



NTNU – Trondheim
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Between Innovation and Governance

The Case of Research-based Software
Development in a Large Petroleum Company

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PROBLEM DESCRIPTION

The overall problem addressed by this project is that despite significant investments in developing innovative research-based software in the subsurface domain, such software is being used in a very limited and small scale by engineers in the operators' operational units. This is an industry-wide problem, and significantly hampers the operators' ability to improve their production volumes and the recovery rate of their fields. Therefore, the goal of this research project is to study the existing barriers of innovative research-based software development. Moreover it tries to investigate how the barriers are related to the relationship between IS innovation and IT governance.

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ABSTRACT

Software innovations can offer organizations with competitive advantages. Research and development entities within the petroleum industry therefore seek to utilize IT capabilities to produce innovative software. Many factors may influence the success or failure of developing and implementing research-based software innovations in organizations. Of these issues the relation between software innovation and IT governance remains largely unexplored in the research literature.

This study explores the effects IT governance has on the success or failure of research-based software development projects in an international petroleum company through an interpretive case study. The results of the study are twofold: 1) practical and 2) theoretical.

The practical results show that the investigated petroleum company's emphasis on formalization has unfortunate side-effects on successful development and implementation of research-based software in the organization. IT governance, focused on stability of operations, is not well aligned with the corporate strategy of increased innovation. Moreover, the central IT department uses governance structures to guard the boundaries around the department.

The theoretical results from the study presented that the impact of IS innovation or digital technology innovation on the research projects and how they can help the researchers to realize their ideas, remain unnoticed in the literature. Furthermore, In IS innovation literature, the organizations' IS unit is the main responsible for IS innovation and it starts the innovation. However in the presented study R&D department had the main responsibility in innovation and it initiates innovation.

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1. INTRODUCTION

Making up for over half of the world's primary energy consumption, oil and gas are among the world's main sources of energy (Luciani 2004). The petroleum industry therefore plays an important role in the world economy and has a direct impact on society. However, petroleum industry faces a significant challenge: the world's oil reserves are limited and known reservoirs are quickly running out of recoverable oil. The processes and systems involved in producing oil and gas, especially in offshore fields, are both complicated and require advanced technologies, and are consequently costly (Sams 2010).

These issues have led researchers to use software tools for predicting the features and locations of oil reservoirs with the lowest margin of error. However, the existing software in the market cannot always satisfy the requirements of researchers. Researchers look for ways to produce innovative software tools or add changes to existing software. Developing and implementing innovative research-based software is not easy and several issues have effects on it, i.e. budgeting and financial issues, availability of expert developers, corporate infrastructure, IT governance, IT strategy, etc. Problems in one of the mentioned issues can lead to a project failure.

Studying all the issues that can affect innovation is too broad topic to be addressed by a single study. In this study, I will therefore focus on the relationship of IT governance and innovative research-based software. This study has been conducted as part of the project "Software innovation for subsurface disciplines in petroleum production". The overall problem addressed by this project is that despite significant investments in developing research-based software for the subsurface domain, such software is being used in a very limited and small scale by engineers in the operators' operational units. This is an industry-wide problem, and significantly hampers the operators' ability to improve their production volumes and the recovery rate of their fields. The overall goal of the research project is to evaluate how IT governance may contribute towards the development of innovative research-based software within operational subsurface departments.

Research on the relationship between IT governance and IS innovation has been limited to date. The existing literature on IT governance and IS innovation has seldom explored the interaction between the two issues.

The IS innovation literature is mainly concerned with how innovation spreads within organizations, how it impacts on the firm's structure and processes (Sambamurthy, Bharadwaj et al. 2003; Swanson and Ramiller 2004) and how it influences on the industrial products (Yoo, Henfridsson et al. 2010).

In a similar fashion the IT governance literature is empty of explaining the relationship between IT governance and IS innovation. The IT governance literature deals with the ways in which a suitable IT governance of an organization's IT infrastructure (ITGI 2011) can help meet the stakeholder's expectations (ITGI 2011). The IT governance literatures mainly focus on "controlling" or "decision making" aspects of IT governance. From the "controlling" perspective : IT is complex, fast changing and has unique conditions; these unique conditions of IT create a need to apply management regulation and control over it (NCC 2005). From the "decision-making" perspective, IT governance is related to determining different members' responsibilities in relation to the creation and implementation of IT decisions.

Since the literature is not clearly explained the relationship between IS innovation and IT governance, there is a need to bring together these two broad areas of study. This study tries to help in fulfilling this need.

This study is carried out in cooperation with a big international petroleum company. The company is called "Intoil" in this research. The research-based software development and implementation process in Intoil and existing challenges of this process are studied. Subsequently, it is tried to clarify the relationship of the challenges with IT governance. The following section includes a detailed description of Intoil including innovation and IT governance issues.

1.1 INTOIL

Intoil is one of the world's largest supplier of oil and gas which has operations in around 40 countries all over the world. Intoil has grown up along with the emergence of the Norwegian oil and gas industry, dating back to the late '60. It is headquartered in Norway with approximately 21, 000 employees worldwide, and is listed on the New York and Oslo stock exchanges. Intoil is committed to accommodating the world's energy needs in a responsible manner, applying technology and creating innovative business solutions. Being in an industry with high dependency on technology and HSE routines, Intoil needs new technology development to take these demands into account. Moreover, technology is a driving factor in the competition, staying in front of the industry development could give Intoil a competitive advantage.

1.1.1 INNOVATIVE TECHNOLOGY DEVELOPMENT IN INTOIL

The Intoil's goal is developing technologies to meet their challenges. Therefore, technology in Intoil is seen as a key to giving the company a competitive edge and it is critical to being successful in a business environment with increased complexity. Intoil believes that innovation, invention and improvement in all phases and processes of industry will lead to

higher levels of performance across all their global activities. Taking on the challenges of meeting energy demands makes great opportunities to invent, innovate and improvement. To meet the challenges, Intoil has identified some technology areas as “areas of particular interest for development and innovation”; “IT” is one of those areas. Intoil identified that as a global energy company they have several IT challenges. Intoil’s IT department is looking for solutions that can enhance the utilization of IT in their daily work, whether it is onshore, offshore or subsurface. IT challenges in Intoil are for instance mobility, collaboration and utilization of experts, need for speed, technical complexity and large amount of data. They currently use different technologies in trying to address these challenges. Some examples are the use of data centers, replication technologies, remote access technologies supporting 2D/3D and virtualization. However, they look for new technologies and innovative ideas to help them meet their challenges.

The challenges identified by the IT department in Intoil, are more related to keeping the installed-base running and providing the common IT services for the other departments. They didn’t focus on helping the researchers in the development of innovative research-based software ideas or providing the required infrastructure for them.

1.1.2 TECHNOLOGY AND IT GOVERNANCE IN INTOIL

Intoil has two governing documents related to this subject of study: FR12 and FR15.

FR12 is a technology development and implementation governing document in Intoil (the definition of “technology” is not clarified in this document. It seems that it includes all non IT and IT-based technologies). It is a guideline for the Intoil personnel who involve in technology development and implementation process. It describes functional requirements for a common and efficient work process for development and implementation of new technologies. The different phases of technology development and implementation process (from the planning to the first use and then multi-use) and decision gates are clarified in this document. However the differences of IT-based or not IT-based products are not clarified in this document. In IT-based products, researchers need to hand over the product to SDD department which is not required in any other types of the product development process.

FR15 document describes a governance model for how information systems should be developed and maintained. Furthermore it describes how information is distributed in Intoil. The role of different high level IT responsible people according to the use of IT in Intoil are clarified in this document. It is a high level document and therefore people who make decisions and define priorities should use this document.

1.2 RESEARCH QUESTIONS AND OUTLINE

The goal of this study is to discover the existing barriers of innovative research-based software development from the perspective of people who involve in software development projects in Intoil. The research questions that can help me to reach the research objective are:

1. What is the process by which research-based software is developed in Intoil?
2. What are the barriers to developing and implementing research-based software in Intoil?
3. What is the relationship between IT governance and innovation in Intoil?

This report is structured as follows: Chapter 2 is a literature review on innovation and IT governance. It introduces the concept of innovation with emphasis on IS innovation (process innovation) and digital technology innovation (product innovation). In addition, it describes the background of IT governance and its related disciplines, and explains IT governance structure and framework. Chapter 3 describes interpretive case study research method and a research design model for conducting this method. Chapter 4 contains the information about how the research is conducted and evaluated. Chapter 5 describes the findings of the study. Chapter 6 discusses the results of the study according to the literature review and gives a short conclusion of the whole report.

2. THEORETICAL BACKGROUND

This chapter includes the literature review regarding IS innovation and IT governance. There is no sufficient explaining about the relationship between these two issues in the literature; therefore they are investigated separately in this chapter.

2.1 INFORMATION SYSTEMS AND DIGITAL INNOVATION

The literature regarding innovation which is explained in this study is mainly divided into two parts. In the first part, “technology” is considered as a driver of organizational change while in the second part “R&D” is considered as a driver of organizational change. The chapter starts by reviewing the theoretical background of innovation and then continues with explaining the IS innovative concept, the impact of IS innovation in business and the process of applying the new technology into the business. The chapter then compares IS innovation with digital innovation and explains the digital product design and architecture. The last section of this chapter clarifies the role of the R&D department in innovation.

2.1.1 THEORETICAL BACKGROUND OF INNOVATION

The concept of innovation is not limited to the IS field and it is widely used in different areas. Related to the aim and region of each study, the innovation term is variously defined to reflect the particular requirements and characteristics of that specific study (Damanpour and Evan 1984). “Each writer presents a new definition, emphasizing the elements he or she deems relevant” (Biemans 1992). Among the several definitions of innovation, a general and widely accepted definition of innovation is “adoption of an idea or behavior that is *new* to the organization adopting it” (Daft 1978). A unit of adoption in apart from the organization could be a society and also a target market (Nemutanzhela and Iyamu 2011).

The mentioned definition of innovation focuses on the process of adopting a new item. While there are other definitions which emphasize on “developing and implementing a new item” or “a new item itself”. For instance, Martins and Terblanche (2003) focuses on implementation and define innovation as “the implementation of a new and possible problem-solving idea, practice or material artefact (e.g. A product) which is regarded as new by the relevant unit of adoption and through which change is brought about”. Rogers (2003) focuses on the idea itself and considers innovation as “an idea, practice, or object that is perceived as new by an individual or other unit of adoption”. Some researchers believe that a new idea itself or the implementation of it is not enough for definition of innovation. They believe that an innovation, per definition, also must result in some kind of positive development such as growth in the national economy, increased employment, or pure profit for the innovative enterprise (Urabe 1998).

2.1.1.1 INNOVATION TYPES

Innovation is classified differently in literature. However, the most common classification of innovations is the distinction between product and process innovations (Utterback and Abernathy 1975; Karlsson and Olsson 1998). Product innovations are defined as new products or services introduced to meet an external user or market requirements. Process innovations are new elements introduced into an organization's production or service operations-input materials, task specifications, work and information flow mechanisms, and equipment used to produce a product or render a service (Utterback and Abernathy 1975).

The emphases on product or process innovation for providing the competitive advantages are different among firms (Ettlie 1983; Hull, Hage et al. 1985). The rates of product and process innovations adoption are also different during the stages of the development of a business (Utterback and Abernathy 1975).

Product innovation is not taking place independently and without any communication with the external environment. It is driven or stimulated from a collision or a careful matching between technical opportunities and customer requirements. Some key factors are required for the collisions or matching between opportunities and customer need. One of them is communication in an innovation network. Communication with the customers and other participated departments or units is a key factor in product development. Availability of required background knowledge and competence within the enterprises themselves is another key factor for product development. The district or regional environment provides very different conditions for product innovation in terms of agglomeration economies, infrastructure supply, etc. Therefore it is the third key factor for innovative product development (Karlsson and Olsson 1998).

2.1.1.2 TECHNOLOGY AS DRIVER TO CHANGE (IS INNOVATION)

Swanson (1994) defines information systems innovation broadly as “innovation in the organizational application of digital computer and communications technologies (now commonly known as information technology, or IT)”. According to Swanson definition of IS innovation, Information Technology (digital computing and communications technology) supplies the basic material for information systems innovation. However, information systems innovations need that IT be applied in the organizational context (structures, processes). It means that the application of IT be organizationally conceived and executed (Swanson and Ramiller 1997). Therefore, IS innovations involve both technological components i.e., hardware and software and organizational dimensions like the new forms of work, business processes or organization methods (Nemutanzhela and Iyamu 2011). That is, IS innovations frequently require the incorporation of new roles, responsibilities,

relationships, lines of authority, control mechanisms, work processes, and workflows in the organizational designs (Swanson and Ramiller 1997).

IS innovation activity covers an extensive range of activities that involve new IS products or services, new types or forms of information and communication technologies used, or new types of organizational arrangements to manage and deliver IS services (Nemutanzhela and Iyamu 2011).

2.1.2.1 IS UNIT AS IS INNOVATION RESPONSIBLE

In the Swanson 1994 IS innovation theory, IS innovation is mainly a responsibility of the organization's IS department and other subunits served by the IS department. The IS unit is in charge of taking care of successful IS innovation adoption in the organization. However, IS innovation succeed may rest upon an effective partnership between the IS department and its users. Moreover, in some cases the users maybe themselves be the sources of certain IS innovations. Other parties which are external to the host organization like the vendors, providers of outsourced services or consultants will also be seen to take part in the overall IS innovation process (Attewell 1992).

2.1.2.2 IMPACTS OF IS INNOVATION ON BUSINESS (DIFFERENT IS TYPES)

A goal of this section is to develop the understanding of the relationship of IS to the larger business. Innovation in information systems can result in the creation of a new IS product or service, a new IS administrative arrangement or a new IS work technology. Each of the mentioned innovation forms, can impact on the host organization of IS innovation. The direct effect on the host organization occurs only where IS's products and services impact upon the host's basic business processes and products. The direct business impact of information systems innovation may be on either or both the business's administrative and technical work processes (Swanson 1994).

To emphasize on the business impact of IS innovation, Swanson (1994) presented the basic IS innovation typology. He defined three different types for IS innovation based on the Tri-Core representation of IS innovation in organizations. This Tri-Core model is an extension of the Dual-Core model of innovation in organizations. The “administrative” and “technical” innovations are the two cores in the Dual-Core model of innovation in organizations (Nemutanzhela and Iyamu 2011). Swanson (1994) incorporated the “functional IS” as the third core of this model. The functional IS core states between these two cores and provides a link between them. In the other words, in the Tri-Core model the domain of IS innovation is understood to incorporate both the functional IS core and the technology and business administration cores through IS product and services (Swanson 1994). The reason for adding “the functional IS core” to the dual core model, was to illuminate IS

innovation among organizations, in terms of business impact. The impacts of IS innovation on business were mostly masked in the dual-core model.

The first type of IS innovation is restricted to “the functional IS core”. In this type, the other business areas are affected indirectly. The focus of this type of innovation is on IS *administrative* or IS *technical* task. The example of the IS administrative task is the departmentalization of the software maintenance function (Swanson and Beath 1990). In addition, the examples of the technical IS tasks are the introducing of new development tool or a new programming team.

The second type innovation applies IS products and services to the administrative core without directly affecting the organization’s products and services. This type uses IT to support the administrative core of the organization. The examples of this type of innovation are automated financial accounting systems, personnel record systems or as a more recent example, the advent of information centers in the late 1970s.

The third and last type of innovation, integrates IS products and services with core business technology and potentially affects the whole business, including its competitive strategy and position (Haines 2004). The introduction of Material requirements planning (MPR) systems in the 1950s and the emergence of the real-time reservation systems (e.g., The airline reservation systems) in the 1960s are the examples of the this type of IS innovation (Swanson 1994).

2.1.2.3 ORGANIZATIONAL IS INNOVATION PROCESSES

In this section, the process of applying IT in the organization is explained. Several frameworks exist in literature regarding to the IS innovation process (Kwon and Zmud 1987; Cooper and Zmud 1990; Larsen 1998; Fichman 2000; Gallivan 2001). In this section, the Swanson and Ramiller’s (2004) framework is used to explain the application of IS innovation in organizations. In this framework the role of the institutional environment in shaping the pattern of a firm’s engagement with IT innovation is very impressive. The firm starts adopting or rejecting an innovative idea by consideration what other firms are being said to accomplish with the innovation. The firm then ends with investigating of what is achieved by adopting the innovation. Totally, four processes are involved in applying IS innovation in organizations containing comprehension, adoption, implementation, and assimilation.

