



Norwegian University of
Science and Technology

Master's degree thesis

Blockchain and Incumbent Manufacturing Value Chains

Applicability and Adoption
Use case: Ekornes, Norway

Candidate no: 10002

Number of pages: 96

Aalesund, 08.06.2018

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Preface

This thesis project concludes my M.Sc. degree in International Business and Marketing at the Norwegian University of Science and Technology.

This master's thesis would not have been possible without the support and contribution of numerous people.

First and foremost, I would like to thank my supervisors, Prof. Øyvind Strand and Prof. Hao Wang for their guidance, support, and encouragement. Throughout this journey, I was given both the liberty to pursue my interests, as well as an ongoing constructive feedback.

I would also like to extend my thanks to everyone at Ekornes who has supported this project. The numerous meetings, interviews and lunch table discussions we shared, were a great growth opportunity and an invaluable source of insight into the manufacturing industry, and its relationship to innovation.

Last but not the least, I sincerely thank my family and friends for their unceasing encouragement, support, and attention.

I wish you to enjoy reading this research as much as I enjoyed writing it.

Abstract

Technology innovations are one of the most fundamental forces shaping today's increasingly digitized economy. This study focuses on blockchain, as an instance of radically disruptive innovations, and its impact on incumbent manufacturing value chains.

In fact, incumbents often struggle with successfully managing radical innovation, as their processes and business models can be optimized to work best with incremental innovation. Hence, this study aims to explore both the applicability and adoption of blockchain technology within incumbent manufacturing value chain.

To fulfill its purpose, this study adopts a qualitative use case methodology, where Norway's largest furniture manufacturing company serves as a unit of analysis. Furthermore, data is collected using several methods, where literature is analyzed, twenty one interviews are conducted and five months long participant observation activities are carried out.

This study thus makes the following contributions. First, a blockchain applicability evaluation framework is developed, so as it can be used to assess whether blockchain is the right solution for a particular business use case. Subsequently, the Ekornes value chain is reconstructed and analyzed in light of the consolidated supply-demand value chain theory. The goal of this exercise was to identify Ekornes business use cases which could be solved with blockchain. The evaluation framework developed within this study was leveraged to perform such an assessment. Finally, the organizational structures and behavior exhibited by Ekornes as an incumbent managing radical innovation, was collected and analyzed.

The study concludes that blockchain can indeed improve manufacturing value chains, by coordinating their supply and demand processes. Furthermore, the role of open innovation is highlighted as essential in enabling incumbents to properly respond to blockchain. Finally, the study discusses how the distributed architecture of blockchain challenges the executive decision making process among the different incumbents/teams collaborating on the same blockchain project.

The study closes with an overview of the possible implications of such a work, and how future research building upon it might look like.

Keywords: Blockchain, Innovation, Value Chain, Incumbent.

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Abbreviations

Abbreviation	Explanation
ASA	Norwegian term for a stock-based company (limited company)
B2B	Business to Business
B2B2C	Business to business to customer
B2C	Business to customer
BCT	Blockchain technology
CRM	Customer Relationship Management
DCM	Demand Chain Management
Ekoin	Ekornes Cryptocurrency Coin
ERP	Enterprise Resource Planning
MSc	Master of Science
MTO	Make To Order
MTS	Make To Stock
MVP	Minimum Viable Product
P2P	Peer to Peer
PR	Public Relations
RI	Radical Innovation
RQ	Research Question
SCM	Supply Chain Management
SRQ	Sub Research Question
TTP	Trusted Third Party

“As the births of living creatures at first are ill-shapen, so are all innovations. As those that first bring honor into their family are commonly more worthy than those that succeed, so the first precedent (if it be good) is seldom attained by imitation ... Surely every medicine is an innovation, and he that will not apply new remedies must expect new evils”

Francis Bacon, 1909, P. 132

1 INTRODUCTION

The aim of this chapter is to provide an overview of the study’s motivation and background, as well as an outline of its research questions and structure.

1.1 Motivation and background

In 1975, Xerox PARC researchers presented their vision of a “paperless office”, where most workflows and documents would be digital. Around 1990, this vision became a reality and it had been accelerating even since (Gupta, 2017). Today, modern age economies are increasingly becoming knowledge driven, and their reliance on robust ways of storing and sharing digital assets increasingly important.

However, at the global open scale at which networks such as the internet operate, it is imperative to find a way to share digital assets between end users, even over untrusted channels (Gupta, 2017).

