tuesday, Marketwire, Turku, Finland.

Maxwell, J. A. (2005). *Qualitative Research Design: An Interactive Approach*. 2nd ed. Thousand Oaks, CA: Sage.

Mayo, D. D., Callaghan, M. J. & Dalton, W. J. (2001). Aiming for restructuring success at London Underground. *System Dynamics Review*, 17(3), 261-289.

McCarthy, I. P., Tsinopoulos, C, Allen, P. & Rose-Anderssen, C. (2006). New product development as a complex adaptive system of decisions*. Journal of Product Innovation Management*, 23(5), 437-456.

McClelland, D. C. (1951). *Personality*. Dryden.

McQuarrie, E. F. (1993). *Customer Visits. Building a Better Market Focus*. Thousand Oaks: Sage Publications.

McQueen, R. (1998). Four views of knowledge and knowledge management. In: Hoadley, E. and Benbasat, I. eds. *Proceedings of the Fourth Americas Conference on Information Systems*, 609-611.

Meadow, A. & Parnes, S. J. (1959). Evaluation of training in creative problem solving. *Journal of Applied Psychology*, 43(3), 189-194.

Medlin, C. J. (2004). Interaction in business relationships: A time perspective. *Industrial Marketing Management*, 33(3), 185-193.

Mei, S. & Nie, M. (2007). Relationship between knowledge sharing, knowledge characteristics, absorptive capacity and innovation: An empirical study of Wuhan optoelectronic cluster. *The Business Review*, 7(2), 154.

Menguc, B., Auh, S. & Yannopoulos, P. (2014). Customer and supplier involvement in design: the moderating role of incremental and radical innovation capability. *Journal of Product Innovation Management*, *31*(2), 313-328.

Messa, S. & Testa, S. (2004). Innovation or imitation? Benchmarking: A knowledge management process to innovate services. *Benchmarking: An International Journal*, 11(6), 610-620.

Meya, U. (2009). Synosia Therapeutics. Interview.

Meya, U. (2011). Synosia Therapeutics. Interview.

Miles, M. B. & Huberman A. M. (1994). *Qualitative Data Analysis: A Sourcebook of New Methods*. 2nd edition. Beverly Hills, CA: Sage Publications.

Milling, P. (2002). Understanding and managing innovation processes. *System Dynamics Review*, 18(1), 73-86.

Miner, A. S. (1991). Organizational evolution and the social ecology of jobs. *American Social Review*, 56(6), 772-785.

Mitroff, I. (1998). *Smart thinking for crazy times: The art of solving the correct problems*. San Francisco: Berrett-Koehler Publishers.

Mohr, J. (2001). *Marketing of High-Technology Products and Innovations*. Upper Saddle River.

Montoya-Weiss, M. M., & Calantone, R. (1994). Determinants of new product performance: A review and meta-analysis. *Product Innovation Management*, 11(5), 212-329.

Moreno-Luzon, M. D. & Lloria, M. B. (2008). The role of non-structural and informal mechanisms of integration and coordination as forces in knowledge creation. *British Journal of Management*, 19(3), 250-276.

Morgeson, F. P. & Hofmann, D. A. (1999). The structure and function of collective constructs: Implications for multilevel research and theory development. *Academy of Management Review*, 24(2), 249-265.

Morison, E. E. (1966). *Men, Machines and Modern Times*. Cambridge, MA: MIT Press.

Morone, J.G. (1993). *Winning in High Tech Markets*. Boston: Harvard Business School Press.

Mothe, C., Nguyen-Thi, T. U. & Triguero, A. (2018). Innovative products and services with environmental benefits: Design of search strategies for external knowledge and absorptive capacity. *Journal of Environmental Planning and Management*, 61(11), 1934-1954.

Mullins, J. W. & Sutherland, D. J. (1998). New product development in rapidly changing markets: An exploratory study. *Journal of Product Innovation Management*, 15(3), 224-236.

Nag, R., Hambrick, D. C. & Chen, M. J. (2007). What is strategic management, really? Inductive derivation of a consensus definition of the field. *Strategic Management Journal*, 28(9), 935-955.

Nair, J. (2006). Market expansion strategies of Maruti Udyog, ICFAI Knowledge Centre, Hyderabad, India. Case study distributed by European Case Clearing House.

Nalebuff, B. & Ayres, I. (2003). *Why Not? How to Use Everyday Ingenuity to Solve Problems Big and Small*. Boston: Harvard Business School Press.

Nambisan, S. (2002). Designing virtual customer environments for NPD: Toward a theory. *The Academy of Management Review*, 27(3), 392-413.

Neale, M. R. & D. R. Corkindale (1998). Co-developing products: Involving customers earlier and more deeply. *Long Range Planning*, 31(3), 418-425.

Nelson, R. R. & Sampat, B. N. (2001). Making sense of institutions as a factor shaping economic performance. *Journal of Economic Behavior and Organization*, 44(1), 31-54.

Nelson, R. R. & Winter, S. G. (1982). *An Evolutionary Theory of Economic Change*. Boston: Harvard University Press.

Neuman, L. W. (2000). *Social Research Methods: Qualitative and Quantitative Approaches*. USA: Allyn and Bacon.

Newbert, S. L. (2007). Empirical research on the resource based view of the firm: An assessment and suggestions for future research. *Strategic Management Journal*, 28(2), 121-146.