Comprehension: The firm starts innovation by comprehension via sense making efforts of its members. The firm engages in the larger communities and discusses with other firms about their experiences regarding the emerging innovation. After achieving the first

understanding about the features of the innovation, it decides on whether it wants to adopt it or not (Rogers 1995).

Adoption: in the adoption process, the firm tries to have a deeper consideration of the IT innovation follows in which the firm typically develops a supportive rationale, or business case. The participants try to discuss about why they should have the new technology in their organization and what's the benefit of that for them (know-why) (Swanson 2003). Although the firm can understand the other firms' ideas about the innovation by participating in communities, they need to know what the innovation can specifically bring to the organization at this step. The organization then compares the business value of the innovation and the challenge presented by the prospective change before it decides whether to proceed and commit its resources.

Implementation: The implementation process contains several considerations, choices, and actions that will shape the transition. The main goal of the firm in this process is bringing the innovation to a productive life for its users. Their wider goal is being to advantageously reposition in their larger environment. Timing is one of the important issues that needed to be considered (know-when). It is related to the organization's preparedness and the readiness of the enabling technology and the maturity of complementary services in the larger community. The firm also needs to know the details of "what may be, and commonly is, a perilous venture" (know-how) (Swanson 1998). Some of the answers to the know-how question can be achieved in the marketplace. The communication with larger community may provide some guidelines, although what is acquired will need adjusting to the firm-specific context (Swanson and Ramiller 2004).

Assimilation: Assimilation begins at the start of applying IT innovation in the firm's work life and the demonstration of its usefulness. At this step, the innovation may come to be infused and woven into the original organization's work systems. At this step the role of the larger community (of different firms) which motivated the firm to use the innovation may be disappearing. Alternatively, the innovation may be faced with persistent and disruptive problems that can make it eventually discredit in the opinion of different users or managers in the firm. These kinds of problems sometimes lead to the innovation curtailment or eventual rejection. In this situation, "the larger community may now provide contrary rationales, particularly where the organization's own encounter with the innovation mirrors the problematic experiences of others" (Swanson and Ramiller 2004).

2.1.3 IS INNOVATION ADOPTION AND DIFFUSION VS. IT ARTEFACT DEVELOPMENT

The IS innovation literature mainly concerned with how IS innovation spreads within organizations and how different types of IS innovation impact on the firm's strategy, structure and processes (Sambamurthy, Bharadwaj et al. 2003; Swanson and Ramiller

2004). Moreover, the IS literature tried to discover the role of information technology in building competitive advantages and creating business value (Kohli and Grover 2008; Nevo and Wade 2010).

In spite of these efforts on the organizational processes, the impact of digital technology on the industrial products has remained unnoticed. The product architecture term which means the arrangement of functional elements, the specification of interfaces among components, the mapping from “functional elements” to “physical components” is not widely discussed in the IS literature. The product architecture changes according to the emergence of the new digital technologies. The changes in product architecture affect the firm’s IS strategies and use (Yoo, Henfridsson et al. 2010). The following sections then, contain the explanation of the digital product innovation, its design characteristics and architecture.

2.1.4 DIGITAL INNOVATION

In the recent years, digital technologies have developed rapidly. The examples of these new digital technologies are web 2.0, cloud computing, pervasive computing and the open source approaches. These new technologies affect organizations in different ways e.g. reshaping markets, changing the traditional industry boundaries, creating technological discontinuity and changing the business models (Rothaermel 2005; Benner 2010; Tilson, Lyytinen et al. 2010). The massive changes in digital technology on the organizations, has made it as a primary source of innovations. It establishes new organizing logics, helps in creating new products and innovative services that are the solutions to many challenges in the organizations.

Yoo, Lyytinen et al. (2010) defines digital innovation as “the carrying out of new combination of digital and physical components to produce novel products”. Unlike of the other IT innovation researches that have been primarily focused on process innovation (Swanson 1994), this definition of digital innovation emphasizes on product innovation.

To understand the meaning of the digital innovation it is important to know the different between digitization and digitalization. Digitization is the technical process of encoding diverse types of analog information into the digital format. An example of purely technical digitization is the installation of digital switching in the 70’s in the telecom industry. This example of digitization did not have any effect on the socio-technical context. In contrast, digitalization goes beyond of the purely technical processes and involves organizing new socio-technical structures with digitized artefacts or with the changes in artefacts themselves. Examples of digitalization are mobile media, digital publication, Internet-based TV and digital cameras. In these examples, the major innovation concerned not only the digitization of artifacts such as mobile phones, TVs or books, but also a much broader

socio-technical restructuring of organizing logics among different firms that are newly interrelated or interconnected through a common digital infrastructure (Yoo, Lyytinen et al. 2010).

2.1.4.1 DESIGN CHARACTERISTICS OF DIGITAL PRODUCTS

Digital technology has three important design characteristics that separate it from non-digital products. These design characteristics play crucial roles in facilitating digital innovations. They form a powerful set of common and mutually re-enforcing impacts that have created the unique socio-technical dynamics of digital innovations (Yoo, Lyytinen et al. 2010). In the following paragraph these design characteristics of digital technology are reviewed.

The first design characteristic is the homogenization of digital data (Yoo, Lyytinen et al. 2010). In analogue technology, there is a tight coupling between the analog data and analog devices. For example, between the vinyl records or VHS tape. This tight coupling between data and device leads to the emergence of vertically incorporated industry structures for analog media (Tilson, Lyytinen et al. 2010). However, in the digital data, “any type of content (audio, video, text and image) now can be stored and transmitted using the same device” (Yoo, Lyytinen et al. 2010). The homogenization of digital data dissolves the boundaries between different media (Yoo, Lyytinen et al. 2010).

The second characteristic is the programmable digital computing architecture (Yoo, Lyytinen et al. 2010). In digital technology, computers use a processing unit and a storage unit to hold both programs and data in the same format and in the same locations. This provides a significant flexibility to perform many different functions all with the same device. For instance, calculating, video editing, word processing, web browsing and many other functions can be done on a personal computer. Thus, the digitalization of non-digital artifacts leads to the separation of the semiotic logic of a program from the physical hardware device that executes it. Unlike non-digital devices, digital artifacts can be easily programmed and re-programmed.

Third design characteristic is the self-referential nature of digital technologies (Yoo, Lyytinen et al. 2010). “Digital innovation requires the use of digital technology” (Yoo, Lyytinen et al. 2010). Extensive diffusion of digital innovation involves ubiquitous access to digital tools. For example, PCs as a design platform and the internet as a communication network, this is what the self-referential nature of digital innovation means (Yoo, Henfridsson et al. 2010). Unlike industrial technologies that require widespread capital to obtain, users could more easily access digital technology platforms. This characteristic of digital technology leads to new types and forms of innovation creation (Tuomi 2002; Hippel 2005).

2.1.4.2 FOUR-LAYERED GENERIC MODEL OF DIGITAL TECHNOLOGY

With the emergence of the concept “digital technology”, a generic model of digital service architecture with four layers of devices, networks, services, and content (Benkler 2006) is formed. A good example of the layered architecture use is the Internet. In the layered architecture, the network and content layer are separated due to the homogenization of data and similarly the device and service layer are separated due to the re-programmability (Yoo, Henfridsson et al. 2010).

Device layer: The device layer is divided into a physical machinery layer (e.g. Hardware) and logical capability layer (e.g. Operating systems). The logical layer provides the control and maintenance of hardware devices. Moreover, it connects the physical machinery layer to the other layers (Yoo, Henfridsson et al. 2010).

Network layer: The network layer is divided into a physical transport layer (e.g. Cables, transmitters, etc.) and a logical transmission layer that includes the network standards such as TCP/IP or P2P (Yoo, Henfridsson et al. 2010).

Service layer: The service layer interacts with application programs that directly deal with users as they create, store, use and manipulate different content. With the service layer, users can send and receive emails, read books, listen to music, watch videos, and receive navigation information (Yoo, Henfridsson et al. 2010).

Content layer: The content layer consists of the actual data such as images, videos, texts, etc. The content layer can also include meta-data such as copyright, content tags, and ownership, etc. (Yoo, Henfridsson et al. 2010).

This layered architecture of digital technology is not new and previously was introduced to the computer and network technologies. The differences of this layer architecture with the previous version of layered architecture (which existed before the digitalization) is on the relationship of different layer together. Previously these four layers were tightly coupled within a particular media, industry or product boundary. Furthermore, in purely physical or mechanical products such as cars, clothes and so on, those layers did not exist. However, as a result of digitalization, “these four layers can be de-coupled, or loosely coupled, through the integration of general purpose computing and networking capabilities” (Yoo, Henfridsson et al. 2010). The loosely couple means that in this architecture, the individual design decisions for each layer can be made with a minimum consideration of the other layers (Yoo, Henfridsson et al. 2010).

2.1.5 R&D AS DRIVER TO CHANGE

In contrast to Swanson IS innovation theory that considers the IS unit as the most important unit in IS innovation which is responsible for IS innovation success in the organization, the product or process innovation literature beliefs on the critical role of R&D department. Biemans (1992) in the departmental-stage model assumes that a product passes through the four following departments: 1) R&D, 2) Design 3) production and 4) marketing. However, in reality the process is more complicated that was Biemans assumes and the relationship pattern between different departments is so complex. In process development, all of the mentioned departments except marketing department are involved in the process.

In both product and process innovation, R&D department has a critical role. Several studies have pointed out a significant relationship between innovation and R&D activities and investment in organizations (Capon, Farley et al. 1992; Baldwin and Johnson 1996; Koen and Kohli 1998). According to Jankowski (1998), the important role of R&D in innovation relates to its functions as the technological “gatekeeper” in the organization. Lowe (1995) discusses the role of R&D in innovation in a more specific level. From his point of view, a firm can use R&D to reach its strategic objectives. For instance, can use R&D as an offensive strategy planned to attack competitors open up new markets, or improve market shares, and each of these strategies is strongly related to innovation (Prajogo and Ahmed 2006).

R&D is seen as “the engine of innovation” (Botkin and Matthews 1992) which has two main functions. It works as a direct source of product and process innovations, and it develops and maintains the abilities to develop and incorporate externally available information (Cohen and Levinthal 1989).

The existence of distinct and varied type of skills in R&D department and the commitment of firm to R&D department will make it easier for the firm to adapt to changing requirements for successful product and process development (Gamser 1988).

2.2 IT GOVERNANCE

IT Governance has become a debated issue nowadays. The frequency of IT within the most commercial and public organizations has created extra pressure on overseeing the effectiveness of IT. The current IT environment is surrounded by the business environment. It requires cost control, risk management, regulatory compliance, availability, timely project delivery, change and innovation in order to deliver stakeholder value. Successful applications of IT Governance rules and principles can provide a mechanism to enhance the effectiveness of IT and, in turn, to meet the increasingly high demands of

business for IT. The purpose of this section is to introduce the concept of IT governance and define its background, related discipline and structure.

2.2.1 THEORETICAL BACKGROUND OF IT GOVERNANCE

In response to the series of business failures and corporate scandals, which were started with Enron in 2001 and were followed by Arthur Andersen and WorldCom, the duties and responsibilities of the boards of directors of public and privately held corporations were questioned. Enron Corporation, a Houston-based energy trading company, becoming the largest bankruptcy case in US history, having in excess of \$62 billion in assets in late 2001 (Posthumusa and Solms 2005). The reason for the collapse of Enron Corp was due to inadequate oversight of accountants, weak corporate governance procedures, stock analysts' conflict of interests, and lack of auditor independence, inadequate disclosure provisions, and grossly inadequate funding of the securities and exchange commission (Lucas 2004). To prevent the same failures, the Sarbanes-Oxley Act was written to stress the importance of business control and auditing and it was enacted by U.S Congress (Sarbanes-Oxley in U. S has been catalysts for the development of the discipline of information technology governance since the early 2000s). The definite purpose of SOX is to protect stakeholders by improving the accuracy and reliability of corporate disclosures made pursuant to the securities laws. SOX outlines the duties of the chief executive officer (CEO), the chief financial officer (CFO), and the auditor, e.g. Making each one responsible for ensuring the credibility of the financial reporting provided to stakeholders. However, the concerns of Sarbanes Oxley are more focused on operational control processes like management changes than IT decision rights (Robles, Rosslin et al. 2008).

2.2.2 THE CONCEPT OF IT GOVERNANCE

Two of the prominent issues in governance are the stakeholder's values (ITGI 2011) and expectations. A way to achieve these expectations is a suitable governance of an organization's IT infrastructure (ITGI 2011). IT governance is a compartment of corporate governance so the definition of the corporate governance is essential to increase the understanding of IT governance. The Corporate governance is the responsibility of boards and to some extent manager. It includes the governance of internal process of an organization and the regulation of rules which help individuals to manage their tasks (Webb, Pollard et al. 2006). Information technology has turned out to be a fundamental component of the business, which has a significant role in the realization of the business goals and objectives. With the advent of information technology, the responsibilities of directors have become more complicated. The directors need to assess and evaluate the impact of IT on their business on a regular basis (Trites 2004).

There is a lack of agreement on the comprehensive and shared definition of IT governance in different books and articles (Simonsson and Johnson 2006). Different authors have focused on different aspects of IT governance and have defined IT governance from the specific aspects:

The first group of researchers which include for instance ITGI (2011), Bowena, Cheung et al. (2007), Grembergen (2007) and Webb, Pollard et al. (2006) have focused on the "control objectives" of IT governance. While the second group that contains e.g. Brown, Grant et al. (2005), Simonsson and Ekstedt (2006), Symons (2005) and Raghupathi (2007) noted the "decision making" concept of IT governance.

From the "control" point of view: IT is complex, fast changing and has unique conditions; these unique conditions of IT create a need to apply management regulation and control over it (NCC 2005). IT governance from the control aspect is the responsibility of boards, executive managements and IT managements. It consists of leadership, organizational structures and processes, which controls the alignment of IT and business strategies and goals.

From the decision-making point of view, IT governance is related to determining different members' responsibilities in relation to the creation and implementation of IT decisions on:

- Goals (e.g. which IT strategy should apply?)
- Processes (e.g. which activities are required to perform IT tasks?)
- People (e.g. which is doing what tasks in IT?)
- Technology (e.g. which kind of servers, firewalls and operating systems?)

In two different tactical and strategic scopes. Tactical decisions are low level and short term managerial decisions. For example, how we want to configure the applicant's user interface? And/or, how often the servers need an update? On the other hand, strategic decisions are high level and long term management decisions. They are the answers to the questions such as whether we need to outsource a part of an application or do it internally. And/or, which type of decision-making structure we should choose? (ITGI 2011).

2.2.3 WHY IT GOVERNANCE IS IMPORTANT?

A successful deployment of information technology systems is an important factor in most of the organizations. It helps organizations to deliver efficient and effective operations, supports numerous business operations, and helps organizations to achieve their strategic goals. The problem of most of organizations is that they usually concentrate on the IT strategies, budget and policies without considering the role of IT governance.

The importance of IT governance largely related to the duality of IT in organizations. The role of IT can be investigated from two perspectives: On the one hand, IT creates lots of opportunity for the organization and plays a critical role in the enterprise success. Therefore, it can create competitive advantages, increase the efficiency of business and facilitate communication and much more. On the other hand IT creates many risks: IT projects can easily get out of control and profoundly affect the performance of the organization. In addition, the implementation of them is a complicated process and requires large investments and need specialization (ITGI 2011). In order to assure the investments in IT generate business value, organizations must effectively manage and exploit IT-related risks and opportunities respectively. Therefore, IT requires considerable board-level guidance in terms of risk management and governance endeavors.

2.2.4 IT GOVERNANCE ELEMENTS

Three elements play the key roles in IT governance: structures, processes and control frameworks. These three elements are explained in the following sections.

2.2.4.1 STRUCTURE

The structure element discusses about the people who have the right to make IT related decisions in the organization. There are different “structural forms” that governance model can select. However, there is no universal structure, which fits for all kinds of organizations, and it is dependent to different elements inside organizations.

The traditional approaches define three structural forms for IT governance: centralized, decentralized and federal (Webb, Pollard et al. 2006). In the centralized mode, the corporate central IS organizational body has the right to decide on IT related issues. The centralized approach provides a strict control among IT standard. In decentralized mode, individuals or line managers have the decision right. This result more customized solutions for separate business units (Brown, Grant et al. 2005). Federal mode is located between these two extreme points (centralized and decentralized). It provides a central IS group to decide about core IT services while allows other units to operate in other parts of the organization with a definite amount of autonomy.

In contrast to the traditional approach concerning the IT governance structures, another viewpoint exists which believes in various degrees of centralized and decentralized structure. It introduces other midrange points between these two extremes, start from a more centralized to more decentralized structures (Weill 2004; Brown, Grant et al. 2005).