The oldest and most widely deployed solution paradigm is the use of centralized trusted third parties. The security assumptions of this architecture are largely based on trust that these central authorities will operate as expected. Such examples of centralized digital services are banks, notaries, auditors, and DNS servers, which have all built their business models around this centralized notion of trust.

However, researchers have since focused on finding distributed peer-2-peer solutions to the digital trust question, so as we would be able to share digital assets without the need for a trusted third party (Pass et al., 2017). In fact, the disruptive power of such a solution has always been well recognized, as it can essentially allow us to restructure the internet, and by extension society, industry, and governance, in entirely new ways which can challenge the current hierarchical structure.

Even with many people working on the distributed digital trust problem, it has always been an unsolved problem. With the advent of blockchain, this statement no more stands. Indeed, blockchain has finally offered the world a practical way to share digital assets over untrusted channels, in a pure peer-2-peer distributed manner. Therefore, “Instead of a hierarchical structure managed by a set of humans interacting in person...via the legal system, a

decentralized organization involves a set of humans interacting with each other according to a protocol specified in code, and enforced on the blockchain” (Botsman, 2017).

The first applications which used this new trust model offered by blockchain was the cryptocurrency bitcoin. As a matter of fact, bitcoin and blockchain were revealed in the same paper by Satoshi Nakamoto (Nakamoto, 2009). This has led to a situation where blockchain was for so long conflated with bitcoin. Once the wider public realized that bitcoin is just one of many applications/services which can run on top of the blockchain backbone, it was just a matter of time before the wider public started appreciating the far-reaching implications of blockchain.

The financial service was naturally the first sector to have been challenged by Blockchain. However, today many more industries are experimenting with blockchain, as the problem of trust is common to many of them. One such industry that is particularly interesting to this study, is manufacturing

1.1.1 Blockchain and manufacturing value chains

Manufacturing companies often need to collaborate and coordinate with a complex network of suppliers, transport service providers, distributors, and consumers. While sharing information across such a network can be extremely valuable, achieving it in practice is not easy. On one hand, members of the same value chain usually deploy heterogeneous non-interoperable information systems. On the other hand, they have complex and delicate business relationships with each other, to a point where it becomes unfeasible for them to agree on one unique member that they can all unequivocally trust to manage and coordinate their digital assets (Hilletofth & Ericsson, 2010).

Interestingly, the above-mentioned challenges are precisely what makes manufacturing value chains a great candidate for deploying blockchain-based solutions. Some studies proclaim that blockchain will be able to finally consolidate supply and demand processes into an integrated supply-demand value chain. This should be possible because blockchain can provide an immutable and transparent link between each stage of the value chain and create a system that is simple to audit and trace in near real-time (Wüst & Gervais, 2017).

1.2 Problem definition and research gaps

The promise of blockchain as a radical disruptive innovation is great. However, manufacturing companies which can benefit the most from such an innovation, are often large incumbent businesses. Unfortunately, evidence shows that incumbents often fail to properly manage

radically disruptive innovations, which challenge their business models and introduce fundamentally new technology solutions (Coccia, 2017). Indeed, incumbents' business models and processes are optimized to focus on growing the company through a series of largely predictable incremental innovations. Furthermore, they often lack the agility and specialized technical expertise that is needed to quickly respond to radical innovation. Such a situation puts incumbents at the risk of being displaced by new agile market entrants, which can eat up their market share and make them irrelevant.

One particularly interesting instance of the above-described problem is the relationship/impact of blockchain as a radically disruptive innovation on incumbent manufacturing value chains. While the promise of such a technology within manufacturing is significant, one can notice a clear lack in studies investigating it. In fact, the interdisciplinary nature of this topic as well as its novelty, made it so that practitioners from these two fields don't seem to have gotten yet the opportunity to deeply collaborate on blockchain projects, which have a business significance to manufacturing, such as value chain integration.

Indeed, one can notice a lack in studies investigating the potential applicability of blockchain in enabling manufacturing companies to unleash the true potential of their value chain systems, and better synchronize its processes. By extension, there is also a lack of real-world examples of blockchain solutions which can be mapped to real-world value chain business use cases.