Nijssen, E. J., Hillebrand, B., Vermeulen, P. & Kemp, R. (2006). Exploring product and service innovation similarities and differences. *International Journal of Research in Marketing*, 23(3), 241-251.

Nijssen, E. J. & Lieshout, K. F. M. (1995). Awareness, use and effectiveness of models and methods for new product development. *European Journal of Marketing*, 29(10), 27-44.

Nonaka, I. (1991). The knowledge creating company. *Harvard Business Review*, 96-104.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organizational Science*, 5(1), 14-37.

Nonaka, I. & Konno, N. (1998). The concept of ba: Building a foundation for knowledge creation. *California Management Review*, 40(3), 40-54.

Nonaka, I. & von Krogh, G. (2009). Tacit Knowledge and Knowledge Conversion: Controversy and advancement in organizational knowledge creation theory. *Organization Science*, 20(3), 635-652.

Nonaka, I. & Takeuchi, H. (1995). *The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation*. New York: Oxford University Press.

Nonaka, I., Toyama, R. & Konno, N. (2000). SECI, Ba and leadership: A unified model of dynamic knowledge creation. *Long Range Planning*, 33(1), 5-34.

Norman, D. A. & Bobrow, D. G. (1975). On data limited and resource limited processess. *Cognitive Psychology*, 7(1), 44-64.

O'Connor, G. C. (1998). Market learning and radical innovation: A cross case comparison of eight radical innovation projects. *The Journal of Product Innovation Management*, 15(2), 151-166.

O'Connor, G. C. & DeMartino, R. (2006). Organizing for radical innovation: An exploratory study of the structural aspects of radical innovation management systems in large established firms. *Journal of Product Innovation Management*, 23(6), 475-497.

O'Mahoney, J. (2011). Embracing essentialism: A realist critique of resistance to discursive power. *Organization*, 19(6), 723-741.

O'Mahoney, J. & Vincent, S. (2014). Critical realism as an empirical project: A beginner's guide. In: Edwards, P., O'Mahoney, J. and Vincent, S. eds. *Putting Critical Realism into Practice: A Guide to Research Methods in Organization Studies.* London: Oxford University Press.

Obstfeld, D. (2012). Creative projects: A less routine approach toward getting new things done. Organization Science, 23(6), 1571-1592.

Oke, A. (2007). Innovation types and innovation management practices in service companies. *International Journal of Operations and Production Management*, 27(6), 564-587.

Olson, E. & G. Blake (2001). Implementing the lead user method in a high technology firm: A longitudinal study of intentions versus actions. *Journal of Product Innovation Management*, 18(6), 388-395.

Ordanini, A. & Parasuraman, A. (2011). Service innovation viewed through a service-dominant logic lens: A conceptual framework and empirical analysis. *Journal of Service Research*, 14(1), 3-23.

Orlikowski, W. J. (1992). The duality of technology: Rethinking the concept of technology in organizations. *Organization Science*, 3(2), 398-427.

Osborn, A. F. (1953). *Applied imagination: Principles and procedures of creative thinking*. New York: Charles Scribner's Sons.

Ozgen, E. (2003). *Entrepreneurial opportunity recognition: Information flow, social and cognitive perspective*. Doctoral dissertation, Rensselaer Polytechnic Institute, U. S.

Parmentier, G. & Mangematin, V. (2011). *Community as a Locus of Innovation: Co-Innovation with Users in the Creative Industries.*

Pawson, P. & Tilley, N. (1997). *Realistic Evaluation.* SAGE Publications.

Pedhazur, E. J. & Schmelkin, L. P. (1991). *Measurement, Design and Analysis: An Integrated Approach*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Pentland, B. T., Feldman, M. S., Becker, M. C. & Liu, P. (2012). Dynamics of organizational routines: A generative model. *Journal of Management Studies*, 49(8), 1484-1508.

Pentland, B. T. & Rueter, H. H. (1994). Organizational routines as grammars of action. *Administrative Science Quarterly*, 39(3), 484-510.

Pentland, B. T. (1995). Grammatical models of organizational processes. *Organization Science*, 6(5), 541-556.

Perez, C (2009). Technological revolutions and techno-economic paradigms. Working Papers in Technology Governance and Economic Dynamics, TOC/TUT Working Paper No. 20.

Phaneuf, J., Godbout, A.J., Beltzner, K. & Fortin, R. (1996). Knowledge Management Framework, Working Group on Knowledge Management, Godbout Martin Godbout & Associates, Technical Report.

Plotkin, H. (1994). *The Nature of Knowledge*. Allen Press-Penguin, London.

Polit, D. E. & Hungler, B. P. (1995). Evaluating research reports. In: *Nursing Research. Principles and Method*, 574 - 588. Philadelphia, J. B. Lippincott.

Poole, M. S., Van de Ven, A. H., Dooley, K. and Holmes, M.E. (2000). *Organizational Change and Innovation Processes, Theory and Methods for Research*. New York: Oxford University Press.

Priluck, R. (2003). Relationship marketing can mitigate product and service failures, *Journal of Services Marketing*, 17(1), 37-52.

Racela, O. C. (2014). Customer orientation, innovation competencies and firm performance: A proposed conceptual model. *Social and Behavioural Sciences*, 148, 16-23.