Business monarchy: Senior business executives decide on IT related issues in the enterprise. This mode is near to centralized governance with some differences in the explanation of the central unit.

IT monarchy: IT professionals, e.g. Senior IT managements, have the decision-making right in relation to the issues that have impacted on the IT architecture. IT monarchy is more likely to centralized approach (Weill 2004; Brown, Grant et al. 2005).

Feudal: Every region, business units or functions make their own decisions about IT related local problems (Weill 2004; Brown, Grant et al. 2005).

IT duopoly: Two parties contribute in decision-making, one IT executives and one business group. IT duopoly is a simpler version of federal model (Brown, Grant et al. 2005), (Weill 2004).

Anarchy: Every small group makes their own decisions related to their requirements. The difference in this mode with feudal is in the size of the unit. Feudal mode is about larger parts or group while anarchy is about smaller groups (Weill 2004; Brown, Grant et al. 2005).

2.2.4.2 PROCESS

A set of IT processes are required to meet organizational IT goals. It is essential that IT governance processes are aligned with corporate governance processes (Webb, Pollard et al. 2006). The first step in IT governance process is defining goals or objectives of the enterprise's IT, the next step is the continuous process of checking the performance of different parts according to the aims of an enterprise's IT, and the last step is changing directions or goals when it was necessary (ITGI 2011). The processes might contain the budget allocation mechanism, tests and stabilities, report creation, IT procurement, etc (Webb, Pollard et al. 2006).

2.2.4.3 CONTROL FRAMEWORKS

To check, evaluate and assess the situation of organizations in relation to predefined factors or criteria, a set of processes, procedures and policies are required. The task of control framework is to help managers evaluate and control the performance of IT and its usefulness inside the organization (Webb, Pollard et al. 2006). The Control frameworks are composed of structure, processes and communications between them (Haes and Grembergen 2009).

Not any generally accepted control framework for IT governance exists. However, some international framework support implementation of IT governance including Control

Objectives for Information and related Technology (COBIT), The IT Infrastructure Library (ITIL) and ISO 17799; each of these frameworks focus on a different aspect of IT governance.

COBIT is the most frequently used and globally recognized framework (Simonsson and Johnson 2006), which focuses on monitoring and assessment of IT processes. COBIT contains 34 IT processes and each enclosed in four sections. These sections demonstrate a complete instruction on how to manage, measure and control the processes according to process descriptions, key activities, inputs and outputs to the processes and responsibilities (Hard 2006).

ITIL has focused on IT service management and consists of eight books: "Software Asset Management", "Service Support", "Service Delivery", "Security Management", "Application Management", "ICT Infrastructure Management", "The Business Perspective" and "Planning to Implement Service Management". COBIT and ITIL are considered as complementary frameworks and can collaborate with each other to build a governance framework (Symons 2005).

ISO 17799 is the third most frequently used governance framework and is based on the IT risk management and security plan (Symons 2005; Simonsson and Johnson 2006). It contains security policy, personal security, physical and environmental security and some other security related issues. This unilateral attention to the security has made it an incomplete framework, which is not suitable to use as a basis for IT governance framework. It can only be used partly in specific security related issues (Symons 2005).

2.2.5 RELATIONSHIP BETWEEN IT GOVERNANCE AND OTHER IT DISCIPLINES

IT governance is a wide and continuous process, requires ongoing review and adjustment. It involves several concepts including, IT security governance, IT portfolio management, Data governance, and regulatory compliance amongst several others.

2.2.5.1 IT SECURITY MANAGEMENT

The information security is an important issue for both organizations and individuals. The aim of the organizations is to keep the information safe and more reliable in the networks and products. Maintaining information security is a complex process. It is not solely a technical issue, but also a corporate governance challenge. Hence, it requires an active engagement of executive managements. Information security governance is the set of responsibilities and practices exercised by the board of directors and senior executives to direct and control IT security (adapted from ISO 38500). IT security governance is a connected and essential part of the enterprise governance and should be aligned with the

IT governance framework (ITGI 2006). IT security governance manages risks, monitors the security program of the enterprise and provides strategic directions about enterprise IT security (ITGI 2006).

To exercise effective enterprise and information security governance, boards and senior executives must have a clear understanding about their responsibilities. They need to know the way they want to implement the information security program and the process that are required to evaluate the program. Directors have important responsibilities. They need to ensure that managers take all necessary measures to secure key information, systems and networks, which store, manipulate, and transmit this key information. Furthermore, they need to ensure that these efforts are continuously in progress (ITGI 2006).

2.2.5.2 IT PORTFOLIO MANAGEMENT

Today most of organizations invest significantly in IT. Due to the significant investments, they need to establish proper processes and systems in order to evaluate the value, cost, risk and performance of IT services. Therefore, a great importance is placed in IT portfolio management.

The IT portfolio includes a group of anticipated and ongoing IT projects as well as the whole IT systems within an organization. Thus, an IT portfolio management is a process which can be applied to the entire portfolio of activities in order to establish a balance between the risks and returns (Verhoef 2003). The IT portfolio management methodology can help organizations to reach to a greater control over their portfolios through the ability to categorize, evaluate and manage IT recourses and the capability to prioritize projects (Verhoef 2003).

2.2.5.3 DATA GOVERNANCE

Data is the most valuable asset of an organization. It helps organizations to stay competitive and agile, able to meet customer needs and to remain costs in check. Due to the critical role of data there is a need to establish standards, policies, and processes for the usage, development, and management of data throughout the organization (Panian 2010).

Data governance is an emerging trend in enterprise information management. It is defined as the processes, policies, standards, organization, and technologies required managing and ensuring the availability, accessibility, quality, consistency and security of data in an organization (Khatri 2010). Data governance like other governance issues refers to who holds the decision rights and is held accountable for an organization's decision making regarding its data assets (Khatri 2010).

2.2.5.4 GOVERNANCE VS. MANAGEMENT

One of the problems of IT governance is that it is usually confused with IT management practices. Although, these two concepts seem to be similar, they have several differences. IT governance is about decision making while the IT management is about making sure that the enterprise governance processes are executed. It should be considered that the processes which are being used to identify new process, are different from the processes which are being used to create new product, services and goods from a given business unit.

The governance process is used to identify the chains of responsibility, authority, and communication in an organization. These processes empower people and to define the measurement and control methods to enable them to do their roles and responsibilities. Therefore, the aim of governance activities is to define general organizational strategy and structure, decision rights, direction and culture, workflow and authorization points, to create a target workflow. This target workflow uses a business entity's resources in alignment with the goals and objectives of the business.

On the other hand, management processes are the output of the governance processes. A management process unlike a governance process, creates a specific chain of responsibility, communication and authority to help people to do their daily jobs (Webb, Pollard et al. 2006). The management process provides suitable measurement and control methods. These measurement and control methods give the executive team the ability to monitor the execution of both the governance and management processes remotely, as well as monitor the output quality of the management process in execution (Mueller, Magee et al. 2008).

2.2.6 ROLE OF TOP MANAGERS IN IT GOVERNANCE

Whilst there are lots of emphasis regarding the involvement of top managers in IT governance, there is no empirical evidence (Sohal and Fitzpatrick 2002) which proves the value of top manager's involvements. Furthermore, an implementation program can succeed or fail in the middle or lower levels of implementation. For that reason the role of middle managers in IT programs is also very important and shouldn't be neglected (Sohal and Fitzpatrick 2002).

The participation of top managers in IT governance is not the same in different organizations. First, it is related to the type of the business and second, it is related to the role of IT in that business.

In some businesses, IT plays the role of most important and fundamental factor of the business, for instance in banking or IT services. In these sorts of organizations, the high level or director level management decides on strategic IT decisions. However, this may lead to neglecting the important role of middle managers in the organization.

For some other type of industries, IT is essential and has fundamental influences on business but it is not the main constituent of the organization, e.g. selling and purchasing goods, health care, etc. The medium level managers (who states at two lower level positions from the top managements) manage these types of manufacturers (Sohal and Fitzpatrick 2002).

In the last type of industries, IT is used to increase the productivity of the company by automating the wide tasks of the organization. Transportation, building and construction are the major examples of this sort of entrepreneurships. The lower level manager (who states at two or three lower level positions from the top management) manages the organization at these types of businesses. However these manufacturers need to decrease the gap between managers and make contacts with top managers to benefit from the supports of top managements for more innovative IT infrastructures or applications (Sohal and Fitzpatrick 2002).

3. RESEARCH METHOD

I have conducted an interpretive case study research. The reason I chose the interpretive case study research was related to the objective of my study. I think that the interpretive case study research can help me to reach the goal of my study more than the other available way of conducting IS research. Therefore, in this chapter I seek to explain the interpretive case study research. Since the interpretive paradigm is one of the three existing paradigms in IS research, the chapter starts by clarifying the differences between paradigms for carrying out a research. Then the different types of data that can be obtained through conducting an interpretive case study are defined and compared. Subsequently the case study research method and different ways of collecting and analyzing data are presented. The chapter concludes with an explanation of “research design” and a model for it.

3.1 PHILOSOPHICAL PARADIGMS

The interpretive case study builds upon an interpretive paradigm. Interpretive paradigm is defined as one of the three dominant paradigms in the IS research in the literature (Orlikowski and Baroudi 1991).

Oates (2010) defines a paradigm as “a set of shared assumptions or way of thinking about some aspect of the world”. Philosophical paradigms are shared ways of thinking about how do researches and create knowledge. In the other words, philosophical paradigm has particular views about the nature of the world and the way we can obtain knowledge about it. Generally, three different research paradigms are identified in the literature: positivist, interpretive and critical research (Orlikowski and Baroudi 1991). These different paradigms are defined in the following sections.

3.1.1 POSITIVIST

Positivist paradigm is a classic scientific research paradigm and has a long history especially in physical and natural science research. Research is considered positivist if there are “quantifiable measure of variables, hypothesis testing, evidence of formal propositions, and the drawing of inferences about a phenomenon from a representative sample to a stated population” (Orlikowski and Baroudi 1991).

The goal of the positivist paradigm is to find the universal laws, patterns and regularity and increase understandings of phenomena (Myers 1997). The experiment is considered as the best suited method for this. The experiment is a form of quantitative research where a causal relationship between x and y are studied. Robson (2002) believes that if you can

relate an event, observation or other phenomenon to a general law, then you have explained it.

Within the positivist paradigm measuring instruments are seen as independent from the observers. The observers should not interfere and changes in the phenomena. In other words, the researcher is seen as having a passive role in this approach. For instance, in positivist research when observers examine the relationship between information technology and business management, they presume structure to be objective. Thus it is capable of being described via different measures such as: hierarchical levels, formalization, centralization, division of tasks, scope of control, etc (Orlikowski and Baroudi 1991; Myers 1997).

3.1.2 INTERPRETIVE

Interpretive research can help researchers to understand human thought and action in social and organizational contexts (Klein and Myers 1999). In other words, the interpretive research attempts to understand phenomena through the meanings that people assign to them (Orlikowski and Baroudi 1991; Deetz 1996).

In Interpretive approach to research, organizations are dynamic and the relationships between people, organizations, and technology are constantly changing. Consequently, the interpretive research tries to understand a moving target (Klein and Myers 1999). Moreover, the role of other people who involved in the study is so important in the interpretive research. It tries to see how different people look at their world and tries to understand phenomena through the meanings and values that people assign to them.

The role of the researcher also is different from the positivist research. The researcher is not completely neutral in this approach. His/her own background and values will affect the research process and the situation. The researchers must explain how the data were collected and reflect on how they may have affected the data.

3.1.3 CRITICAL RESEARCH

Critical research aims to critique the status quo. It contains: challenging the existing norms, exposing the structure of power and domination, evaluating and transforming the social reality (Orlikowski and Baroudi 1991).

A critical researcher believes in the existence of the objective reality such as positivist researcher. They try to find the fundamental contradictions within the social organizations by evaluating the situation. In addition, they attempt to find some ways to change these adverse social conditions (Orlikowski and Baroudi 1991). The aim of the critical researchers is to eliminate the social injustice. This is in contrary with other two

approaches (positivist and interpretive) which aim to predict or explain the status quo (Orlikowski and Baroudi 1991).

For instance, consider a need for a computer-based system in a sport club, which is jointly used by both men and women. There is a shared view between the club members, that the captain of men's group should have the right to select the date of holding competitions. Therefore, the captain of the women's group should select from the remaining dates. At this situation, interpretive researchers would evaluate how different group see the world and how members share understandings about the way of organizing a sport club.

On the other hand, critical researchers would go further and attempt to find the answer of question such as why this way of seeing the world is dominated at this group. The critical researchers would struggle to eliminate the barriers of fairness in the sport club. They encourage women to critique status quo and help them to organize themselves (Oates 2010).

3.2 DATA

The type of data and the way of collecting data are the important issues contribute in a research process. Depending on the subject and the area of study, the data can be qualitative or quantitative and subjective or objective. In this section, different types of data and their relationships and differences are explained.

3.2.1 QUALITATIVE VS. QUANTITATIVE

Quantitative data are usually demonstrated in the form of numbers (Hodgson 2010) and qualitative data are described in the shape of texts and sentences (Gilgun and Daly 1992). Consider an oil painting as an example, the quantitative data talk about the size, the weight, and the cost of the painting while the qualitative data talk about the texture, the colors are used, the beauty of the painting, etc. Quantitative data are mainly collected through experiments and surveys while qualitative data are achieved through oral explanation of the person's perceptions, opinions, experiences, knowledge and feeling.

The quantitative data usually attempt to prove phenomena, whereas qualitative data try to understand phenomena. For instance when we want to know the exact weight of people, we employ precise instrument of measuring weight and document the numbers. On the other hand, when we want to know about the meaning of people weight, we need to have a discussion with people and ask them some questions related to their weights (Patton 2002). To find qualitative data, the observation techniques like participatory observations, interviews, company's documents, reports and researcher's reactions and opinions and much more are involved (Myers 1997).

3.2.2 SUBJECTIVE VS. OBJECTIVE

Subjective data are personal judgments or opinions about different subjects. For instance, the statement “I am a fat person” is subjective. On the other hand, objective data are external to the people’s mind. They are about things existing in the real world and can be packed up with concrete data like mathematical proofs. For example, the statement of “I am 60 kg” is objective.

A 60 kg person maybe does not appear fat from the external observer view. However, at this example, it seems fat from the personal judgments of the person (Seaman 1999).

3.2.3 QUANTITATIVE VS. QUALITATIVE DATA, SUBJECTIVE VS. OBJECTIVE

In case of the relationships between qualitative and quantitative data vs. Subjective and objective data, two kinds of confusion are discussed in the literature. The first one comes from since people think that qualitative data is synonym of subjective data and quantitative data is equal to objective data. The second confusion comes when people transform the shape of qualitative data into numerical data and consider the new data as objective data.

For the first problem consider the question: “do you have any laptop at your home?” The answer to this question is “yes” or” no”. These answers are in the form of text, hence they are qualitative data. Since they demonstrate an indisputable fact, they are not considered as subjective data. Consequently, they are qualitative objective data. Assume another question: “what do you think about the price of your laptop?” And the answer of: “I think it is cheap.” This answer shows the respondents’ personal judgment so it is both qualitative and subjective.

For the second problem, consider some codes that they are attached to qualitative data. For example”1” to “yes” and”0” to “no”. These codes show the numerical data and change the form of the qualitative data into quantitative data. However, they are resulted from the subjective opinion of the responder, thus they are both quantitative and subjective data. As another example, the rating scale of “zero to ten” is assigned to the question “what is the rate of your laptop speed from 0 to 10?” The answer of this question can be for instance, “it is 7 from my point of view”. This answer is quantitative and subjective since it shows the respondents’ personal judgment (Gilgun and Daly 1992; Hodgson 2010).

From the above examples, it is clear that the objectivity or subjectivity of data is not related to whether it is qualitative or quantitative.

3.3 RESEARCH METHOD: INTERPRETIVE CASE STUDY

I have applied the interpretive case study research method. The research methods are used by researchers during a research to help them reach their goals (Rajasekar, Philominatha et al. 2006). Within interpretive research, there are several different methods like ethnography, action research and case study to choose between, and I chose case study research. Therefore, a short description of the case study with a focus on interpretive case study will be presented.

3.3.1 QUALITATIVE INTERPRETIVE CASE STUDY

Since the mid-1980, by growing the focus of information system research on social issues, the interest of using empirical researches has also increased. Empirical researches focus specifically on the interpretation and meaning of human beings and use a variety of qualitative data sources (Walsham 1995).

One way of investigating social issues is qualitative interpretive case study. Case study method facilitates explanation of phenomena by applying different data sources which have been collected via frequent visiting of the case (Baxter and Jack 2008).