However, even with a complete understanding of the applicability of blockchain to manufacturing, the adoption of such a radical innovation by incumbents would need to be further investigated. While there is an abundance of such studies within industries such as finance and banking (Verhulst, Rutkowski, de Vreede, & de Vreede, 2017), this insight is not available to the manufacturing industry. Thus, it becomes difficult for its incumbents to understand how such an adoption process might look like, what organizational challenges they might face, and which competencies they need to develop in order to maximize their adoption success prospects.

1.3 Purpose of the study and research questions

In light of the identified gaps, this study aims to enrich the understanding of two essential topics: applicability and adoption of blockchain as a radically disruptive innovation to incumbent manufacturing value chains.

This study provides answers for both the theoretical and practical gaps. Insights about the latter have been gained through a case study conducted over a period of nine months within Ekornes, Norway's latest furniture manufacturing company.

1.3.1 Research questions

1.1.1.1 Blockchain applicability evaluation- theory

Several studies have shown that it is common for fundamentally groundbreaking innovations such as blockchain, to experience a hype period where people claim that it can solve all problems. Such a hype usually leads to many proposed projects in which the technology is not needed, or where it even is not possible to use (Alexopoulos, Daubert, Mühlhäuser, & Habib, 2017). In addition to that, one can also observe that companies with a legitimate blockchain use case are unable to properly evaluate it, as the hype noise drowns the technology. This is due to the nuanced novelty of the technology, the lack of clear guidelines for its use, and the abundance of false hyperbolic claims for its applicability.

Currently, there are a number of evaluation frameworks that can be used to assess the applicability of blockchain to some business use case. However, these frameworks are neither targeted towards manufacturing value chain nor are they holistic. Indeed, they are developed with a bias towards the technical evaluation of the use case, ignoring other equally important aspects such as governance, business strategy, and industry specificities (Wüst & Gervais, 2017). Therefore, this study aims to answer the following first research question (RQ1):

RQ1. Which dimensions should be considered, and which questions should be asked as part of a blockchain applicability framework?

This first research question is a composed one. This is why it needs to be subdivided into three sub-research questions:

In fact, one important way which can inform the choice of the dimensions to be considered in the framework is identifying the class of innovation blockchain fits within. Indeed, the word innovation is a wide umbrella term. It encompasses different types and classes of innovation, where each category exhibits a unique set of characteristics that subsequently require different competencies to manage it properly (Kotsemir & Abroskin, 2013). For instance, disruptive

innovations focus more on the market, while radical ones are more concerned with the technology. Fortunately, the innovation management theory offers different classification studies and guides, which can be used to gain more insight into specific technology innovations. Hence, the three sub-research questions which need to be considered are:

SRQ 1.1. What type of innovation does blockchain represent, specifically when applied to manufacturing value chains? (Descriptive)

SRQ 1.2. Which dimensions should be considered as part of a blockchain applicability framework? (Descriptive)

SR 1.3. Which questions should be asked within each dimension? (Framing)

1.1.1.2 Blockchain applicability and evaluation in action

RQ1 sets the theoretical foundation for this study. However, the aim is to also provide insight into the practical uses of blockchain within manufacturing value chains, through achieving integrated supply-demand chains. Hence, this study uses Ekornes to perform a qualitative case study in order to explore the following research question:

R2. What are the main blockchain business use case solutions one can identify within Ekornes value chain?

Answering RQ2 requires the investigation of three separate sub-questions.

SRQ2.1. what are the main business use cases of points of friction within the Ekornes value chain? (Descriptive)

SRQ2.2. which uses cases, amongst those identified in RQ2.1, can blockchain solve? (Analytics)

RSQ2.3. what are the main components of the blockchain solution corresponding to the identified uses cases? (Framing)

1.1.1.3 Blockchain adoption

Identifying blockchain use cases that are applicable to Ekornes does not necessarily mean that Ekornes will be able to properly evaluate and manage this opportunity (Danneels, 2004). In fact, incumbents firms such as Ekornes often don't have the necessary skills to manage radical innovations such as blockchain.

Hence, with a set of legitimate blockchain use cases at hand, this study aims to investigate and s how Ekornes will acquire the necessary competencies to understand and evaluate blockchain use cases, and which ones it will subsequently pursue. This will allow us to answer the following research question:

RQ3. How will Ekornes as an incumbent manufacturing firm manage blockchain as a radical innovation, specifically along the lines of the radical innovation competency framework of discovery, incubation, and acceleration?

1.4 Thesis structure

The rest of the thesis will be organized as illustrated in Figure 1.