Ragin, C. C. (1987). *The Comparative Method: Moving Beyond Qualitative and Quantitative Strategies*. University of California Press.

Ram, S. (1987). A model of innovation resistance. *Advances in Consumer Research*, 14, 208-213.

Ram, S. & Sheth, N. J. (1989). Consumer resistance to innovation: The marketing problem and its solution. *The Journal of Consumer Marketing*, 6(2), 5-14.

Ramaprasad, A. (1983). On the definition of feedback. *Behavioural Science*, 28(1), 4-13.

Ramaswamy, V. (2008). Co-creating value through customers' experiences: The Nike case. *Strategy & Leadership*, 36(5), 9-14.

Ramus, T., Vaccaro, A. & Brusoni, S. (2015). Addressing institutional complexity: The role of formalization and collaboration. *Academy of Management proceedings*, 2015(1), 113-150.

Rice, M. P., Leifer, R. & O'Connor, G. C. (2002). Commercializing discontinuous innovations: bridging the gap from discontinuous innovation project to operations. *IEEE Transactions on Engineering Management*, 49(4), 330-340.

Richardson, G. P. & Pugh, A. L. (1981). *Introduction to System Dynamics Modelling with DYNAMO*. Cambridge, Massachusetts: Productivity Press.

Riggs, W. & von Hippel, E. (1994). The impact of scientific and commercial values on the sources of scientific instrument innovation. *Research Policy*, 23, 459-469.

Ritchie, J. & Lewis J. (2003). *Qualitative Research Practice: A Guide for Social Science Students and Researchers*. London, Thousand Oakes, New Dehli: SAGE Publications.

Ritter, T. & Ford, D. (2004). Interactions between suppliers and customers in business markets. In: Håkansson, H., Harrison, D. and Waluszewski, A. eds. *Rethinking Marketing*. Chichester: John Wiley and Sons, Ltd, 99-116.

Ritter, T. & Gemuenden, H. G. (2003). Network competence: its impact on innovation success and its antecedents. *Journal of Business Research*, 56(9), 745–755.

Roche, C. (1998). Organizational assessment and institutional footprints. In: Thomas, A., Chataway, J. and Wuyts, M. eds. *Finding out Fast: Investigative Skills for Policy and Development*. London: Sage and the Open University.

Rosted, J. (2005). User-driven innovation. Results and recommendations. FORA, 13 October.

Rothwell, R. & Dodgson, M. (1991). External linkages and innovation in small and medium-sized enterprises. *R&D Management*, 21(2), 125-138.

Rowley, J. (2007). The wisdom hierarchy: Representations of the DIKW hierarchy. *Journal of Information Science*, 33(2), 163-180.

Rowley, J. & Hartley, R. (2006). *Organizing Knowledge: An Introduction to Managing Access to Information*. Ashgate Publishing, Ltd.

Royer, I. & Zarlowski, P. (2001). Research design. In: Thietart, R. A. ed. *Doing Management Research*. London: Sage Publications.

Rubenstein-Montano, B., Liebowitz, J., Buchwalter, J., McCaw, D., Newman, B., Rebeck, K. & Team, T. K. M. M. (2001). A systems thinking framework for knowledge management. *Decision Support Systems*, 3(1), 5-16.

Rubera, G. & Kirca, A. H. (2012). Firm innovativeness and its performance outcomes: A meta-analytic review and theoretical integration. *Journal of Marketing*, 76(3), 130-147.

Runde, J., Jones, M., Munir, K. & Nikolychuck, L. (2008). On technological objects and the adoption of technological product innovations: Rules, routines and the transition from the analogue photography to digital imaging. *Cambridge Journal of Economics*, 33(1), 1-24.

Sabbagh, K. (1996). *Twenty-first-century Jet: The Making and Marketing of the Boeing 777*. New York, NY: Scribner.

Salomo, S., Steinhoff, F. & Trommsdorff, V. (2003). Customer orientation in innovation projects and new product development success - the moderating effect of product innovativeness. *International Journal of Technology Management*, 26(5), 442-463.

Sanchez, R. & Mahoney, J. T. (1996). Modularity, flexibility, and knowledge management in product and organization design. *Strategic Management Journal*, 17(S2), 63-76.

Sandberg, B. (2008). *Managing and Marketing Radical Innovations. Marketing New Technology*. Abingdon: Routledge.

Sandberg, B. & Aarikka-Stenroos, L. (2014). What makes it so difficult? A systematic review on barriers to radical innovation. *Industrial Marketing Management*, 43(3), 1293-1305.

De Sarbo, W. S., Di Benedetto, C. A. & Song., M. (2007). A heterogeneous resource based view for exploring relationships between firm performance and capabilities. *Journal of Modelling in Management*, 2(2), 103-130.

Sarry, C. (2012). Roche Diagnostics Corporation. Interview.

Sawhney, M. & Prandelli, E. (2000). Communities of creation: Managing distributed innovation in turbulent markets. *California Management Review*, 42(4), 24-54.

Sayer, A. (1998). Abstraction: A realist interpretation. In: Archer, M., Bhaskar, R., Collier, A., Lawson, T. and Norrie, A. eds. *Critical Realism: Essential Readings*, 120-143. London: Routledge.