A case is an instance of an object that it will be investigated. It can be an organization, a computer-based system, a group of developers, a project in an organization, a community, etc. The case study method attempts to explain the details of the case. It tries to find a deep understanding of the phenomena by investigation of the relationships and processes of the case in connection with its external environment (flyvbjerg 2011).

Miles and Huberman (1994) explain the case study method by a figure of a circle with a heart inside of it. The heart is the focus of study and the circle shows the boundary of the case. Nothing stated outside the borders is considered in the case study, in other word it is required to determine the boundary of the study and limit the parts that they are needed to be studied. For instance limit the people who are needed for the interview, the time it is needed to spend, the amount of budget it is required during the investigations and so forth.

The case study is a suitable method when it is not possible to divide the phenomenon from its context (Merriam 1998), for instance the behavior of a child “among his classmates” or the impact of new software on “the staff of an organization”. It is also suitable when there is not enough historical or theoretical background about the research subject or the focus of research is on a contemporary event or phenomena in its natural setting. However, it is not proper when it is required to control or exploitation of variables (Benbasat, Goldstein et al. 1987). The case study method can be positivist, interpretive or critical depending on the philosophical assumption of the scientist (Myers 1997).

A qualitative case study according to Merriam (1988) is a comprehensive and accurate description and analysis of an instance, phenomena or social unit. Using this type of case study reveals many features of phenomena by exploring the issues according to various points of views (Baxter and Jack 2008). According to the meaning of qualitative data, the qualitative case study method presents the soft uncountable and textual data (Roger and Anders 2001).

As an example of applying interpretive qualitative case study, consider the study that the scientist wants to know how a child has learned the subtraction and addition. In this situation, the researcher not only includes what is observed during the study but also demonstrates the steps or sequences are taken by the child during the subtraction learning process.

As it is mentioned above, qualitative data are used in interpretive case study. The interview is a technique for gathering the qualitative data. During the interview, researchers can have access to the participant interpretations about the questions and can compare the views of themselves (their views) with participants aspects (Walsham 1995). The things are needed to include in an “interpretive case study researches” are the method of finding data (interview or other data sources), the way of analyzing data and the iterative process between data gathering and its influences on the previous analysis (Walsham 1995).

3.4 DATA COLLECTION TECHNIQUE: INTERVIEWING

The interview is a frequently used technique for collecting qualitative data (Marshall and Rossman 2006). Each research strategy contains one or more data generation techniques. Different techniques of collecting data in qualitative research are classified into three broad categories: interview, observation methods and document overview.

Kahn and Cannell (1957) describe an interview as “a conversation with a purpose”. The aim of the interview is to uncover and describe the participants' perspectives about different issues. The interview usually begins with introductory, clarification about the intent, purpose of the interview, getting permission to record and giving assurance about confidentiality and anonymity. Before beginning the interview, the researcher explores some general topics, which help him/her to uncover the participants' view. However he/she respects to how the interviewee structures and frames the answers (Oates 2010).

The interview has some advantages, for instance significant amount of information can be obtained in a short period. The variety of information could be obtained will rise with growing the numbers of participants in the interview. The instant follow-up and clarification is possible in the interview. The interviewers have the opportunity to request more explanation from participants or they can continue questioning about different aspects of the topic to clarify the vigor answers. The successfulness of the interview mostly

depends on the skills of interviewers. The skills of interacting, collaborating, question framing and gentle probing for elaboration, help the interviewer to obtain the goal of the interview (Marshall and Rossman 2006).

3.4.1 ACTIVE INTERVIEW

Among different ways of conducting interviews, I have decided to follow the active interviewing approach. The active interview is well suited for interpretive research because it seeks to elicit interviewee's world. In the traditional interview approaches, the interviewer is defined as a person who has the required skill sets to ask appropriate questions in order to explore the desired data (Hyman, Cobb et al. 1975; Fowler and Mangione 1990). In these approaches the respondents have passive roles and seem as repositories of facts and the related details of the experience that the interviewer wants to use them (Holstein and Gubrium 1995). However, in the active approach of the interview, both the interviewer and respondent are "necessarily and unavoidably active" (Holstein and Gubrium 1995). The active approach to interview identifies the interview as a conversation but not without guiding purpose or plan. As in other interviews, interviewer's questions incite responses that address the researcher's interests (Holstein and Gubrium 1995).

The traditional or standard interview approach is appropriate for providing uncomplicated behavioral or demographic information such as the respondent's age, sex or the place of birth (Holstein and Gubrium 1995). However, the active interview does not seek for the specific answer but it wants to encourage the respondents to tell their story by details related to the interview's subject.

In the active interviewing approach, the interview guide can provide the interviewer with a set of predetermined questions that might be used as appropriate to engage the respondent and designate the narrative terrain. In contrast to the standardized questionnaire, which dictates the questions to be asked, the active interview guide is advisory, more of a conversational agenda than a procedural directive. The use of the guide may vary from one interview to the next (Holstein and Gubrium 1995).

3.4.2 SAMPLING

Whenever you have a choice about "when and where to observe, whom to talk to, or what information sources to focus on, you are faced with a sampling decision" (Maxwell 2005). Selecting a sample for active interviewing is conceived quite differently from sampling done for standard or traditional way of research.

Traditional approaches target a population in advance, then select individual who are assumed capable of speaking reliably and validly for the population based on their representativeness. However, sampling for an active interviewing is an ongoing process; designating a group of respondents is tentative, provisional, and sometimes even spontaneous. The people you want to interview may change during the research process; you may add new members to interview or remove the people from your list. Depend on the process of research, the researcher actively modifying the sample. The sampling process then is indigenous and never fully under the control of the sampling design. This is of course both the complication and the strength of the active sampling. It suggests that sampling as an ongoing activity involving all interview participants includes respondents, researchers, and interviewers (Maxwell 2005).

3.5 DATA ANALYSIS METHODS

After collecting qualitative data from the interview, researchers should start to analyze the data. I have selected the coding method to analyze my qualitative data. Different ways exist to analyze qualitative data e.g. narrative analysis, constant comparative, coding, etc (Thorne 2003). The coding method focuses on a large amount of data with the aim of empirically revealing answers to research questions. The coding method starts with unsorted data to the development of categories that are more refined, themes, and concepts. The number of steps needed to complete the coding process depends on the amount of raw data, but it usually contains the following steps:

The coding process starts by labeling the units of data with “codes” (a word or short phrase). Based on the terms and concepts are found in data, a list of the findings codes is created. At the next step, the researcher tries to find the relationship between codes and defines their similarities and differences. For example, some codes are more important than the others and should be considered as headings, while the others can be incorporated under the broad headings. At the last step the researcher needs to focus on the core codes (those are appearing as being critical for any explanation of the complex phenomena being investigated) and use them for any explanation of phenomena or theory making (Oates 2010).

3.6 EVALUATION OF THE INTERPRETIVE RESEARCH

In recent years, interpretive research has emerged as an important way of research in information systems research (Walsham 1995b). By increasing the interest in interpretive research, the questions about how interpretive field research should be conducted and how its quality can be assessed have raised (Klein and Myers 1999). Klein and Myers (1999) believe that “although the interpretive research does not subscribe to the idea that a pre-determined set of criteria can be applied in a mechanistic way, it does not follow that there

are no standards at all by which interpretive research can be judged” (Klein and Myers 1999). Evaluation in interpretive research involves determining whether the research is convincing (Oates 2010). Different criteria can be used to evaluate interpretive research. It can be judged by looking at the credibility of the research rather than the validity, as in positivist research. This requires asking the question, e.g. how much can we trust the research? Another way is to judge the adaptability of the findings that come from data and experience in study setting. This can be judged by looking at raw data, summary of data, analysis, notes, etc.

Klein & Myers (1999) has developed a set of seven principles for evaluation of interpretive field studies in IS. These principles are the fundamental ideas that may help authors and reviewers to evaluate their researches or the other researches. The authors encourage researchers to judge whether, how and which of the principles to use, even though they are, to some extent, interdependent. A short description of the seven principles is given in the following section.

1. The fundamental principle of the Hermeneutic Circle

This principle emphasis on the idea that the understanding of a whole text is established by reference to the individual parts and the understanding of the individual parts relates to the whole text. This dependence between the whole and parts creates a circle. In this circular model, the meaning of a text must be found within its cultural, historical, and literary context. This principle is foundational to all other principles and the other principles are expanded based on this principle (Klein and Myers 1999).

2. The principle of Contextualization

This principle is based on the idea that there is an expected difference in understanding between the interpreter and the author of a text. This difference is created by the historical distance between the interpreter and author. Contextualization principle needs a “critical reflection of the social and historical background of the research setting, so that the intended audience can see how the current situation under investigation emerged”(Klein and Myers 1999).

3. The principle of Interaction between the Researchers and the Subjects

“This principle requires the researcher to place himself or herself and the subjects into a historical perspective”(Klein and Myers 1999). Two primary points are related to this principle; one is how the researcher affects the object of his study by introducing disturbing elements or by the researcher’s presence in his/her observed setting, and the other is to what extent the researcher creates the meaning of observed phenomena.

4. The principle of Abstraction and Generalization

The principle requires mapping the finding discovered by the data interpretation of theoretical, general concepts that describe the nature of human understanding and social action. It is essential that the field study details and the study characteristics be considered in theoretical abstractions and generalizations (Klein and Myers 1999).

5. The principle of Dialogical Reasoning

This principle requires the researcher avoid involving his or her preconceptions or prejudices with the data that emerge through the research process. The most important point is that the researcher should make the historical background of the research as transparent as possible to the reader and himself or herself (Klein and Myers 1999).

6. The principle of Multiple Interpretations

The principle requires attention to various interpretations among the participants. These interpretations are usually expressed through multiple stories or narratives in the same sequence of events in the study. The researcher needs to document multiple viewpoints along with the reasons for them. “The analysis of reasons may include seeking to understand conflicts related to power, economics, or values” (Klein and Myers 1999).

7. The principle of Suspicion

Although the other six principles encourage different forms of critical thinking, they are more concerned with the interpretation of meanings than the exploring of the false preconceptions. The principle of suspicious requires sensitivity to “possible *biases* and systematic *distortions* in the narratives collected from the participants” (Klein and Myers 1999).

3.7 RESEARCH DESIGN

The aim of this section is summarizing all the steps of conducting an interpretive research in a “research design model”. Research design is a series of steps or tasks in planning or conducting a study (Merriam-Webster’s collegiate dictionary). The research design model for the positivist research is to a large extent different from the interpretive research design model. In this section the differences between the two research design models are explained. Then the Maxwell model of research design is presented.

The positivist model of research design is linear and sequential. In positivist researches, a single optimal order exists for different components or tasks in a study, although this sequence may be repeated (Maxwell 2005). Positivist research has a fixed design strategy calls for a tight pre-specification before you reach the main data collection stage. If it is not

possible to pre-specify the design, it is not appropriate to use the fixed approach. The disadvantage of this approach is that it is not adequately demonstrates the logic and the process of the qualitative research, in which each component of the design may require to be considered or modified in response to new developments or changes in the other components (Maxwell 2005).

In oppose to the sequential approach to the research design, Hammersley & Atkison believe that in a qualitative study “the research design should be a reflective process operating through every stage of a project”. This means that the research design in a qualitative process is an iterative and flexible process. In the iterative process, different components have active interactions during the research process. It involves “tacking” back and forth between the different components of the design, assessing the implications of purpose, theory, research question, methods and validity treats for one another (Maxwell 2005). In addition, the researcher may need to reconsider or modify any design decision during the study in response to new developments or to changes in some other aspect of the design (Maxwell 2005).

Joseph A. Maxwell presented the “interactive” model for designing the qualitative research (see Figure1). This model consists of five different components of a research study. Each component closely tied to several others and they all together shape the integrated whole. The model defines how the components may affect the others and be affected by them. These components are:

- 1. Goals:** Why is your study worth doing?
- 2. Conceptual framework:** What theories, literature, and prior research findings will guide or inform your research?
- 3. Research questions:** What do you want to learn or understand by doing this study?
- 4. Methods:** What will you actually do in conducting this study?
- 5. Validity:** How might your results and conclusions be wrong?



Figure 1: An interactive model of research design (Maxwell 2005)

This model is divided into three main parts: the heart of the model, the upper triangle and the bottom triangle (presented in Figure 1). The heart of the model is *research questions* and they are closely connected to all the other components, and should inform, and be sensitive to these components.

The upper triangle of the model should be a tightly integrated unit. The research questions should have a clear relationship to the goals of the study and should be informed by what it is already known about the phenomena is studied, and the theoretical concepts and models that can be applied to these phenomena. In addition, the goals of the study should be informed by current theory and knowledge, while the decisions about what theory and knowledge are relevant depend on the goals and questions (Maxwell 2005).

Similarly, the bottom triangle of the model should also be a closely integrated unit. The methods are used must help to answer the research questions, and it also needs to deal with credible validity threats to these answers. In turn, “the questions require to be framed to take the feasibility of the methods and the seriousness of particular validity threats into account, while the plausibility and relevance of particular validity threats, and the ways these can be dealt with, depend on the questions and methods chosen” (Maxwell 2005).

4. RESEARCH PROCESS

This chapter tries to explain the research process behind the results which are reported in the next chapter. Most of the methodology material described in the previous chapter gathered before the start of the actual study and then I have continually adjusted the understanding of the previous chapter during the research process. The purpose of this chapter is therefore to present what has been done and why. It also includes the way that I collected and analyzed the data and finally the method of evaluating the obtained data.

According to the previous chapter, I decided to apply “interpretive case study” method to achieve the objectives of the research. I had a single case study (“Intoil Integration Tool”) in my opinion to start with. However, many changes accrued until the end of the study. In the following sections these changes to the research methodology will be clarified.

4.1 STUDY GOALS

Before starting the research, it was important for me to find the goal behind the study. For what reasons this study is important and why I should do it (Maxwell 2005). The overall problem addressed by our project was that despite significant investments in developing innovative or research-based software in the subsurface domain, such software was being used in a very limited and small scale by engineers in the operators' operational units (what Intoil calls it “assets”).

At the initial step of studying this project (during the pilot study), the focus of the project was on “software ecosystem” and thus the literatures on software ecosystems have been reviewed. The overall goal of the research project was to evaluate how software ecosystems may contribute towards increasing adoption of software within operational subsurface departments. According to the interactive model of research design (Maxwell 2005), my research questions were related to the goal of the study :

1. What are the implications of the software ecosystem adoption to IT governance within an oil and gas company?
 - 1.1 What are the existing challenges of IT governance in an oil company?
 - 1.2 How a software ecosystem adoption might affect the existing challenges of IT governance in Intoil?

By the start of the empirical phase of study, it is decided to remove software ecosystem from the research. It is believed that studying the effects of both software ecosystems and IT governance can far the study away from solving the main research problem. Therefore, it is decided to not focus on the software ecosystem in the study.

Different components of an interpretive research are tightly integrated and they influence on the other parts (Maxwell 2005). Therefore removing the software ecosystem from our research, changed the research method of the study and removed one of the case studies (it was the ocean ecosystem from Schlumberger Company). The changes to the research method and the contextual framework of the study affected the research question and consequently the research goal (Maxwell 2005).

By removing the software ecosystem from the study, the new research objective changed to “discovering the existing barriers of innovative software development from the perspective of the people involved in software development project in Intoil”. Thus, the research questions that could help the study to find research objective were:

1. What is the process by which research-based software is developed in Intoil?
2. What are the barriers to developing and implementing research-based software in Intoil?
3. What is the relationship between IT governance and innovation in Intoil?

As a result, I started my research by focusing to find the answers to these three main and wide questions. The method of the research should help the researcher to find the answers to the research question (Maxwell 2005). From my perspective, the best way of reaching the research question was conducting several active interviews with people involved in research-based software development process. In the following sections, I will describe the process of data collection and data analysis.

4.2 DATA COLLECTION

In this section, the data collection process will be explained. This means how I got access to the object of study, field trips, and the data collection technique I used.

4.2.1 FIRST INTERVIEW AND THE CHALLENGES TO FIND THE FIRST PERSON

At the beginning of the project, it is decided to focus on a single case study and find the answers to the research questions by investigating that specific case. The case was “Intoil Integration Tool”. This software tool development was stopped before it became able to be used in the operational unit. Therefore, it was a good case that could help the research to reach its objective. I tried hard from the beginning to the end of our project process to set meetings with the people who were responsible in the Intoil Integration Tool project and unfortunately. However, they avoid of talking with us about the project. What I identified from their answers was that they preferred to remain silent about the project failure and weren’t interested to talk about it.