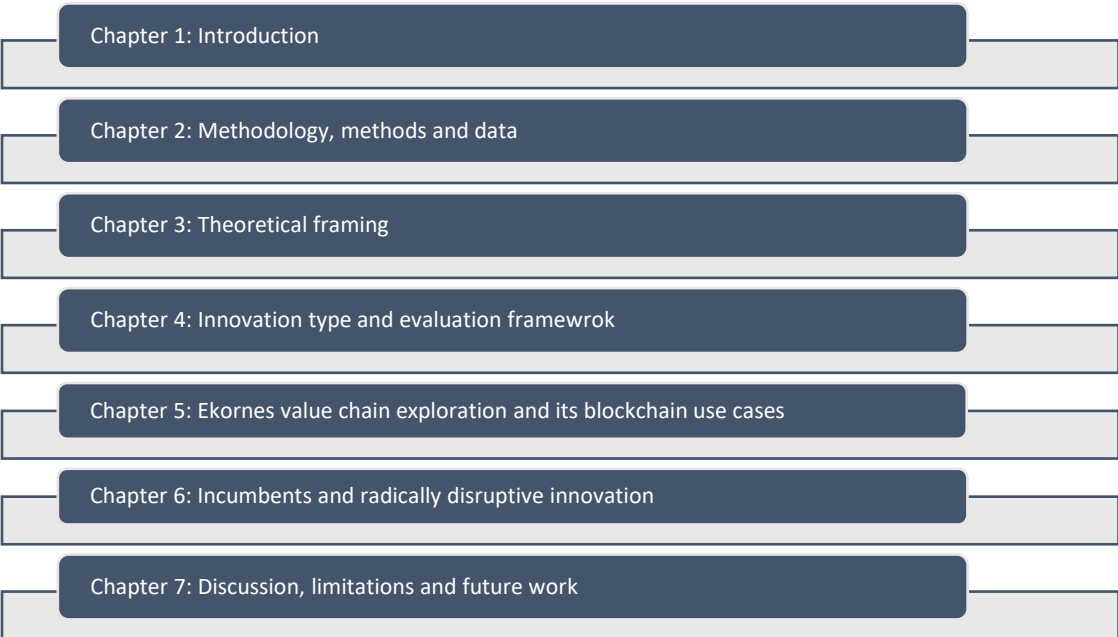


Figure 1: Thesis structure

Chapter one provides an overview of the study’s motivation and background, as well as an outline of its research questions and structure.

Chapter two provides the rationale behind the way this research has been conducted, specifically its underlying methodology, and data collection methods.

Chapter three main goal is to act as the theoretical framing for the concepts which were necessary to carrying out this study.

Chapter four provides the foundation and necessary tools for carrying out applied blockchain research. This is mainly achieved by developing an evaluation framework which can be used to assess the applicability of blockchain to manufacturing business use cases.

Chapter five presents Ekornes business use cases which can be solved using blockchain with a focus on the use cases which case improve the company's value chain, and help it achieve better integration between its supply and demand processes.

Chapter six studies how Ekornes as an incumbent responds to blockchain as a radically disruptive innovation. This will shed the light on the competencies needed to manage a successful radical innovation project and the organizational challenges which may hinder it.

Chapter seven concludes this study. It provides an overview of what has been achieved, as well as a critical reflection over how it has been achieved. It also provides an overview of the possible implications of such a work, and how future research might look like.

2 METHODOLOGY AND DATA

The aim of this chapter is to provide the rationale behind the way this research has been conducted, specifically its underlying methodology and data collection methods

2.1 Methodology

This study focuses on answering research questions that are at the intersection of blockchain and manufacturing incumbents. This is a topic where little prior published research has been completed. Hence, the research questions of this study aim to investigate the applicability and potential impact of blockchain on incumbent manufacturing value chains, as well as gain insight into its adoption management.

The exploratory nature of the above research questions motivated the choice of the methodology to be a qualitative case study. In fact, such a methodology is used when one wants to answer “how” and “why” type questions, while taking into consideration how a phenomenon is influenced by the context within which it is situated” (Baxter & Jack, 2009). Furthermore, this methodology offers a high degree of freedom and flexibility (Bryman & Bell, 2015), which we deem to be necessary to study a topic as complex and novel as blockchain.

Finally, a qualitative case study methodology is suitable for collecting data from a multitude of sources (Yin, 2009). This makes it particularly suitable for this study, which needs to ensure that the research questions are holistically explored through the perspectives of blockchain as a technology, manufacturing as an industry, and innovation management as a theory.