Sayer, A. (2000). *Realism and Social Science.* Sage.

Sayles, L. R., & Chandler, M. K. (1971). *Managing Large Systems: Organizations of the Future*. New York, NY: Harper and Row.

Schmoch, U. (2007). Double-boom cycles and the comeback of science-push and market-pull. *Research Policy*, 36(7), 1000-1015.

Schofield, J.W. (2002). Increasing the generalizability of qualitative research. In Gomm, R., Hammersley, M. & Foster, P. eds. *Case Study Method*, 69-87. London: Sage Publications,

Schumpeter, J.A. (1942). *Capitalism, Socialism and Democracy*. 8th edition. Stuttgart: UTB.

Scudder, G. D., Schroeder, R. G., Van De Ven, A. H., Seiler, G. R. & Wiseman, R. M. (1989). Managing complex innovations: The case of defense contracting. In: Van de Ven, A. H., Agle, H. L. & Poole, M. S. eds. *Research on the Management of Innovation*, 401-438. New York, NY: Harper & Row.

Seidl, D. & Whittington, R. (2014). Enlarging the strategy-as-practice research agenda: Towards taller and flatter ontologies. *Organization Studies*, 35(10), 1407-1421.

Selltiz, C., Wrightsman, L. S. & Cook, S. W. (1976). *Research Methods in Social Relations*, 3rd edition. New York: Holt, Rinehart and Winston.

Senge, P. M. (1990). *The Fifth Discipline*. New York: Doubleday/Currency.

Shane, S. & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. *The Academy of Management Review*, 25(1), 217-226.

Shankar, R., Singh, M. D., Gupta, A. & Narain, R. (2003). Strategic planning for knowledge management implementation in engineering firms. *Work Study*, 52(4), 190-200.

Shanklin, W. L. & Ryans, J. K. (1987). *Essentials of Marketing High Technology*. Massachusetts: Lexington Books.

Sharma, A & Lacey, N. (2004). Linking product development outcomes to market valuation of the firm: The case of the US pharmaceutical industry. *Journal of Product Innovation Management*, 21(5), 297-308.

Shih, W., Pisano, G. & King, A. (2008). Radical collaboration: IBM microelectronics joint development alliances. HBS Case Collection, 1-21.

Simon, K. (1973). Modern economic growth: Findings and reflections. *The American Economic Review*, 63(3), 247-258.

Slade, R. & Bauen, A. (2009). Lignocellulosic ethanol: The path to market, 17th European Biomass Conference and Exhibition.

Slater, S. F. & Narver J. C. (1995). Market orientation and the learning organization. *Journal of Marketing*, 59(3), 63-74.

Slater, S. F. & Narver J. C. (1998). Customer-led and market-oriented: Let's not confuse the two. *Strategic Management Journal*, 19(10), 1001-1006.

Slater, S. F. & Narver J. C. (2000). Intelligence generation and superior customer value. *Journal of the Academy of Marketing Science*, 28(1), 120-127.

Smith, A. M. & Lewis, B. R. (1989). Customer care in financial service organizations. *International Journal of Bank Marketing*, 7(5), 13-22.

Smith, K. (1991). Innovation policy in an evolutionary context. In: Metcalfe, J. S. & Saviotti, P. P. eds. *Evolutionary Theories of Economic and Technological Change*, 265-275. London: Hardwood.

Sorescu, A. B. & Spanjol, J. (2008). Innovation's effect on firm value and risk: Insights from consumer packaged goods. *Journal of Marketing*, 72(2), 114-132.

Souder, W. E., Buisson, D. & Garrett, T. (1997). Success through customer-driven new product development: A comparison of U.S. and New Zealand small entrepreneurial high technology firms. *Journal of Product Innovation Management*, 14(6), 459-472.

Spender, J. C. (1993). Competitive advantage from tacit knowledge? Unpacking the concept and its strategic implications. *Academy of Management Best Paper Proceedings*, 37-41.

Srinivasan, S., Pauwels, K., Risso, J. S. & Hanssens, D. M. (2009). Product innovation, advertising and stock returns. *Journal of Marketing*, 73(1), 24-43.

Stacey, R. D. (1995). The science of complexity: An alternative perspective for strategic change processes. *Strategic Management Journal*, 16(6), 477-495.

Stahlberg, M. & Maila, V. (2012). *Shopper Marketing: How to Increase Purchase Decisions at the Point of Sale*. Kogan Page.

Stake, R. E. (2006). *Multiple Case Study Analysis*. New York: The Guilford Press.

Stebbins, R.A. (2001). *Exploratory Research in the Social Sciences*. Thousand Oaks: Sage Publications Ltd.

Stene, E. (1940). An approach to the science of administration. *American Political Science Review*, 34(6), 1124-1137.

Sterman, J. (2000). *Business Dynamics*. Boston, MA: McGraw Hill/Irwin.

Sterman, J. & Repenning, N. (1997). Unanticipated side effects of successful quality programs: Exploring a paradox of organizational improvement. *Management Science*, 43(4), 503-522.

Strauss, A. & Corbin, J. (1990). *Basics of Qualitative Research*. Newbury Park: Sage.

Strauss, A. & Corbin, J. (1998). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. 2nd ed. Thousand Oaks, CA: Sage.