Usually when you want to set interviews or meetings in a big company like Intoil where the people are so busy, the best or one of the best options—from at least my point of view—is asking help from the person you know in the company. I decided to set a meeting with my project “contact person” in Intoil to help me find the people who are appropriate for my project. The contact person readily agreed to have a meeting with me. When I described the project for him, he showed interest in the project subject. He was agreeing with the whole idea of the project and the way I decided to conduct it. However, I had a main problem. He did not contribute in the "Software innovation for subsurface disciplines in petroleum production" project anymore and he did not know exactly about the people who I could talk with them. He gave me some reference documents e.g. “FR12” that helped me to find some basic information about how the technology development process works in the Intoil. However understanding the FR12 for someone out of the process is not easy at all. I will describe more about the FR12 in the next chapters.

4.2.2 CHANGES IN THE CASE STUDY

After the initial efforts to find relevant people to interview failed, I decided to keep the project from another path. I worked for in Intoil as a web developer of the UD (Underground Wisdom) project during the last summer. I worked with one other developer and two geologists to design and develop a web based tool for integrating the geologist and geophysicists’ data. During my summer job in Intoil, I became familiar with different people working in relation to this or other different projects. Therefore, I had my own network in Intoil. I thought that the UD is a research-based software project and my manager has at least about 11 years of experience in collaboration with these kinds of software development projects in Intoil. Thus, he might be the best person that I can start my interviews with.

Another reason that I decided to start with UW project was that, I informed that a unit in Intoil has the responsibility of support and maintenance and researchers should hand over their project to this unit. However, in UW project as I remembered we did not have any delivery to that unit. We were responsible to support and maintenance of the project and we did not deliver it to any other unit. Therefore, I thought this UW is different from the other projects and maybe I can find some useful information by studying this especial case.

I sent an email to the UW’s project manager in Intoil and described the project, its goal, why I think he can help me in the project and why this project is important from my point of view for Intoil. Fortunately, my efforts were successful and he showed the interest quickly and we set an interview at the Intoil office.

4.2.3 CONDUCTING THE FIRST INTERVIEW

My task before conducting the first interview was thinking about how to start an interview, what I should ask from the interviewee and how I should manage the time. I decided to follow the active interviewing approach based on “the active interview book” from Holstein & Gubrium (1995). According to the Holstein and Gubrium (1995), in the active interview the researchers do not seek for specific answers however they want to encourage the respondents to tell their story by details related to the interview’s subject. Based on this approach I prepared an interview guide, including these main parts (Appendix):

1. Interview introduction
2. Opening questions including the general information about the interview
3. General understanding about the entire project
4. The process of the project
5. The role of IT department in R&D projects and the reason of project failure
6. The Closing section

It was my first experience in conducting an interview; hence, I did not have any idea about how I should prepare an interview guide. I tried to follow the other similar interview guides for the interpretive qualitative studies.

I met the first interviewee at Intoil office and started the interview by introducing the project and asking for the permission to record his voice. He openly accepted the request and I started to ask my questions. The interview was more similar to the question and answering rather than an open discussion which is the main purpose of the active interviewing approach (Holstein and Gubrium 1995).

During the first interview, after receiving the answer of each question, I immediately switched to the next question. I did not know how to maneuver on the given answer and how try to explore it in more details. I see the problem with the lack of experience in interviewing. Although I tried to be an active interviewer, the result of the first interview was more like the standard interviews with structured and prefixed questions (Holstein and Gubrium 1995).

4.2.4 CONDUCTING THE SUBSEQUENT INTERVIEWS

At the end of the first interview, I asked the interviewee to give me the contact details of those he thinks are relevant to my subject of study. He sent me the names of two people who I knew them before. Since I knew those people, I did not have any problem with

setting interviews and they easily accepted the request for an interview. During my study I interviewed with people from different disciplines: from leaders of the geology projects to managers of IT groups, IT consultants and geologists. In the next paragraphs I will present an explanation of those interviews.

In the second interview, I still had my “interview guide” (Appendix) with me. However, I tried to ask the questions out of what I prepared before the interview. I tried to listen carefully to the answers of the interviewee and ask questions regarding the parts which were unclear for me or I needed to receive more explanation.

Actually, what I learned from the initial interviews was that, having a list of the same questions and asking them from all interviewees is not appropriate for my subject of study. I was interviewing with people from different disciplines, so for instance the questions I asked from IT people should not be the same as geologists. They did not have the same domain knowledge and couldn't understand some domain specific questions. As an example, whenever I asked from a researcher do you know about IT governance? The answer was clear, “no we do not or we heard but not know exactly”. Therefore, I decided to remove the concepts e.g. IT governance and related issues from my interviews when I wanted to talk with researchers. Instead, I asked for example: “are there any IT requirements or rules that you should follow when you want to develop research-based software?” Then I received good answers instead of “I do not know exactly”.

I transcribed the first two interviews and thought about the parts which were unclear to me and I needed to receive more information about them. I prepared a new list of questions for my third and fourth interviews. At the same time I considered that the third person who I am going to interview is an IT manager. Thus, it was a good opportunity for me to ask the questions that the researchers didn't know about them—the more technical IT questions. During the interviews, I did not look at my list of questions. I think that it helped me to change the interview trend from question and answering to discussion. After four interviews consequently, my interviews were becoming more look like to the active interviews than the previous ones and I had more self-confidence at the interviews. At the end of the interviews, I again asked for the contact person of relevant people and used this trend in all the other interviews, and I found it so helpful.

The remarkable thing in the previous interviews was that the type of people who I interviewed with them, had impacts on the interview's trend. Some people could talk about a subject until I switched to another question and some of them just present short answers for each question. Whenever I received short answers to the questions, I tried to remain silent and show to the respondent that I am waiting for more explanation.

There was another issue that I faced during initial interviews that I tried to solve them in the subsequent interviews. Most of them were related to the lack of experience in

interviewing. For example, I spent a few minutes on the initial explanation and moved on immediately to the first question or I ask questions so fast and it was maybe not so easy for the respondent to follow me. To solve the problems I asked for one-hour interviews instead of the 45 minute interview, then I found enough time for the explanation of the subject and could avoid of talking fast.

4.2.5 A FIELD TRIP TO STAVANGER

I had a trip to Stavanger for carrying out three interviews with Intoil's IT leading advisors. One of the IT managers I interviewed with in Trondheim suggests me to have a discussion with these people. I sent email to them and finally found a free time to have an interview with them. Before my trip, just two of them showed the positive attitude to my project and I did not receive any answer from the third person. I stayed two days in Stavanger and fortunately received a positive response from the third person during the first day. Therefore, I became able to set a meeting with him on the second day. During these three interviews, I tried hard to apply what I learned from previous experiences. I asked for one-hour instead of a 45 minute interview and I started the interview by an explanation of "what I did until that time and what I wanted to know more about". Then I asked very general and wide questions e.g. "managers in Intoil think that just a few parts of the software developed in R&D go to the assets. What do you think about this statement?" If you think that it is correct then what are the reasons behind that? ". These general questions helped interviewees to start the conversation easier. Most of them could talk about these issues for several minutes. The answers of these questions guided me how and what I should ask as a next question.

I have applied the exploratory study during my research process. Exploratory research is used when problems are in a preliminary stage, when the topic or issue is new and when data is difficult to collect (Babbie 1989). Therefore, after each of the interviews, I reviewed my interview notes; I found some interesting parts related to the objective of the study which was needed to be more explored. Consequently at the next interviews, I tried to ask questions in order to receive more information about those parts.

4.2.6 SAMPLING

According to Holstein and Gubrium (1995), the sampling in active interviewing is an ongoing process. The sampling in my study was also an ongoing process. I did not create a specific list of the people I should interview before conducting the study. The people I wanted to interview were modified during the research process. Some people were added to the interview and some people were removed. In most of the cases I asked the people I interviewed with to introduce the people who can help me in my research. I chose the next people to talk, from the list of people that the researchers suggested me. The sampling

process was not under my control (Holstein and Gubrium 1995) and several other issues had impacts on it, e.g. the distance between the offices, the negative answers of the researchers to my request to interview, etc.

4.3 DATA ANALYSIS

I analyzed the data that I collected during the interviews to answer the research questions. Analysis in my study was an ongoing activity, and it was intertwined with data collection. I started the data analysis after my first interview. The process of data gathering via interviews was like the process of solving a puzzle for me. My main goal of the study was to find the problems behind the development of research-based software in the Intoil. After the nine interviews and putting the different part of the puzzle together it seemed from my perspective that I was very near to reach the goal of the study. Klein and Myers (1999) clarified that the activity of putting different parts of the findings together would continue until the “pieces of the puzzle” fit together (at least in the researcher’s mind).

My initial results after nine interviews were in the shape of figures and business processes models. After completing my figures I started to write the analysis chapter. The process of analyzing data is explained in more details in the following sections.

4.3.1 TRANSCRIBING THE INTERVIEWS

I started the analysis by transcribing the interviews. At the initial interviews, I transcribed the interviews word by word. It was so time consuming and sometimes difficult to focus on the main subject of the interview by paying too much attention to the irritating details. In subsequent interviews, I tried to avoid focusing on irritating details. For instance, in an interview, the interviewee had a problem in finding the right words to complete a sentence. He repeated the beginning of a sentence for several times. In this case, I just wrote the final complete sentence and removed non-important repeated words.

4.3.2 ANALYZING THE TRANSCRIPTS

I read each of my transcripts and marked the parts that were more related to my research question than the other parts. I deleted the parts that I thought are not relevant to my study. These reductions helped me to focus on the main problem of the study. I categorized each transcript according to some keywords. The keywords were for example “problem”, “suggested solution”, “collaboration with other departments” and “end-users”. However, these were just the keywords for my initial transcripts and they changed rapidly in the next interviews.

By categorizing the transcripts and putting them in a new document, I had a summary of what I received in the interviews. Each time after writing the summary, I tried to visualize

my understandings in a piece of paper. I think that I can better communicate with forms and drawing rather than texts. To ensure that I did not forget anything from the transcripts, as a last step I went back again through them and read them for several times. In the next interviews to ensure about the validity of what I found until that time, I showed my visuals to the interviewees or explained to them about my findings, and asked them to state their opinions about my findings and correct me if I was wrong. This respondent validation is one of the most important ways of ruling out the possibility of misinterpreting the meaning of what participants say and do and the perspective they have on what is going on (Maxwell 2005). I repeated the previous steps and tried to find a relationship between the findings in the previous interviews with the findings from subsequent interviews.

After about nine interviews, my drawing became more completed and I thought that “I am so near to find the answer of the research questions”—at least from my point of view. I started to write the analysis chapter at this step.

4.3.3 GAPS IN THE DATA

When I started to write the initial version of the analysis chapter, I found that some concepts or roles are still not very cleared for me in the process, for example the roles of CIT departments in the process or some parts of the FR12 document related to the project startup. Thus, I set two new meetings with the researchers from Intoil’s Bergen and Trondheim offices. According to the long distance to Intoil’s Bergen office, I decided to set a video conference with the first researcher. However, my attempts to find a meeting room for the video conference in the Intoil failed. Consequently, we did a phone interview. Conducting a face-to-face interview was easier for me than the phone interview. The phone interview had some deficiencies e.g. sometimes I could not hear the interviewee very well, I could not recognize his body expressions and I could not record his voice. I tried to take notes during the interview and used those notes instead of the regular transcript for my analysis. I had my second complementary interview in the Trondheim office, it was my last interview. After that interview, I started again to edit and review the analysis part and it is decided to stop interviews afterwards. The complete version of my analysis is given with more details in the next chapter.

4.4 EVALUATION

As mentioned in Chapter 3, the aim of a research evaluation is to determine whether the research is compelling. Klein & Myers (1999) identified seven principles to evaluate the interpretive study within the IS domain. It is usually difficult to decide whether, how, and which of the principles should be applied and is appropriated to evaluate the interpretive research project (Klein & Myers, 1999). To evaluate the analysis of the interviews, I decided

to follow three principles of Klein & Myers (1999). My evaluation based on these principles is presented in the following parts.

4.4.1 HERMENEUTIC CIRCLE

In accordance with this principle, I iterated my attention between “each challenge of innovative software development process” in Intoil as parts, and my “general understanding of IS innovation and IT governance” in a wider context in order to interpret the “barriers of innovative software development” as a whole. This approach seemed to be working, as through this iteration, the steps, participants and barriers took new meaning as I returned to them after analyzing the whole picture. Similarly, detailed observations yielded new considerations and input to my wider understanding of IS innovation and IT governance.

As Klein and Myers (1991) defined, the process of finding the meaning from the relation of parts and the whole is similar to putting the pieces of a puzzle together. However at this puzzle the pieces are not all given but have to be partially fashioned and adjusted to each other. As I mentioned in the data analysis section, my data analysis was like putting the pieces of a puzzle together until I found that the pieces of the puzzle are fitted together from my point of view.

4.4.2 THE INTERACTION BETWEEN RESEARCHERS AND PARTICIPANTS

Interviewing is one of the techniques for getting access to personal thoughts and opinions. Since I needed to know the peoples' opinions to reach the goal of my study I chose the active interviewing technique for collecting the data in my research. The way of conducting an interview has a direct effect on the interaction between participants and researchers. The ideal interview format occurs when the interviewer makes short questions and the participant will be able to give long and detailed descriptions. To achieve this, as far as possible, I tried to avoid of asking “Why?” questions and instead I tried to ask e.g. “Could you tell me about the situation that the problem happened?” I had some problems during the first interviews. However after conducting some interviews my interviewing techniques improved and consequently I could catch more related and useful data during interviews.

4.4.3 MULTIPLE INTERPRETATIONS

It is important to consider in every research that, different people may have different interpretations of the same situations. Take as an example of this, how two persons can make the same story sound like two different stories. People naturally perceive different things as important and therefore focus on different things. This different explanation of a

same situation for example is caused by different backgrounds and different experiences. During my research, I have kept in mind the differences between my background and the background of the people I interviewed. In some cases we had different technical competence, for instance the researchers whom I interviewed were professional in the energy area and did not have too much information about the information systems area. For example we had different understandings about the concept of IT governance, IT strategies and other similar issues. As a result, we had different ways of interpreting things. Maybe if another researcher with a different background, study the same subject finds a different conclusion with a different focus.

5. ANALYSIS

Intoil is as a large corporation with many competitors all over the world. The corporation faces different business challenges and has specific business ambitions. Intoil is committed to accommodating the world's energy needs in a responsible manner, applying technology and creating innovative business solutions. To meet the business challenges and support the business ambitions, Intoil has to develop and implement new technologies. However, the corporation experiences significant difficulties in developing and implementing research-based software. By research-based software I mean the research projects, which are started in R&D department and contain IT components.

This chapter starts by explaining the ideal process of research-based software development in Intoil. However the existing process is far from the ideal process and it is faced with different challenges. The chapter then continues with explaining the challenges of the existing process and it describes how managers and researchers in Intoil try to solve the existing problems.

5.1 INTOIL ORGANIZATION

To better understand the data which are presented in this chapter, it is required to familiarize with the Intoil's organizational structure and the participants of research-based software development process.

5.1.1 INTOIL STRUCTURE

Intoil consists of several business areas, staffs, support divisions and corporate communication (see Figure 2). These business areas are defined briefly in the next paragraph. Among these business areas, TPD and GBS are more related to this study.