2.1.1 Case company description- Ekornes ASA

In order to perform a meaningful case study and eventually answer the study’s research questions, the case company should be an incumbent manufacturing firm with some degree of technology innovation familiarity, and which has expressed an interest in blockchain technology. Ekornes ASA satisfies all these sought-after characteristics, and this is why it has been chosen for this study. The rest of this section will present the company’s profile.

Ekornes is, Norway's largest furniture manufacturer and it owns the Stressless brand which is one of the world’s most recognizable brands of premium furniture. The other brand names it owns, Ekornes and Svane are largely recognized and appreciated within the local Norwegian

market. The head office of Ekornes is located at Ekornes in Sykkylvei municipality, where one of its main manufacturing facilities are also located.

Ekornes, ASA is the group's parent company that handles corporate management, marketing, financial management, procurement & product development and it has been listed in the Oslo Stock Exchange since 1995 (Ekornes, 2017).

From an organizational perspective, Ekornes is divided into 10 factories, amongst which 6 are in Norway and one factory in the United States of America. The 3 remaining plants have been acquired through the IMG acquisition. In 2012, Ekornes became “Norway’s most highly automated company. With the installation of industrial robot no. 100, Ekornes has 10 per cent of all the industrial robots in existence in Norway” (Ekornes, 2016, p.110))

Within the last three years, Ekornes experienced decreasing sales revenues. Hence, the company has been engaged in rolling out a number of new measures to enhance the brand recognition and stimulate the market.

2.1.2 Reporting the findings of the case study

Reporting the case study results is very important as it can influence the way readers understand and appreciate the insights it provides. However,” many researchers struggle with choosing the right way to do so. Even if there is no one way of reporting the study results some suggested ways are by telling the reader a story, by providing a chronological report, or by addressing each proposition” (Baxter & Jack, 2009).

In this report, we want to allow the reader to feel as an active participant in the research and give them a real feel of what has been experienced throughout this study. Hence, a sequential chronological reporting approach is chosen.

2.1.2.1 Case study reporting and research questions

This study has been conducted sequentially. Since we are relying on a story telling reporting technique, the findings’ reporting was guided by the sequence in which the study has been conducted.