Strauss, A. & Corbin, J. (1999), Grounded theory methodology: An overview. In: Bryman, A. & Burgess, R. G. eds. *Qualitative Research*, vol. III, pp. 72-93. London: Sage.

Subramaniam, M. & Youndt, M. A. (2005). The influence of intellectual capital on the types of innovative capabilities. *Academy of Management Journal*, 48(3), 450-463.

Sundbo, J. & Gallouj, F. (2000). Innovation as a loosely-coupled system in services. In: Metcalfe, S. and Miles, I. eds. *Innovation Systems in the Service Economy: Measurement and Case Study Analysis*, 43-68. Kluwer Academics Publishers.

Sutton, R. & Straw, B. M. (1995). What theory is not. *Administrative Science Quarterly*, 40(3), 371-384.

Svendsen, M. F., Haugland, S. A., Gronhaug, K. & Hammervoll, T. (2011). Marketing strategy and customer involvement in product development. *European Journal of Marketing*, 45(4), 513-530.

Swan, J. & Scarbrough, H. (2001). Knowledge, purpose and process: Linking knowledge management and innovation. Proceedings of the 34th Hawaii International Conference on System Sciences.

Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal*, 17(2), 27-43.

Szulanski, G. & Jensen, R. J. (2008). Growing through copying: The negative consequences of innovation on franchise network growth. *Research Policy*, 37(10), 1732-1741.

Tajeddini, K., Trueman, M. & Larsen, G. (2006) Examining the effect of market orientation on innovativeness. *Journal of Marketing Management*, 22(5), 529-551.

Taylor, D. W., Berry, P. C. & Block, C. H. (1958). Does group participation when using brainstorming facilitate or inhibit creative thinking? *Administrative Science Quarterly*, 6, 22-47.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, 15(6), 285-305.

Teece, D. J. (1996). Firm organization, industrial structure and technological innovation. *Journal of Economic Behaviour and Organization*, 31(2), 193-224.

Teece, D. J., Pisano, P. & Schuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509-533.

Teixeira, T. S. & Caverly, A. (2012). Mekanism: engineering viral marketing. *Harvard Business School*, January, 1-16. Boston, MA: Harvard Business School Publishing.

Tellis, G. J., Prabhu, J. C. & Chandy, R. K. (2009). Radical innovation across nations: The preeminence of corporate culture. *Journal of Marketing*, 73(1), 3-23.

Tidd, J. (2001). Innovation management in context: Environment, organization and performance. *International Journal of Management Reviews*, 3(3), 169-183.

Therin, F. (2002). Organizational learning and innovation in high-tech small firms. Proceedings of the 36th Hawaii International Conference on System Science.

Thomke, S. & von Hippel, E. (2002). Customers as innovators. *Harvard Business Review*, 80(4), 5-11.

Trott, P. (2005). *Innovation Management and New Product Development*. 3rd edition. UK: Prentice Hall.

Turner, S. F. & Rindova, V. (2012). A balancing act: How organizations pursue consistency in routine functioning in the face of ongoing change. *Organization Science*, 23(1), 24-46.

Tushman, M. L. & Rosenkopf, L. (1992). Organizational determinants of technological change: Toward a sociology of technological evolution. In: Staw, B. M. & Cummings, L. L. eds. *Research in Organizational Behaviour*, 14, 311-347. Greenwich, CT: JAI Press Inc.

Tushman, M. L., Newman, W. H. & Romanelli, E. (1986). Convergence and upheaval: Managing the unsteady pace of organizational evolution. *California Management Review*, 29(1), 583-594.

Tzeng, C. H. (2009). A review of contemporary innovation literature: A Schumpetrian perspective. *Innovation: Management, Policy & Practice*, 11(3), 373-394.

Urban, G. L. & von Hippel, E. (1988). Lead user analyses for the development of new industrial products. *Management Science*, 34(5), 569-582.

Utterback, J. M. (1994). Mastering the dynamics of innovation: How companies can seize opportunities in the face of technological change. University of Illinois.

Vaccaro, A., Veloso, F. & Brusoni, S. (2009). The impact of virtual technologies on knowledge-based processes: An empirical study. *Research Policy*, 38(8), 1278-1287.

Van de Ven, A. H. (1992). Suggestions for studying strategy process: A research note. *Strategic Management Journal*, 13, 169-188.

Van de Ven, A.H., Angle, H.L. & Poole, M.S. (2000). *Research on the Management of Innovation. The Minnesota Studies*. Oxford: Oxford University Press.

Van de Ven, A. H. & Polley, D. (1991). Learning while innovating. *Organization Science*, 3(1), 91-116.

VanLehn, K. (1996). Cognitive skill acquisition. *Annual Review of Psychology*, 47, 513-539.

Varian, H. R. (2010). Computer mediated transactions. *American Economic Review: Papers and Proceedings*, 100(2), 1-10.

Vercauteren, A. & Vanhaverbeke, W. (2007). Where's the customer in technology-based radical innovation? *International Journal of Technology Marketing*, 2(2), 101-118.

Vercesi, P., Kanpandegi, I. X. M., Vecchiato, R. & Pugno, R. (2014). Entrepreneurship collaboration, new business models and firm creation: Enhancing local economical networks. In: *Sustainable Social, Economic and Environmental Revitalization in Multan City*, 87-99. Cham: Springer.