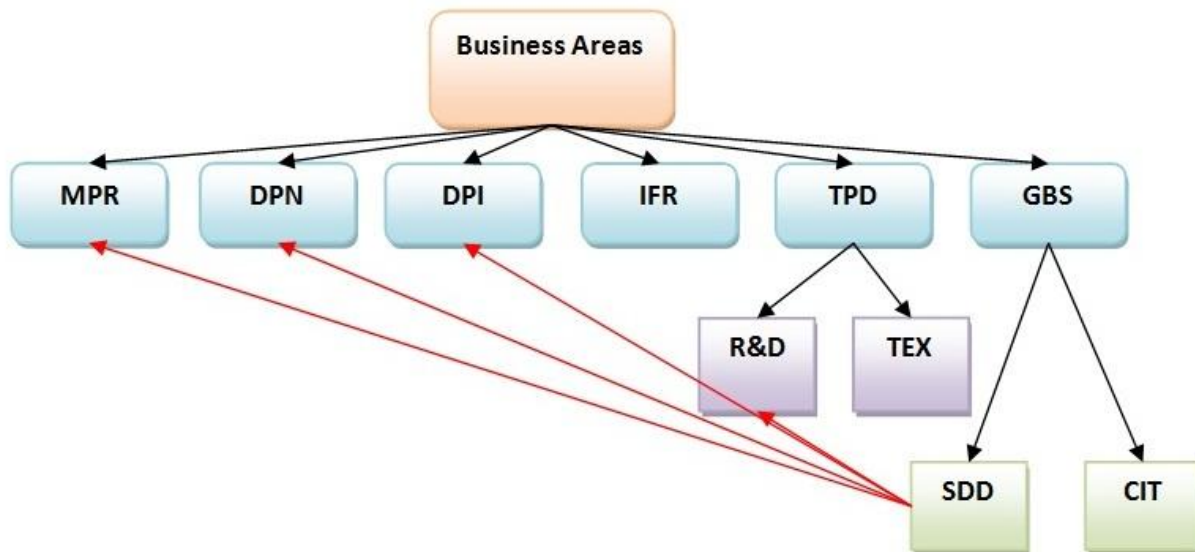


Figure 2: Organizational structure in Intoil

Marketing, Processing and Renewable Energy (MPR) is responsible for the transportation, processing, manufacturing, marketing, trading of oil and gas. Development and Production Norway (DPN) consists of Intoil’s field development and operational activities on the Norwegian continental shelf. Development and Production International (DPI) is responsible for the development and production of oil and gas outside the Norwegian continental shelf. Intoil Fuel & Retail (IFR) is road transportation fuel retailer and it is involved in the sale of stationary energy, marine fuel, aviation fuel, lubricants and chemicals. Technology, Projects and Drilling (TPD) is a global service provider for delivering projects and wells and for providing support through global expertise, standards and procurement. Global Strategy and Business Development (GSB) sets the strategic direction for Intoil and identifies, develops and delivers opportunities for global growth.

Three subunits of business areas which relate to this study (R&D, SDD and CIT):

Research and Development (R&D): it is part of the TPD business area and is responsible for carrying out research to meet Intoil's business needs.

Software Development Department (SDD): it is part of the GBS business area and is responsible for developing software solutions for the corporate. Moreover, it helps R&D in developing research-based software products.

Central IT (CIT): it is part of GBS and is responsible for supporting and maintaining the software running in Intoil and providing the infrastructure for technology. Moreover, it is responsible for implementing the new solutions in assets.

5.2 RESEARCH-BASED SOFTWARE DEVELOPMENT PROCESS

To develop software and implement it into the assets (assets in Intoil mean the people who work in an operational environment, for instance oil platforms) in Intoil, different people from different department need to cooperate. This group of people can be divided into three main categories. The first category is “the initiating organization”. It contains people from R&D or any other departments who have an idea in mind and want to implement their ideas into assets. The second group is “service provider”. This group contains software developers or consultants who are responsible for helping R&D in developing their ideas. The third and last category is “operation responsible”. People in this group are responsible for providing the required infrastructure for the upcoming technology. Moreover, they are responsible for implementing the new solutions in the assets. They are in charge of software support and maintenance.

The idea of developing innovative research-based software can emerge in different ways. One respondent described the projects start up in Intoil as:

“The projects can start in various ways. They are actually the R&D people who write ideas; it is probably a project map. However, it also could be from somebody from the professional ladder who actually has a good idea and initiates a pre-project or the feasibility study.”

Customer pull (the requirement they receive from the assets) or technology push (new technology opportunities) may lead to a new idea creation. Usually when an innovation is based on technology push, a new product is pushed through R&D to the market without accurate consideration of whether or not it satisfies a user need. In contrast, when an innovation is based on a customer or business pull, the product is developed in response to an identified business need. The new idea can then be written by researchers in R&D division, or it can be presented to the researcher by professional ladders.

Research-based software which are developed in R&D can be divided into four different categories: 1) developing new software tool, 2) adding changes to existing software 3) developing a ready for implementation project and 4) starting an early prototype to show the potential of a technology. These project types are explained in the following paragraphs.

Some researchers divided the research-based software projects into *developing a completely innovative software tool* or *improving the existing tools* by adding plug-ins to them: “Researchers can add plug-ins or new modules to an existing software tool to customize the tool according the emerging business needs. In the other cases, researchers create a completely new software tool, which does not exist previously in the Intoil or in the market.”

Some other researchers divided research-based software projects into *clean implementation projects* or *early prototypes* to show the potential of the new technology: “Basically we do two types of IT project; one is the clean implementation project. That it is quite clear that we will go into production in some stages. The second kinds of projects are those when you make a demonstrator or early prototype in order to show the potential of the technology or the research”.

However, when researchers want to develop a completely new software tool—which is not already in use in Intoil—they need to show the potential of the technology before they could receive a long term fund for developing and implementing the project on a large scale. This process is called “feasibility study” and described in the following section.

5.2.1 SHORT-TERM FUNDING (FEASIBILITY STUDY)

When a researcher decides to initiate a new project, he receives limited funds for usually about a year or half a year until he reaches some initial expected results. The results of this study should be able to satisfy the steering committee, professional ladders and first user to accept the researcher’s idea and fund the project for the further developments.

The professional ladders are responsible to check whether the scope of work is acceptable—are there ongoing or past initiatives that have had the same scope. They also come in at given decision gates to do quality control of the work and deliverables. The steering committee can have a similar role since it can consist of people from the professional ladder also, but mainly are managers that will help the project to implement the solution developed. This means that future user organizations have to be part of the steering committee. The first user is an asset who is going to use the product when it has been finished.

This initial version of the project with the focus on showing the potential of an idea for further development is called a “feasibility study”. In Figure 3, I draw a business process model of the feasibility study based on my understanding of this process in Intoil. After the feasibility study, the researcher should write the TDP (technology deliverable plan) for the project. One respondent described the TDP as:

“To be able to create a project, you have to describe the TPD. TPD is a technology description or the technology deliverable plan. This is some sort of the project contract that is set up between the first user, the professional ladder and steering committee. The TPD includes a matrix that numbers of people have to fill it to show their commitment to it. It also describes what should be developed in the time schedule and what types of resources are needed.”

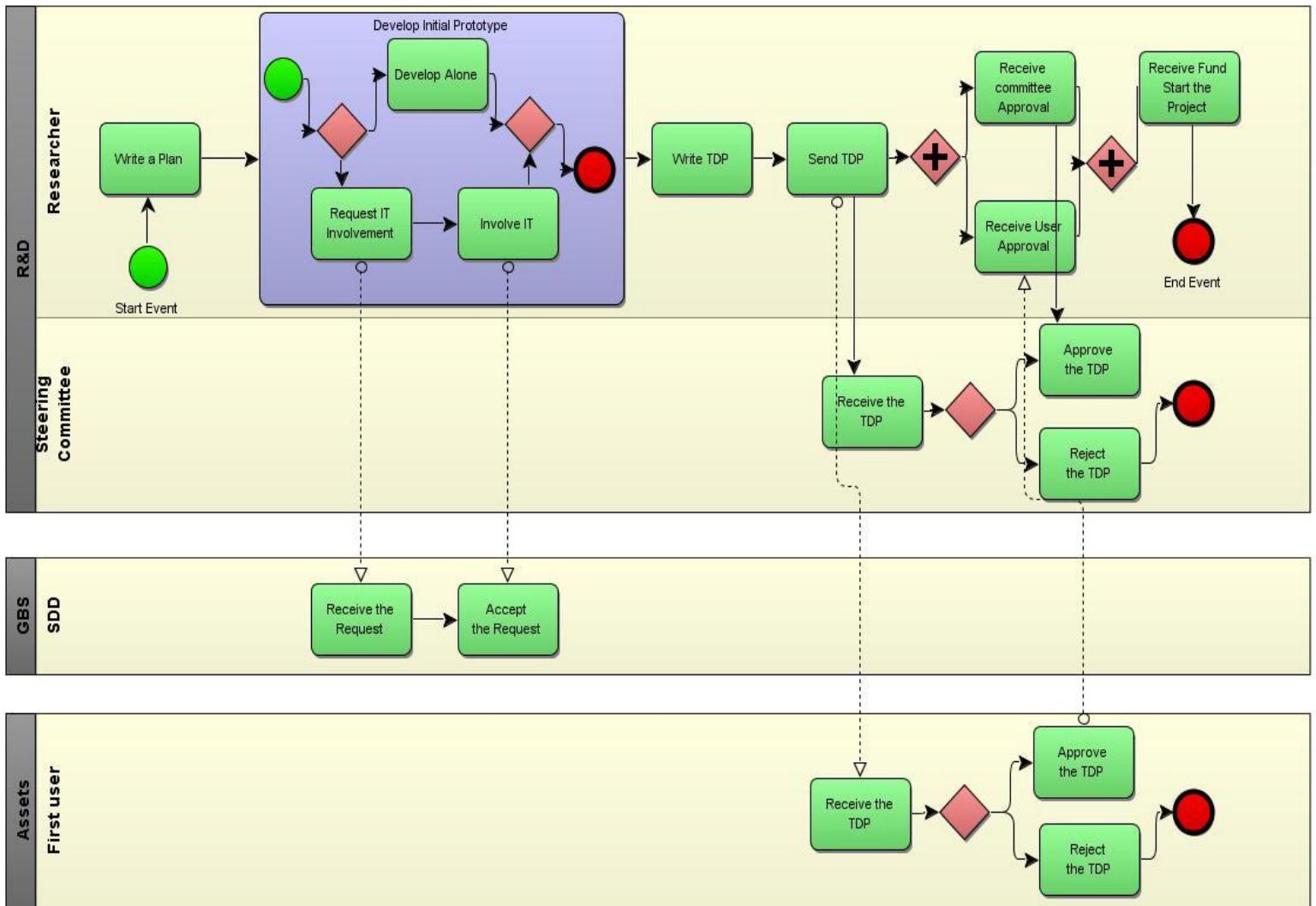


Figure 3: Feasibility study process

5.2.1.1 FIRST USER AGREEMENT

As the respondents mentioned above, a first user of the product also needs to approve the TPD and if he/she does not approve it, the researcher cannot start the project. The requirement of first user involvement in the projects is defined in the FR12 document. The FR12 is a governing document for implementing new solutions in Intoil that researchers refer to it during their projects.

This early user involvement is included in the project process to ensure that the new projects align with the requirements in the business areas and the end-users of the product agree with the project start up. One informant responded that:

”The idea behind this requirement is to use the fact that you need some end user to be motivated to start using your technology and that will help the adoption of the new technology. “

The strategies researchers employ to satisfy the first user to approve research-based software is different from other general technologies. This is reflected through the researchers’ use of a specific software development method. Researchers mentioned that in the interviews: “if we start with Scrum, we can show some useful result to the user after some iteration”. They believe that it is difficult to receive funds in the first year and present the product to the user in the fourth year. They need to demonstrate some intermediate results in the first year to the user to receive his/her agreement for further development.

Researchers usually perform a feasibility study and write TPD without receiving help from any other department. In most of the cases, they have some basic abilities of programming. They do the initial steps alone until they find some useful results, and can receive approval from the first user by presenting those initial results. Then they will request the SDD department involvement to improve the initial version of the software. The SDD department will help them to transform the initial version of a product with a complete version. The product consequently is changed into a useful product that can be implemented for all the predefined assets in Intoil. In other cases, the researchers do not start the programming by themselves. They prepare a plan or a description of what they have in their mind, present it to SDD department, and request the developers in SDD departments to help them start the project.

5.2.2 LONG-TERM FUNDING

The project can obtain long term funds after writing TPD and receiving the signature and approval from different participants. The first handover in software development process takes place when researcher hands over the initial prototype of software to SDD department and requests the product improvement (see Figure 4). SDD is a consultancy department with software developers. They work as a service provider for different departments. They are involved in projects when they receive any request from researchers. They do not reject any request they receive from the researchers. However, due to the lack of resources, it may take some time in responding to the requests. They have the responsibility to improve the software and consider some critical IT requirements in them. For instance they need to check whether the new software is compatible with the Oracle database—which is the main database is used in the Intoil. When SDD department, developed a complete version of a new software product successfully, the researcher in collaboration with SDD will send the complete version to the assets for the first use. As is defined in FR12 document, the first use of new technology is defined as the first application

of a new technology in Intoil operations. The main purpose of first use is to mature “new technology” to “proven technology”, ready for multi-use in Intoil.

A small IT department in the operational unit is responsible for ensuring that the new software tool coming from R&D is implemented in one specific user. It also puts the new software on a server and ensures that it works properly. The first user then checks whether the new software can work properly and can pass the tests successfully and can satisfy business needs. One informant described the first user of software as:

“The users are geologist, geophysicists or any other related scientist that will use the system for the first time in the operation. The first user usually is responsible for testing the software and give feedbacks to the researchers and finding a way to incorporate the new software tool to the business”

There is an obligation for first users to test the new software out. However, they are not responsible for large-scale implementation. Therefore, software is needed to be handed over to the CIT department for large-scale implementation.

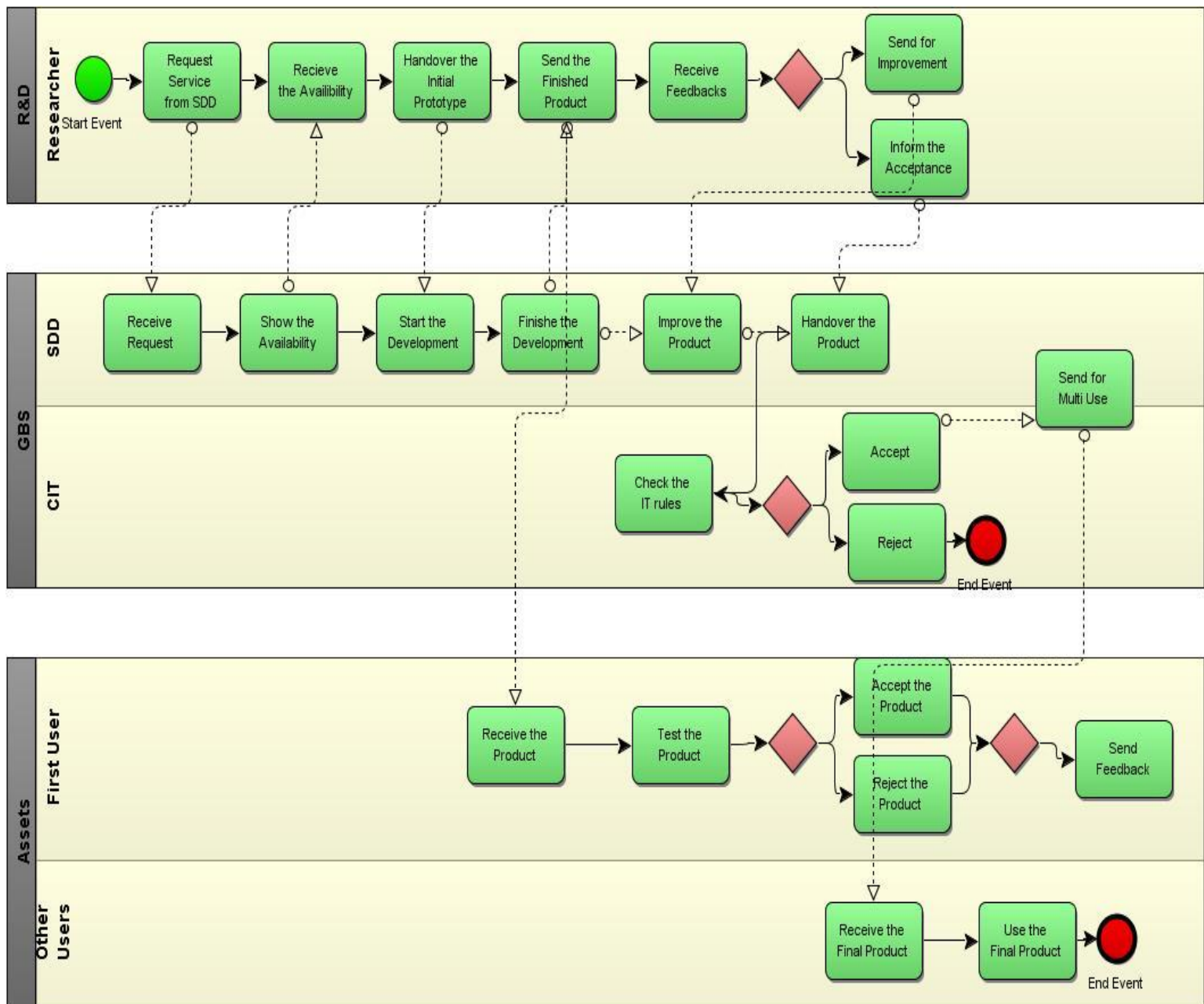


Figure 4: The process of research-based software development (long term funding)

The CIT department is an “IT production unit” in Intoil. It composed of people with the IT domain knowledge background. People in the CIT department have several kinds of roles and responsibilities. They are responsible for supporting and maintaining of two different types of software. The first types are common and general software which are already running in the Intoil e.g. operating systems (for instance Windows 7), mail system (for example Outlook) and other kinds of common software. Common software are those that usually exist in most of the other companies and not developed specifically for Intoil. Moreover, they are not developed for a group of specific people or not for handling any

specific tasks. The second types are specialist software tools (professional software) which are initiated in R&D department. These software are related to the core business of the Intoil and do not exist in the market. Therefore, Intoil cannot buy them and need to develop them internally.