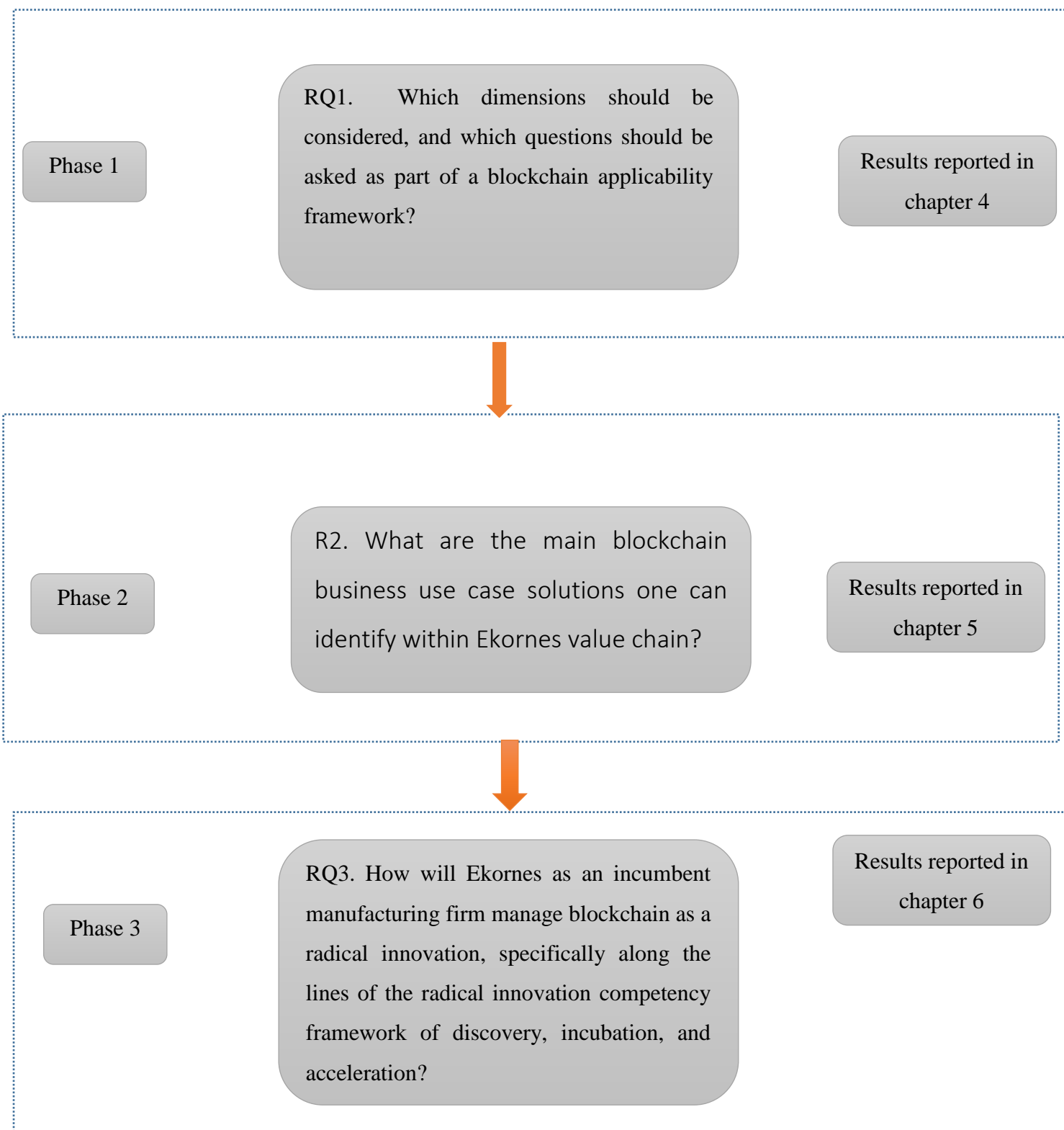


Figure 2: Mapping of study findings to research questions

2.2 Methods and data sources

Using multiple data methods within a qualitative case study is highly encouraged. Examples of the latter are: interviews, focus groups, physical artifacts, participant observation, and literature reviews. In this particular study, a mix of literature review, interviews, and participant observation was used. While details of each phase will be discussed separately, the below table provides an overview of the distribution of methods per phase:

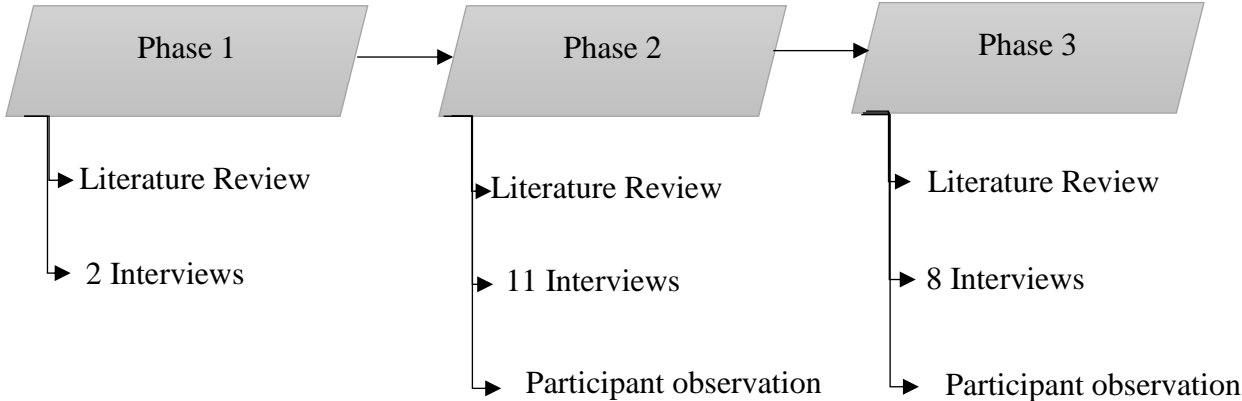


Figure 3: Overview of data collection methods

For the sake of clarity and completeness, the rest of this chapter will be organized as follows:

1. Guiding principles which motivated the way we designed and conducted each data collection method will be explained.
2. How the guidelines have been used in practice to conduct data collection through each phase of the study.