Veryzer, R. W. (1998). Discontinuous innovation and the new product development process. *Journal of Product Innovation Management*, 15(4), 304-321.

Vidal, R.V.V. (2002). *Dealing with problematic situations*. IMM working paper, DTU, Lyngby.

von Hippel, E. (1986). Lead users: A source of novel product concepts. *Management Science*, 32(7), 791-805.

von Hippel, E. (1988). *The Sources of Innovation*. Oxford: Oxford University Press.

von Hippel, E. (1998). Economics of product development by users: The impact of 'sticky' local information. *Management Science*, 44(5), 629-644.

von Hippel, E. (2005). *Democratizing Innovation*. MIT Press.

von Hippel, E., Ozawa, S. & De Jong, J. (2011). The age of the consumer-innovator. *MIT Sloan Management Review*, 53(1), 27-35.

von Hippel, E., Thomke, S. & Sonnak, M. (2000). Creating breakthroughs at 3M. *Harvard Business Review*, 77(5), 47-57.

Vosniadou, S. & Brewer, W. F. (1987). Theories of knowledge restructuring in development. *Review of Educational Research*, 57(1), 51-67.

Walker, R. M. (2005). Innovation and organizational performance: A critical review of the evidence and a research agenda. *Academy of Management Proceedings*, B1 - B6.

Wallace, D. P. (2007). *Knowledge Management: Historical and Cross-Disciplinary Themes.* Libraries Unlimited.

Weiss, H. M. & Ilgen, D. R. (1985). Routinized behaviour in organizations. *Journal of Behavioural Economics*, 14(1), 57-67.

Wheelwright, S. & Clark, K. (1992). *Revolutionising Product Development*. New York: Free Press.

Wiig, K. M. (1997). Integrating intellectual capital and knowledge management. *Long Range Planning*, 30(3), 399-405.

Williamson, O. E. (1975). *Markets and Hierarchies: Analysis and Antitrust Implications*. New York: Free Press.

Williamson, O. E. (1979). Transaction cost economies: The governance of contractual relations. *Journal of Law and Economics*, 22(2), 233-261.

Winter, S. G. & Szulanski, G. (2001). Replication as strategy. *Organization Science*, 12(6), 730-743.

Wolstenholme, E. F. (1993). *The Evolution of Management Information Systems: A Dynamic and Holistic Approach*. Toronto: Wiley Sons.

Woodside, A. G. & Wilson, E. J. (2003). Case study research for theory-building. *Journal of Business and Industrial Marketing*, 18(6/7), 493-508.

Woolley, R. N. & Pidd, M. (1981). Problem structuring - A literature review. *The Journal of the Operational Research Society*, 32(3), 197-206.

Yin, R. K. (1984). *Case Study Research: Design and Methods*. Beverly Hills, CA: Sage.

Yin, R. K. (1994). *Case Study Research: Design and Methods*. 2nd ed. Applied Social Research Methods Series, Sage.

Yin, R. K. (2003). *Case Study Research: Design and Methods*. 4th ed. Thousand Oaks: Sage Publications Ltd.

Yin, R.K. (2012). *Applications of Case Study Research*. 3rd ed. Sage Publications, Inc.

Yin, R. K. & Moore, G. (1987). The use of advanced technologies in special education. *Journal of Learning Disabilities*, 20(1), 60.

Zalot, G. N. & Lussing, F. J. (1983). A process for establishing health care priorities. *Health Management Forum*, 4(4), 31-45.

Zander, U. & Kogut, B. (1995). Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test. *Organization Science*, 6(1), 76-92.

Zeleny, M. (1987). Management support systems: Toward integrated knowledge management. *Human Systems Management*, 7(1), 59-70.

Zeithaml, V. A., Berry, L. L. & Parasuraman, A. (1993). The nature and determinants of customer expectations of services. *Journal of the Academy of Marketing Science*, 21(1), 1-12.

Zins, C. (2007). Conceptual approaches for defining data, information and knowledge. *Journal of the American Society for Information, Science and Technology*, 58(4), 479-493.

Zhou, J. & Woodward, R. W. (2003). Managers' recognition of employees' creative ideas: A social-cognitive model. In: Shavinina V. L. ed. *The International Handbook of Innovation*. Oxford: Elsevier.

Zhou, K. Z., Yim, C. K. & Tse, D. K. (2005). The effects of strategic orientations on technology-and market-based break-through innovations. Journal of Marketing, 69(2), 42-60.

Zollo, M. & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. Organization Science, 13(3), 339-351.