The CIT's another task is checking R&D software according to the Intoil's governing rules. They check the software to decide on whether they can scale them up or not. They are also responsible for providing the basic infrastructure for IT projects which is a server, a database and a security setting. One respondent clarified the tasks of the CIT department in the following sentences:

“Every software project need some infrastructure and need support and maintenance. If you want these people to take over the responsibility of maintenance then you need to follow the rules and put it into their infrastructure”

The second handover in the process occurs by handing over the software from SDD department to CIT department (see Figure 5). After delivering the software to CIT department, they will care about IT standards and requirements. They will check whether this product is valid to be used in the whole Intoil departments. IT governance comes to the project at this phase. A respondent mentioned:

“IT governance comes to the project after delivering it to the CIT department. It comes very late to the project, at the last step.”

When a researcher decides to put a product in operation, he should change many things and he should follow some guidelines. If the researcher was successful to pass all the requirements of the CIT department, the CIT will accept the responsibility of supporting and maintaining of the software on a large scale. It will roll the software out and send it to assets for the multi-use in Intoil. The complete and ready software product then will be implemented by a small IT department in the operational unit for the other users.

5.3 HANDOVERS AND GATEKEEPERS IN RESEARCH-BASED SOFTWARE DEVELOPMENT

Research-based software have some key differences with other types of technology development in Intoil. In other types of the projects, researcher or his/her team should work on a project alone until the first use of the product in assets. However, in research-based software development projects, researchers need to have good knowledge of software development to produce useful products. Researchers—who are usually a geologist or geophysicists—cannot develop software products alone and need other departments for taking the responsibility of the software development. There are therefore, two handovers in IT-based projects. One handover is from a researcher to SDD department and the other is from the SDD department to CIT department (see Figure 5).

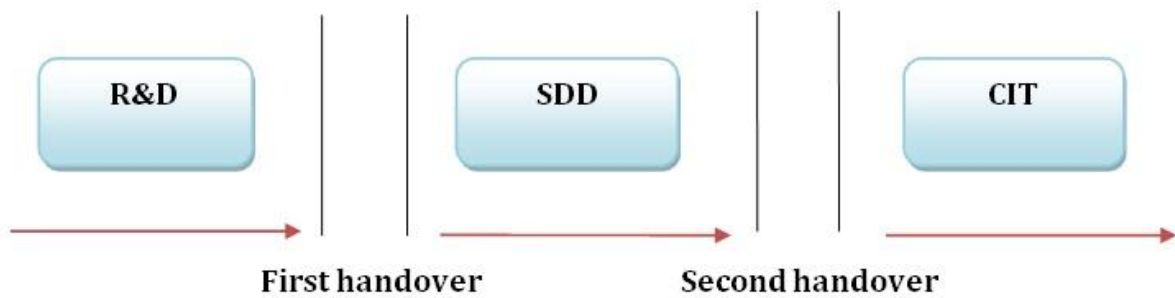


Figure 5: Two handovers in research-based software development process

In addition, two gates involve in IT-based projects that do not exist in other types of projects (see Figure 6). The first gate is for passing SDD department and moving forward to CIT department, and the other is for passing the CIT department and moving to the operational unit (for the multi-using of the software in the assets). The SDD department plays the role of a gatekeeper for the first gate. SDD department knows general IT rules and IT-product requirements and it tries to produce products according to those requirements. If the products fail to meet the requirements, SDD department will not send them to CIT department. CIT department is a gatekeeper of the second gate; it checks the products according to standards and the governing documents more specifically than SDD department. They check whether the product can fulfill the minimum requirements for scaling up and whether the CIT department has enough resources to support and maintenance of the product.



Figure 6: Two additional gates in research-based software development process

5.4 CHALLENGES OF RESEARCH-BASED SOFTWARE DEVELOPMENT PROCESS

As I mentioned above there are two main handovers and two gates in the process of research-based software development in Intoil (see Figure 5 and 6). Several issues are involved in delivering a product to another department. For example, the department

which receives the product, needs to get some information about how the product works, what is the aim of the product and what are the tasks of this department in the process? And so on. This requires a tight communicate between the two parts that involve in handovers. If each of the mentioned tasks not done properly and many others related issues not considered, the product development process will face many contradictions and the product cannot pass the gates successfully.

One of the challenges that the handovers will create for the products is “competence reduction” after each handover. One respondent described the competence reduction in handovers by an example:

“If I make the requirement specification in my own fashion and writing down all the requirements of the product and give it to you and ask you to please take it and develop a system. I am sure that it will not get what I believe that I should get. Because even I have done it very well, you cannot read my handwriting and understand exactly what I mean. Hence, that is the loss of competence. . . .”

“Competence reduction” may be due to the different domain knowledge between the two parts (the part which hand over a product and the part which receive it). One respondent explained this problem as:

“They don’t necessarily have the same domain knowledge. People who work in the GBS department have the general IT competence and people in R&D have a Strong R&D approach. You use lots of competence moving from R&D until the end. . . . You lose some of the holistic understanding associate with the usage of the tool, which is very much embedded in how the geologist and geophysics do their work, here is just IT on the service level agreement. ”

Another issue that researchers mentioned as a reason of competence reduction was scaling up projects and fitting them in the installed-base: “when you scale up things, they are also traded off. There are functionalities that can just be used by the small group, if you want to make it scalable you need to remove or change those functionalities. When you go to the product infrastructure, the installed-base of the technology is in place and your product has to fit into it. So many changes are needed to happen to fit your product into the installed-base . . . seen it from the researcher there is lots of competence reduction. ”

However, this competence reduction is not only seen from R&D side. IT side also thinks that researchers do not know a lot about how the software in the real life should be.

In addition to competence reduction, this handovers in the process can create other problems. In each handover, a new and separated department takes the responsibility of product development. It has the responsibility to improve the software until it can pass the

upfront gate and then it transfers the software to another department. A set of specific requirements is defined in each of the departments. Therefore, products are improved and evaluated according to those specific requirements. Each department will change the software to fit it in their predefined criteria. If they failed to fit the software to their criteria, the software will fail to pass the upfront gate and the process will be stopped.

5.4.1 PASSING THROUGH THE FIRST GATE (OVERLAPPING R&D AND SDD)

IT advisors and managers in Intoil now try to get rid of the challenges that “the product handovers” and “the changes in product development responsibility” create. They provided a solution that is to some extent successful in removing the “first handover” from the process and easing “the passing through the first gate” for research-based software development projects. However it has its own challenges and cannot be applied in different types of software development processes. In this section I will explain how IT managers in Intoil want to solve the challenges by their new solution (overlapping IT and R&D departments).

Leading advisors in SDD decided to use the idea of “product team” or “software product line”. They decided to have one or several product teams in Intoil that will take the responsibility of the whole product development and will help the researchers to develop qualified software.

The idea of this team is based on overlapping R&D and IT departments. In this approach, instead of delivering a product from R&D to SDD, a group of developers will move from SDD department to R&D department to participate in the project from the initial phases. Leading advisors believe that having this team from the beginning of the product development process which has the close communication with R&D researchers, will reduce the negative effects of the first handover and help products to pass the upfront gates easier:

This team, which comes from SDD department, knows about the IT requirements of SDD and CIT departments. It also knows how standard and qualified software should be. Therefore, it will try to develop the software from the beginning according to their rules and thus help the products to pass through the upfront gates.

Overlapping the SDD and R&D departments and the close communication between these departments will remove the “competence reduction” that was previously created due to the different domain knowledge between researchers and IT experts. On the one hand, R&D can be sure that the software is created according to their initial ideas and on the other hand, the SDD can be sure about the quality of the software.

One IT advisor explained the reason of using the “product team” idea in the following paragraph:

“One of the reasons that we want to apply this trend is that we believe that the software, which is developed in the research areas, has less focus on the craftsmanship of the software. We think that the researcher has more focus in the algorithms domain, the way they need to handle models, the data and other parts. Therefore, making standard products out of the software is not probably the most highest on their priority list. So, we believe that we will have a better approach if they can mix some people from the software department together with the research department to handle the software part of it in the more proper software craftsmanship way.”

From the point of view of a leading another advantage of these types of teams closely attached to a group of researcher is, increasing the trust issues between R&D and SDD departments. He explained the trust issue as:

“I think having these types of teams closely attached to a group of researcher seems to work better than being far apart. . . It’s created lots of trust. . . It seems that we now also have the trust issue between different parts of the organization. . . It is easy to understand why you have these handovers in the process and you lose information. . . I understand that they have a trust issue and I think having teams that are able to take responsibility and be responsible for whole solution is a very good way of going forward. . .”

IT advisors in Intoil think that if the idea of “product team” done appropriately, they can spread it to the other parts of process development and can include some people from the CIT (overlapping the SDD and CIT). They think that if they become able to involve some people from the CIT department in the product team who could take the responsibility of product support and maintenance. Then they will remove the second handover from the process. Consequently they can eliminate the problems that the second handover was created in the process. One respondent described it as:

“If we will lucky we also can have some people from CIT in the projects. A product team means that I like a team responsible for a product and that means not only developing it but also maintain it . . . Then we have the same person doing development doing production and doing maintenance”

However, advisors think that they cannot do it now. On the one hand, they do not have the capacities to do it and on the other hand, they think it is not correct to do it for all types of software. They clarified two types of software. The first type software are initiated in R&D department and then are delivered to other departments. These software change frequently and need especial care and support. The second types of software are the common software (like the operating systems) that remains constant for several years. In

both of the cases, the software first is tested in SDD department and after passing the tests successfully; it will receive permission for passing the first gate and can be delivered to CIT department.

However, in case of “common software” there is just one delivery to CIT department. SDD department first tests software and after the software could pass the test successfully, it will be delivered to CIT department. CIT then tests the software according to the IT governing rules and if the software could pass the test, it will be sent to assets. These types of software can then work for some years until managers decide to use another one (changing the Windows XP to Windows 7 after some years).

In the second type, software changes frequently and after each small change, a new handovers should occur from SDD to CIT department. In this type of software, if researchers can find some people from the CIT department who can participate in the product team and take the responsibility of support and maintenance, they will not need to hand over the software to CIT anymore.

According to the characteristics of the two mentioned types of software, IT advisors think that the idea of having “product team” is just useful for the second type of software. They do not want to spend their resources in these teams to maintain the first type of software (common software e.g. Microsoft Office or Windows 7).

IT advisors believe that, in product team approach, the CIT department should be responsible to give some common resources to product teams e.g. a server, a security setup, an access to database and any other kind of fundamental prerequisites. Moreover, the CIT should be responsible to develop, support, maintenance and any other related issues:

“I think that the production part will have some common services for delivering applications. Say that we want to develop a product and we need a server we need a database and making sure that we have an integration platform you can integrate to the others. . . Those are the parts I want to buy from the CIT department . . . These are some common stuff in Intoil. ”

In the above paragraphs the positive effects of applying product team in research-based software development mentioned. Although using a team of researchers and developers work on a same project can solve many problems and it can improve the process of software development in Intoil. They just have few resources (according what the interviewees mentioned) in the SDD department which are not enough for creating several kinds of these product teams in R&D department. Furthermore interviewees emphasized that: Intoil is comprised of several departments (see Figure 2) and each department requires different services from SDD department. SDD is a small department with few

resources, which cannot handle all requests from different departments (MPR, DPN, and DPI). In addition, working with R&D, requires a special skill set and the SDD department has just a few resources with those especial skill sets.

5.4.2 BYPASSING THE SECOND GATE

In this section, the second handover (from SDD to CIT department) and the barriers of passing the second gate is described. For better understanding the problems which exist in “passing through the second gate”, it is needed to look at the CIT department organization and the governing documents and guidelines which are applied in this department. Based on the CIT department governing documents, the CIT department's role is to improve standardization and provide the products with the lowest price for the whole organization. Therefore, the main goal of this department is cost reduction. According to the respondents' opinions the CIT is very successful at providing the common software e.g. operating systems, mail systems and other services very cheap for the whole organization. What they are not good at are the specialized tools which are initiated in R&D department.

The reason that the CIT is not successful in the second type of software is related to the cost issue. Working with these kinds of tools requires lots of dedicated resources which are expensive. Moreover they need to pay special attention to the way that R&D do the work because they do their work more differently from the CIT and that's hard for CIT to cope with them. Therefore, the governing rules of the CIT department which are based on “cost reduction” and “reducing resources” are not appropriate for the second type software (which change rapidly and need special people to take the responsibility of support and maintenance). One informant describes the limited resources in CIT in the following sentence:

“I think some of the solutions that R&D initiates are based on the solutions that are not in the current portfolio and that's an issue for the CIT because they don't have the resource or the capacity to handle other stuff than what they already have.”

Another issue which effects on the CIT department is the “KPI” which is defined for this department. The GBS unit—which is the upper unit of CIT—defines the rules and KPIs for CIT department. Since it is clearly stated on KPIs about how each unit is measured and what this unit should focus on, The KPIs are important. If it is stated in the KPI that this unit will be measured based on cost reduction, then the unit should focus on cost reduction. In the CIT case, having one KPI for the unit that needs to do two completely different tasks does not seem a good idea. CIT needs to deliver the standard stuff very cheap and it needs to focus on the specialized tools by providing required services to them. Therefore, having one unit that supposes to deliver two different regimes probably will not work.

The existing situation in CIT is: they have very few people, they have optimized the processes, they outsourced a lot and they have very little control of the processes. They use about ninety percent of their resources on support and maintenance of what is already running in Intoil. Consequently, the very tiny left part is not enough for R&D or any other software. Thus, what they already do is trying to limit the researchers a lot and define different kinds of requirements to reject the most of the projects. The reason of having this situation is that the CIT department just focuses on one scenario and that is: “having common solutions very cheap in Intoil”. The top-level managers in CIT say that “we are not going to hire any more people; we are not going to add more resources because we take care of the cost”. Respondents see the CIT issue as an Intoil top-level management problem. One leading advisor stated that:

“If we ask to have 20 more people in the SDD or CIT departments. The top-level managers will not accept it but if you ask for 200 more people in exploration, they will accept because that’s the part which is the most important for them. ”

5.4.3 WORKAROUND

The existing problem in the CIT department has led to use workarounds in order to pass the second gate of the process. People in other departments see the CIT as an obstacle instead of a service provider and they try to avoid of the direct communication with this department. As an example, a research-based software project related to the reservoir knowledge management (which is called Underground Wisdom) is now developing in R&D department with the collaboration of IT consultants from SDD department. This project is an instance of innovative research-based software which has not existed in the market. Moreover it is a specialized tool that focuses on solving a very specific problem in the reservoir engineering domain. Therefore, it will change frequently after its first release and thus it requires lots of handovers to the CIT department.

IT experts who contribute in the project decided to carry out the project in other ways than the routines. They created a completely separate infrastructure with production quality but outside of the normal channels. They think that it is much easier to put things in production and manage them in this way. They made this alternative environment to be able to deliver the products directly and have more flexibility. One of the informants stated that:

“We make our own product infrastructure that we can use to deliver the solutions completely under our own control rather than throw it to the normal bureaucracy of putting things into production.”

People who used the workaround think that it is a direct response to the problem of delivering solutions. They use this way especially in the research projects when they need to test software so quickly and they want to give the software to the end user to get it

verified. It is much easier for them to do these steps when they have the full control of the infrastructure, web servers, etc. They configure the servers and other basic infrastructure and take the responsibility of support and maintenance by themselves. By this workaround, they want to eliminate the role of CIT from the process and have direct deliveries to the end users. One of the respondents mentioned that:

“At first we did it to make some production tools but now we also use it to send applications to the end users”

People in this project believe that to overcome the problem of the CIT department there are two different ways. One way is to change the corporate infrastructure in order to make easier to put things into the production and the other solution is to isolate the part which makes problem to the whole process. They see the corporate infrastructure as a problem. Hence, they decided to isolate it by building some layer above it and having their applications running elsewhere.

5.4.4 PRIORITY CHALLENGES

IT arena is the Intoil’s official arena where IT resources (both personal resources and money resources) are prioritized. This unit like the other areas in Intoil receives a specific amount of budget each year. This budget is limited while the requests of different departments from IT are huge. It is not enough money to spend on what everybody wants to have. Therefore, IT arena has to prioritize its resources.