2.2.1 Participant observation guidelines

“The main goal of this method is to acquire an intimate familiarity with a given group of individuals and their practices through an intensive involvement with people in their cultural environment, usually over an extended period of time” (Kawulich, 2005, p. 38)

Unlike other qualitative data collection methods, participant observation usually takes place over extended period of time. Hence, it should be managed as process:

- Establishing reports,
- Selecting key informants,

- Recording observation and data,
- Analyzing data,

Furthermore, the level of involvement of the observer with the observed is critical to the quality of the results. None or too little involvement might result in a lack of well-built rapport, while a complete participatory immersive involvement might compromise objectivity of the study.

2.2.2 Participant observation in practice

One of the main research questions of this study is investigating How Ekornes, as an incumbent company, responds to blockchain, specifically along the lines of the radical innovation competency framework of discovery, incubation and acceleration. While this question seems to emphasize the organizational response, it is indeed the sum of the people's behavior and common culture which determines such a response in practice. Hence, being able to get involved with the group and having a direct access to the needed data is very valuable.

Using participant observation as part of this study was possible because Ekornes extended an invitation for me to sit at their headquarter office in Sykkylven for 5 months.

Throughout this study, I made an intentional effort to maintain a balanced level of involvement, where I could get enough data, yet preserve my outsider critical view to it. Furthermore, I focused on the supply chain director as a key informant, given his great interest in championing the blockchain project, and his collaborative mindset. Finally, the main methods which have been used are: informal interviews, direct observation, and collective discussions. All data which has been collected through the latter, has been carefully transcribed in the form of notes. For the same of clarity, observations were recorded right after they take place.

2.2.3 Interview guidelines

2.2.3.1 Choosing an interview strategy

Interviews can be categorized as open-ended, semi-structured, and structured (Runeson & Höst, 2009).

Open-ended interviews typically discuss themes rather than specific questions (Runeson & Höst, 2009). Such interviews help the researcher gain valuable insights and get information outside the preconception of interview scope. However, there is also the risk that the interviewer avoids subjects not comfortable with (Runeson & Höst, 2009).

Structured interviews are based on completely predetermined questions with bound answers which can be seen as similar to a survey study. The benefit of using structured interviews instead of surveys is that unclear questions can be clarified, also the interviewee does not need to fill in answers (Runeson & Höst, 2009).

In all three phases of this study, we have relied on semi structured interviews. On the one hand, the explorative nature of the research questions meant to give the interviewees the option to expand on their answers. On the other hand, the technical aspect of this research meant to capture accurately other questions.

In all of our Semi-structured interviews, we asked an initial set of structured questions to be followed by broader, open-ended ones.

2.2.3.2 Developing interview questions

Interviews should be conducted in four phases: Context, initial questions, main questions, and summary (Runeson & Höst, 2009).

Practically speaking, this means that the interviewee should be first presented with information about the aim of the study, the expectations from this interview and the reason why he/she was chosen. Subsequently, Initial questions which don't raise much controversy and allow the interviewer to get into the interview should be tackled.

Once the interviewee gets into the momentum of the interview, the core questions should be asked. The latter are usually ones which require the usual to exercise more analytical and judgment skills.

Last, the interviewer should summarize the main takeaways of the interview in order to ensure clarity and completeness and minimize misinterpretation.

2.2.4 Interviews in practice

2.2.4.1 Phase 1

The interviewees in this phase were selected based on their expertise in Blockchain technology and IoT traceability.

- Fitrayti CEO is a computer science engineer by background and She has a well-rounded blockchain and technology experience from both a research and industry perspectives

- The IoT consultant has an engineering background in computer science, and has been advising companies in Norway about the type of IoT devices they should use for their specific business needs

Title	Industry	Place	Length
IoT consultant	Internet of Things	Skype	30 min
Fitrayti CEO	Blockchain	Face To face, The Simula Gründergarasjen, Oslo	90 min

Table 1: Interviewees in Phase 1

Furthermore, in this phase, an initial evaluation framework was developed based on the available literature review which has motivated the choice of the interview questions. The main goal of the interview was thus to capture feedback about the framework’s completeness, accuracy and clarity.

While the full interview guide is available in Appendix 1, below are examples of the questions, which were part of this interview:

- Is the connection between the technical and strategic dimensions clear?
- Which other aspects, other than technical and strategic, should be considered before deploying a blockchain project?

2.2.4.2Phase 2

As the goal of this study was to investigate how much integrated and coordinated is the Ekornes value chain, it was critical to collect data which reflects this holistic approach. This is what motivated the selection of interviewees representing all Ekornes departments, as well as its transport service partner.