2 TABLE OF CONTENTS

3 APPENDIX

3.1 INFORMATION SHEET

Table 3-1: Information sheet

University *Participant Information Form* Research: Customer-supplier interaction reducing uncertainty of radical innovations To whom it may concern: My name is Stefan and I am with University <Name> doing my doctorate in the area of innovation and customer-supplier interaction. Currently, I am in the phase of validating my identified model activities of the customer-supplier interactive mechanism in the context radical innovation processes. Since, radical innovations are rare, I am trying to find interesting firms that have had radical innovations, which could in one interview answer me 6 questions in order to validating or falsifying my model. Hence, I would like to ask you whether you could help me in getting in touch with according contacts (firms) of radical innovations. I thank you already in advance in supporting this doctorate project. If you have any further questions, please do not hesitate to contact me directly via email or phone. Kind regards, Stefan Lettig, MBA Doctoral student

3.2 PARTICIPANT AGREEMENT EMAIL

Table 3-2: Participant agreement form

Dear Mr., I hope this email finds you well. My thesis is coming to an end. Viva is expected in October 2014. In order be on the save side regarding the data; I kindly ask you via email to confirm the following: "I agree to my name, the name of the company where I work, and the name of the innovation being published in Stefan Lettig's doctoral thesis". I thank you in advance for your support and understanding. If you have any particular questions, please do not hesitate to contact me directly. Kind regards, Stefan Lettig, MBA Doctoral student

3.3 PARTICIPANT AGREEMENT LIST WITH AGREEMENTS

Table 3-3: Participant agreement list

Innovation	Respondent	Agreement	Date
Avaloq	Francisco Fernandez CEO and founder	yes	31.07.2014
Avaloq	Engineer 1	yes	Is provided through the agreement of Francisco Fernandez (CEO), and through the fact none of his statements were used on the thesis
Avaloq	Engineer 2	yes	Is provided through the agreement of Francisco Fernandez (CEO), and through the fact none of his statements were used on the thesis
Parkinson SYN-115	Uwe Meya	yes	18.09.2014
Parkinson SYN-115	Ian Massey	no	N/A
Parkinson SYN-115	Christoph Sarry	yes	14.08.2014
Mobile	Martin Cooper	yes	18.08.2014
Token – Ring	Werner Bux	yes	12.08.2014
Millipede Project	Erich Ruetsche	yes	29.07.2014
Software for Mouse Scanner	Dacuda representative	no	N/A
Laptop Osborne	Lee Felsenstein	N/A	Public Information
New World of Work	Kevin Eva Norton	yes	30.07.2014
VoIP Enterprise Solutions	Erich Gebhardt	yes	05.08.2014
Ongoing banking case	Ruth Mojentale-Baumann	yes	06.10.2015
Ongoing chemical case	Jean-Christoph Bogaert	yes	18.04.2016

3.4 CASE STUDY PROTOCOL

Table 3-4: Case study protocol

Section	Contents	Contents
Preamble	▪ Confidentiality and data storage ▪ Publication ▪ Documentation ▪ Layout of protocol	Contains information about the purpose of the protocol, guidelines for data and document storage, publication
General	▪ Overview of research project ▪ The case research method	Provides a brief overview of the research project and the case research method.
Procedures	▪ Initial approach to organizations – Selection of cases – Number of cases – Establishing contact ▪ Scheduling of field visits ▪ Length of sessions ▪ Equipment and stationery	Detailed description of the procedures for conducting each case. These procedures should be utilised to ensure uniformity in the data collection process and consequently facilitate both within case and cross case analyses
Research Instrument(s)	▪ Research instrument(s) that may either be: a) Qualitative – interview guides utilising either open-ended or close-ended questions b) Quantitative – survey questionnaire applied in face to face interviews	Research instruments developed utilising guidelines by Neuman (2000) and Sekaran (2000). It is recommended that these research instruments be highly structured to facilitate the data collection process and uniformity in the collection of said data
Data analysis guidelines	▪ Overview of data analysis processes ▪ Details regarding: a) How convergence of data from multiple sources will be achieved b) How triangulation of perspectives from multiple participants will be achieved ▪ Description of 'Within case' analysis process: a) Descriptive Data b) Explanatory Data c) Individual case report ▪ Description of "Cross case" analysis process ▪ Description of 'Cross sectoral' analysis process (where necessary) ▪ Data scheme a) Summary of primary data types, sources and purpose b) Summary of secondary data types, sources and purpose ▪ Description of data displays that will be used in analysis ▪ A priori list of codes that will be used during qualitative analysis	Guidelines for data analysis based on guidelines such as those provided by Miles and Huberman (1994), Yin (1994) and Neuman (2000).
Appendix	Participation request letter	Template letter sent to potential participants inviting them to participate

3.5 CONTACT SUMMARY SHEET

Table 3-5: Example of contact summary sheet

CONTACT	QUESTIONS	DETAILS
Avaloq	▪What people, events, or situations were involved?	▪Interviewee
	▪What were the main themes or issues in the contact?	▪Radical innovation – automated banking back office system
	▪Which research questions did the contact bear most centrally on?	▪What was your radical innovation and what was the process?
	▪What new hypotheses, speculations, or guesses about the field situations were suggested by the contact?	▪Activities – Identifying Pain (i.e., limitation of base principle and concept) – Brainstorming Invention – Discussing Invention – Evaluating Innovation ▪Involving the customer
	▪Where should the fieldworker place most energy during the next contact, and what sorts of information should be sought?	▪Customer-supplier interaction ▪Activities of the customer-supplier interaction

3.6 INTERVIEW SCHEDULE

Table 3-6: Interview phase 1 - 3 schedule – identifying innovation

SOURCE	INTERVIEW NUMBERS	INTERVIEW THEME	INTERVIEWEE	FUNCTION	DATE
Avaloq	1	General interview on the innovation	Francisco Fernandez	CEO	22.06.2009
Avaloq	2	Interview on the customer involvement	Francisco Fernandez	CEO	23.06.2010
Avaloq	3	Identifying & coding variables of customer involvement	Francisco Fernandez	CEO	28.07.2010
Synosia	1	General interview on the innovation	Uwe Meya	R&D Manager	28.05.2010
Synosia	2	Interview on the customer involvement	Uwe Meya	R&D Manager	26.07.2010
Synosia	3	Identifying & coding variables of customer involvement	Uwe Meya	R&D Manager	18.10.2010