They are too many IT project that actually are started in Intoil and the way to prioritize them between business and R&D is very difficult. They should think about how much of the total money they should spend on maintaining the installed-base that it is already in place and need to keep running because they still are used in the assets and how much should spend on the following up R&D project.

CIT looks at R&D projects as future business while keeping the systems running is related to ongoing business. Since their KPIs are also associated with keeping the business running, their main priority is keeping the installed-base running. They use most of their resources on this part and a tiny part left for R&D projects.

IT advisors in Intoil believe that helping the researchers to develop very especial and customized software, which relates to exploring or finding more oils, should be their first priority. These kinds of software are those that can benefit the whole business and can make competitive advantages for the Intoil. One respondent said:

“At least up until now we have prioritized wrong. We need to prioritize more on R&D . . . We were so busy with different request from different parts and couldn’t prioritize the task very well.”

6. DISCUSSION AND CONCLUSION

Findings in relation to the theoretical aspects will be interpreted and clarified in this chapter. The chapter will focus on discussing IT governance and how it impacts on research-based software, regarding to coordination of R&D, SDD and CIT departments in Intoil. At the end of the chapter the study results and a short conclusion are presented.

6.1 INTEREST IN FORMALIZATION

By reviewing the findings, it is clear that Intoil has a keen interest in “formalization”. Formalization in Intoil can be understood as the presence of a formal and reproducible process for developing new technologies (Froehle, Roth et al. 2000). Intoil believes that a formalized innovation process is more predictable and manageable. They have the FR12 document which is a formal written plan for developing and implementing technology as well as control structure which supports the technology development process. In addition to the FR12, the formal process and rules for developing and implementing research-based software (which is presented in the Figure 3 and 4) confirms the importance of formalization in Intoil.

From the findings it can be seen that, whenever Intoil face a problem in its research-based software development process, it tries to solve the problem by deducting a new rule or process. For instance, they decided to overlap SDD and R&D departments to be able to pass upfront gates. It means that they deducted a new rule (overlapping SDD and CIT) to pass the existing rule (gate number one).

Formalized innovation process can have some positive influences on the innovative product development efforts. For example, it can be contributed to increase the speed of new product development (Froehle, Roth et al. 2000) or it leads to encounter fewer problems in adopting administrative innovations (Zmud 1982). However, it seems that in spite of positive effects of formalization, it has some negative impacts on Intoil. The reason is that, whenever a difficulty or deficiently appears in the process, they do not try to solve the problem itself. In other words, they try to deduct new rules to pass the existing rule instead of solving the source of the problem. Consequently, the source of the problem will usually remain unsolved.

For Example the idea of creating “product teams” which is explained in section 5.4.1, present how IT advisors and managers in Intoil try to get rid of the product handovers’ challenges by creating a team of developers, researchers, etc. This new idea defines how to pass the existing gates by following another process. This process was to some extent successful in removing the “first handover” and easing the passing through the first gate for research-based software. However, it had no effects on the challenges that the second gate

creates. Since the main problem in research-based software development is related to the second gate. This new idea didn't help to solve the main source of the problem and it just added a new process over the existing process.

6.2 UNINTENDED USE OF IT GOVERNANCE

The CIT department in Intoil needs to handle many different kinds of tasks. On the one hand, they need to keep the installed-base running, and on the other hand they are responsible for support and maintenance of research-based software. Yet they do not have the necessary facilities and resources to perform these tasks. They have their hands full with ordinary works and there is no room for handling the innovative software coming from R&D.

To get rid of dealing with research-based software, they used IT governance. They regulated the strict rules and used the gatekeepers in the process to stop software they receive from R&D. The gatekeepers of the CIT department can easily reject the received software according to their strict rules. Thus, CIT can concentrate to keep the common installed-base running and do not use its resources on the innovative products coming from R&D.

The way that CIT uses IT governance is in contrast with the intended use of IT governance. Commonly IT governance is used to align the IT activities in an organization with the corporate governance. However CIT uses IT governance for prioritizing its resources. It needs most of its resources to keep the installed-base running. Therefore it uses IT governance to keep research-based software as much as possible out from its portfolio.

The strict rules in CIT have led to that the CIT department be seen as a barrier to innovation. Researchers or people from other departments see IT governance as the enemies of innovation. They try to bypass the governance rules from various ways; for instance, by using workarounds (as it explained in the section 5.4.3) or by outsourcing their products (use a commercial vendor to develop the product for them).

The researchers' work in bypassing the gates is quite logical. When they have to provide tons of documentation, going through numerous approvals and quality controls that demand an unreasonable effort, then they will simply skip it. In some cases like the Intoil case, governance rules are more than enough or too difficult to follow. At this kind of cases they become a barrier to innovation for innovators.

6.3 IT GOVERNANCE VS. CORPORATE GOVERNANCE

Information technology can have a significant role in the realization of the business goals and objectives. In order to achieve this goal, it is essential that IT governance aligned with corporate governance (Webb, Pollard et al. 2006). This means that IT in an organization should always be at the disposal of business and serve business needs.

Intoil identified in its technology strategy that, it needs to create new technologies to achieve its business goals which is mentioned in the interviews and also in FR12 document. Therefore, IT (CIT, SDD) in Intoil should help the other areas (such as R&D) to achieve this goal. However, this is not what actually happens in Intoil.

It is clear that the goals of separate departments (R&D, CIT, SDD, etc.) are not similar in Intoil. It is not an unusual case and it might be the same in the other companies. The unusual issue in the case of Intoil is that, the goals of the different areas are in conflict with each other. This conflict may lead to stop the other departments reaching their goals.

While the R&D's goal or responsibility is enabling the enterprise by exploiting opportunities and creating new technology, the CIT's goal is keeping the common installed-base running with a minimum cost. Even managers defined the KPIs in CIT department based on cost reduction to be sure that it works according to predefined factors and criteria (keeping the common installed-base running with a minimum cost). It means that if the management in CIT can reduce the costs of this department, it will receive many benefits from its top level unit (GBS unit).

All this happens while R&D department to the large extent needs services from the CIT department to implement innovative research-based software in assets. If R&D fails to receive services from CIT, it cannot achieve its goals. Consequently, the whole organization cannot achieve its goals.

As mentioned earlier, one of the CIT department's goals is to implement research-based software coming from R&D in assets. However, this goal of CIT department is not aligned with the KPI which is used for measuring the performance of this department. This can illustrate that, although Intoil gives great importance to innovation, it failed to present it to all departments. In CIT department the main priority and the great importance is given to installed-base and not innovation.

Although in the literature it is given the great importance to the alignment of IT governance with corporate governance. According to the different priorities of R&D and CIT departments, it is not possible to align them inherently. They have fundamental differences and cannot be aligned easily. Therefore, the efforts for aligning them may fail to be successful. Intoil maybe need to find other solutions for solving the problem instead of trying to aligning them.

6.4 FUNDAMENTAL DIFFERENCES IN CIT AND R&D DEPARTMENTS

In addition to the differences between the goals of R&D and CIT departments, they are also different in other areas. It seems that these differences create some problems for those departments.

On the one hand, according to the role of the R&D department in the organization—which is creating new products that can meet the business challenges in Intoil—it has a great interest for change. People working in R&D want to change the existing technologies or develop new products that can lead to some positive changes in the organization.

On the other hand, CIT according to its role—which is keeping the installed base running—has a great interest to keep everything stable in the organization. Since the changes in organization may change the installed-base, CIT is not interested in change. Consequently, we are faced with two different attitudes, one like to keep the existing situation and the other want to change the current situation rapidly. This fundamental difference of these two departments may lead to deficiencies in communication and make them unable to understand each other well.

The other difference between these two departments is related to the degree of freedom they have in conducting their tasks. Employees within R&D department, seems to have a great degree of freedom in conducting their daily tasks, both from the time and the resource aspects. None of the researchers, who were interviewed in this study, mentioned any limitation in time or resources in their projects. Moreover, they have a great degree of freedom to start a new project (at least during the short term funding). The problems start when the enterprise gives the freedom of imagining to R&D, and then provide a structure to act for it.

While R&D focuses on innovation and novelty, CIT believes in standardization. The freedom in R&D leads to produce the products that are not qualified from the CIT's perspective. CIT thinks that the R&D's products are far from the standard products. They think that R&D's products are needed many changes to become a qualified product than can be used in assets. Moreover, CIT believes that R&D should apply standard processes and solutions with a minimum level of customization while the researchers (in most of projects) try to customize the existing solutions (which are available in the market) according to their needs.

6.5 LACK OF SPECIFIC ATTENTION TO THE PROJECTS WITH IT COMPONENTS

According to the findings, the FR12 document is a technology development and implementation governing document in Intoil. It is a guideline for the Intoil personnel who

involved in technology development and implementation. It describes functional requirements for a common and efficient work process for development and implementation of new technologies. The different phases of technology development and implementation process (from the planning to the first use and multi-use) and decision gates are clarified in this document. During the interviews, researchers mentioned this document several times. It seems that they are familiar with this document and they use it in their projects.

A noticeable and surprising aspect of this document is that, it did not distinguish between IT-based technologies or technologies without the use of any IT components. The two handovers (from R&D to SDD and from SDD to CIT) and the two gatekeepers (SDD and CIT) which are specifically used for technologies with IT components are not mentioned in this document.

During this work, one of the interviewees introduced the FR15 document while we have discussed about the IT governance documents in Intoil. He mentioned that the FR15 describes the governance model for how information systems should be developed and maintained and how Intoil distributes information. He added that the FR15 is a high level document and the high level people who making decisions and priorities should use that. He said that: "It is nothing that a researcher can understand it".

In FR15, it is identified that all technology development initiatives that contain any IT components (in this study they are called: "research-based software") should follow the FR15. However, the FR15 document does not include anything about the phases that the researcher should follow in developing and maintaining research-based software. The two missing handovers and gatekeepers of the FR12 are also not mentioned in the FR15. Consequently, there is not a clear explanation of the phases and gatekeepers of research-based software in none of these two documents.

6.6 RESULTS AND CONCLUSION

At the beginning of this study, some research questions were defined. In this section I want to evaluate to what extent I could reach the answers of my questions. Furthermore I want to present the new findings of this study which are not identified in the literature. My research questions and answers are:

1. What is the process by which research-based software is developed in Intoil?

This question answered almost completely in the analysis chapter. The Figures 3 and 4 which are presented in the analysis chapter show the processes of short term and long

term funding of research-base software development and implementation in Intoil, respectively.

2. What are the barriers to developing and implementing research-based software in Intoil?

The problems were mostly related to the lack of enough resources in the CIT department. Consequently, the department's priority was based on keeping the installed-base running instead of supporting and maintaining research-based software.

3. What is the relationship between IT governance and innovation in Intoil?

The CIT department was responsible for checking the received software from R&D according to the Intoil's IT rules. However since they did not have enough resources to support and maintain all research-based software, they used the gatekeepers to reject most of the products.

The new finding in this study is explaining the relationship between innovation and IT governance. This relationship has not been studied in the literature and consequently there are no previous results that this study can be compared with them. However, the findings of this study are compared with the existing IS and digital technology innovation:

While IS innovation literature mainly concerned with how IS innovation spreads within organizations and how IS innovation impacts on the firm's strategy, structure and processes (Sambamurthy, Bharadwaj et al. 2003; Swanson and Ramiller 2004), Digital technology innovation literature defines the impact of digital technology on the industrial products. Therefore, the impact of IS innovation or digital technology innovation on the research projects and how they can help the researchers to realize their ideas, remain unnoticed. For instance, how a faster computing capabilities or the use of internet services can impact on the research projects in R&D department, remained unnoticed in the innovation literature.

In IS innovation, the organizations' IS unit is the main responsible for IS innovation and it starts the innovation. The other departments in the organization has the role of partners for the IS unit and help the IS unit to adopt innovation successfully in the organization. However in the present study (although it was an IT-based innovation) R&D department has the main responsibility in innovation and it initiates innovation. The GBS unit including SDD and CIT is the partner of this department and helped it to adopt the innovation in the organization.

6.6.1 CONCLUSION

This report has described the main findings of a study on the impacts of IT governance on innovation in Intoil. In this study, I have reviewed existing literature on innovation and IT governance. The literature review was conducted to find the pre-required information both in the area of innovation and IT governance. The key finding of this review was lacking of research on the relation between innovation and IT governance in the literature. Based on the findings of the literature review, the interpretive case study research method is used to study the impacts of IT governance on the process of innovative research-based software development in Intoil. Key results from the study showed that Intoil has a keen interest in “formalization”. So far every time it faces a problem in the process of research-based software development, it deduces new rule or process instead of solving the source of the problem. Consequently, the source of the problem will usually remain unsolved.

Furthermore, IT governance in Intoil is not completely aligned with the corporate strategy. While Intoil strategy emphasizes on solving the business challenges through technology innovation, the goal of CIT department is keeping the installed-base running. Thus, handling the innovative software products coming from R&D is not the first priority in CIT department.

One of the other interesting findings of this study is that, the CIT department has limited resources and cannot handle all the requests from R&D. Therefore, it usually uses the IT governing rules as a way of rejecting the projects. The unintended of IT governing rules has led to perceive IT rules and standards as enemies of innovation from the researcher’s aspect.

Interview Guide

As an initial step, I need to present myself and the project. I will explain the objectives of the interview, the duration of the interview, the rules of taking notes and recording. The reason of doing this step is to ensure that the interviewees know the reason and importance of their answers and to establish a mutual trust between two parties.

1. Interview introduction

I currently study the second year of M. Sc. in Information System at NTNU. I do this project as my master thesis in the last semester of my studies. This project is part of the project "Software innovation for subsurface disciplines in petroleum production". The aim of this project is to investigate the relationship between research-driven software development and IT governance in Intoil. We are seeking to find the answer of "how come so little of the software developed by the corporation's R&D division makes it into operational use?" We need to know that why the use of some research-based software projects failed from your point of view. You are Free to withdraw from the interview or decline to answer any question. All Information collected will remain anonymous, and will be saved in a secure hard drive. To enhance the accuracy of interpretation would we like to ask your permission to record the interview and we appreciate your contribution.

2. Opening questions contain the general information about the interviewee

- Can you begin by telling us a bit about your experiences working with IT department?
- How many projects you involved in the R&D or IT department?
- How many years you are working for Intoil?
- Which percent of the project was succeeded and which percent were failing?
- Have you ever experienced any project failure?
- Have you involved in any similar project before?
- How is your experience with IT governance?
- Have you ever heard about IT governance? (We also don't know what are the rules in IT department)

3. General understanding about the entire project

- Could you tell us about the project?
- What was the aim of the project?

- What were its advantages and disadvantages from your point of view?
- Do you know any other company which did the same project successfully, or you were the first one?
- Who decided to start the project? (Technical staff or higher level managers)
- When the idea of the project created? (What was the problem statement of the project, what was the research question of the project?)
- What was the motivation to do the project? (Benefits for stakeholders)
- Whether a specific unit or department decided to start the project or it was part of a larger project?
- Why Intoil decided to do the project?

4. The process of the project

- What were the phases and process of the project?
- What are the conditions of research projects to be handed over to IT department?
- What were governance rules you should follow if any?
- What were the phases of delivering the software to IT department?
- Could you consider the situation when your project rejected?
- Who had which role in the project?
- The risks of the project were estimated before the project is started or not?
- How was the collaboration with the IT department during the project?
- Did the department catch an agreement with the IT department before start the project?
- Were there any standards or rules those are determinate by the company for these kinds of projects? If yes, did you follow those rules?
- To what extend you could reach your goals in the pilot project?
- Was any collaboration with other departments before start the project?
- What was your role in the project?
- How well do you know people in the R & D and IT team working on the implementation of data governance?
- Can you describe how your department cooperates with other departments?
- What do you cooperate with, how frequently do you cooperate, and can you describe your perception of the quality of the cooperation?
- Can you describe the extent to which you have information about the IT department projects?
- How well do researchers know about the projects run by IT department?
- What happens when a research project handed to the IT department?

- Do you know the end user of the system? Did you have any meetings with the end users?
- What kind of understanding do other departments have of the work you do?
- Can you describe one department, group or persons most likely to oppose it?
- What are the reasons for project failure from your point of view?

5. Interview regarding the IT department's role in R&D projects and the reason of project failure

- Are there any specific terms and conditions that each IT project needs to follow before it can be used at the whole company?
- Do you inform the researchers about these rules before they start?
- What was the specific problem of the “DATA governance” failure?
- Did you have some sessions with those project members during the project?

6. The closing section

- Is there anything you would like to add? Any comments?
- Are there any points of improvements regarding to our interview questions?
- Do you know some other people you know who can help us?

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