Table 3-7: Interview phase 4 schedule

INNOVATION		INTERVIEW THEME	INTERVIEWEE	DATE
Mobile		Verifying activities of the customer involvement	Martin Cooper	15.03.11
Avaloq – Engineer 1		"	Engineer 1	06.06.11
Avaloq – Engineer 2		"	Engineer 2	14.06.11
Synosia – COO		"	Ian Massey	07.09.11
Internet	Packet Switching (Internet)	"	Larry Roberts	05.08.11
	Communication Protocol (Internet)	"	Larry Roberts	29.08.11
	World Wide Web	"	Dave Walden	08.08.11
Laptop Osborne 1		"	Lee Felsenstein	09.08.11
IBM Millipede Project		"	Erich Ruetsche	19.08.11
New World of Work		"	Kevin Eva Norton	26.08.11
VoIP Enterprise Solution		"	Erich Gebhardt	08.09.11
IBM Token Ring		"	Werner Bux	22.09.11
Software for Mouse Scanner		"	Dacuda representative	27.09.11
Roche – Customer view for Synosia's SYN-115 Parkinson Drug		"	Christoph Sarry	27.07.12
Galactic poly-lactic acid		"	Innovation Manager	15.04.15

3.7 CODING GRID

Table 3-8: Part of the coding grid for innovation activities

Interview	Person interviewed	Verbatim	Customer involvement	Employee involvement	Approach to innovation
Interview from banking case	Natalia L., bank manager	"The new approach would be that the client can choose whatever he wants, and the price would be based on the chosen products and services… so it's a modular bundle."	Collecting data (interviews with customers, Bonviva customer satisfaction study)	Brainstorming (an innovation day with the stakeholders)	Project planning with roadmaps and workshops.
Interview Dacuda Mouse Scanner	CEO Dacuda	"The innovation started from one of our founders, Martin, who had the idea of a mouse that could scan and we always had the problem that we had information scribbled down on paper after each meeting but each time someone forgot to share it with the others."	Feedback (interviews at the end to influence the look and feel, trade shows)	Exchanging knowledge (collaboration with research institutes and bringing people in the company)	A detailed planning only for six to eight weeks, possibility to start from scratch in an iterative way.

3.8 MODELLING SESSIONS

Table 3-9: Modelling Sessions

RADICAL INNOVATION	INTERVIEW THEME	INTERVIEWEE	YEAR
Banking Back Office Automation	Modelling the complex scenarios of relationships between the concepts (variables) multidimensional	Francisco Fernandez	2010
Banking Back Office Automation	Defining the relationships impact off one concept over others: (+) for increasing, and (-) decreasing impact	Francisco Fernandez	2010
Banking Back Office Automation	Confirmatory session regarding the relationships and finalising remaining impacts	Francisco Fernandez	2010
Banking Back Office Automation	Cross-checking the model and identified concepts, relationships, and impacts	Francisco Fernandez	2010
Banking Back Office Automation	Final discussion of model	Francisco Fernandez	2010
Banking Back Office Automation	Verifying coding of variables of the customer-supplier interaction	Engineer 1	2011
Banking Back Office Automation	Verifying coding of variables of the customer-supplier interaction	Engineer 2	2011
Drug SYN-115 – Parkinson	Modelling the complex scenarios of relationships between the concepts (variables) multidimensional	Uwe Meya	2011
Drug SYN-115 – Parkinson	Defining the relationships impact off one concept over others: (+) for increasing, and (-) decreasing impact	Uwe Meya	2011
Drug SYN-115 – Parkinson	Confirmatory session regarding the relationships and finalising remaining impacts	Uwe Meya	2011
Drug SYN-115 – Parkinson	Cross-checking the model and identified concepts, relationships, and impacts	Uwe Meya	2011
Drug SYN-115 – Parkinson	Final discussion of model	Uwe Meya	2011
Drug SYN-115 – Parkinson	Verifying coding of variables of the customer-supplier interaction	Ian Massey	2011

3.9 INTERVIEW SCHEDULE

Table 3-10: The interview schedule for the banking case

INNOVATION	INTERVIEW THEME	INTERVIEWEE	DATE
Ongoing innovation case study Bank	Interview 1: New daily banking product model	Project team member A	04.12.2015
Ongoing innovation case study Bank	Interview 2: Details on knowledge management	Project team member A	07.12.2015
Ongoing innovation case study Bank	Interview 1: New daily banking product model	Project Sponsor	17.12.2015
Ongoing innovation case study Bank	Interview 2: Details on knowledge management	Project Sponsor	11.02.2016
Ongoing innovation case study Bank	Interview 3: Details of activities and feedback loops	Project team member A	24.02.2016
Ongoing innovation case study Bank	Interview 3: Details of activities and feedback loops	Project Sponsor	24.02.2016
Ongoing innovation case study Bank	Interview 4: Knowledge filtering and knowledge integration	Project Sponsor	27.06.2017