Title	Department	Place	Length
Customer Service and Planning Manager	Customer Service	Face to face, Ekornes	60 min
DSV Representatives	Logistics Service Provider	Face to face, Ekornes	90 min
Executive Project Manager	Supply Chain	Face to face, Ekornes	40 min
Customer Service	Manufacturing Tour	Face to face, Ekornes	90 min

Finance and controlling manager	Finance	Face to face, Ekornes	60 min
Head of PMO and Deputy CIO	Information Systems	Face to face, Ekornes	40 min
Marketing Manager	Marketing	Face to face, Ekornes	60 min
Supply Chain Director	Supply chain	Face to face, Ekornes	60 min
Supply Chain Director	Supply chain	Face to face, Ekornes	60 min
Technical manager	Technical system	Face to face, Ekornes	60 min
Shipping and Logistics Coordinator	Shipping and logistics	Face to face, Ekornes	60 min

Table 2: Interviews in Phase 2

2.2.4.3 Phase 3

The blockchain use cases we developed included processes from different flows: financial, supply chain, marketing, IT and digitization. Hence, the interviewees were chosen from all these Ekornes departments in order to ensure that they would be able to properly contribute their feedback into assessing the use case.

Furthermore, as blockchain adoption is a strategic decision, I included a meeting with the executive board of Ekornes.

Title	Department	Place	Length
IT System and Application Manager	SAP	Face to face, Ekornes	40 min
Group Director of Digitalization and HR	Digitalization and Human Resources	LinkedIn	-
Management Team	Blockchain use cases for Ekornes	Face to face, Ekornes	40min
Marketing Team	Blockchain Use Cases Presentation	Face to face, Ekornes	30 min
Supply Chain Director	Identified Blockchain use cases	Face to face, Ekornes	60 min
Supply Chain Director	Identified Blockchain Use cases	Face to face, Ekornes	30 min
Supply Chain Director	Blockchain uses cases for the Steering Group	Face to face, Ekornes	60 min
Training Coordinator	Employees Continuous Training	Face to face, Ekornes	60 min

Table 3: Interview in Phase 3

Furthermore, in this third phase of interviews, I spent more time on the context part, as it was necessary to ensure that the interviewees had enough background and grasp of the use cases they were evaluating. The detailed interview guides can be found appendix 3.

2.2.5 Literature review guidelines

A literature review creates a solid knowledge base at an initial stage of the research (Runeson & Höst, 2009) and summarizes current research on the topic (Rowley & Slack, 2004) propose four main research strategies for finding relevant literature as shown in Table1.

Research Strategy	Description
Citation Pearl Growing	Phrases or words within retrieved sources are used to retrieve other sources in new searches
Brief search	Sources are retrieved quickly and crudely
Building Blocks	Search terms are combined with synonyms and similar concepts.
Successive Fraction	Searches are made within a large set of sources to eliminate non-relevant sources

Table 4: Four main search strategies (Rowley & Slack, 2004)

In this study, the screening of articles and books was directed by four principles, based on the (Rowley & Slack, 2004) recommendation. The sources should preferably:

- Be relevant to the research subject
- Hold extensive source referencing,
- Be up-to-date
- And be written by an authoritative author.

2.2.6 Literature review in practice

2.2.6.1 Phase one

The literature review used in these phases focused on:

- Technology innovation and its types
- Blockchain technology principles

- Evaluation frameworks for blockchain projects

2.2.6.2Phase two

The literature review needed for this phase focused on:

- Value chain analysis and the role of integrated supply-demand processes.
- Blockchain technology components.

2.2.6.3Phase three

The literature review needed for this phase focused on:

- Radical innovation competency, and the role of open innovation.
- Incumbent and the radical innovation challenge

3 THEORETICAL FRAMING

The aim of this chapter is to provide the theoretical framing of the concepts which were necessary to carrying out this study.

3.1 Innovation and its typology

Innovation is a concept which has been extensively studied in different disciplines (e.g.: management, technology, and social science), and there exists different innovation classification frameworks to choose from (Rao, 2007). Furthermore, variations in frameworks could be found even within the same discipline, depending on the nature of the object of innovation (e.g.: process, technology or market).

For this study which is focusing on blockchain, it is most relevant to consider classification frameworks for product and service technology innovation (Norman & Verganti, 2014). In this context, an innovation can be either increment, disruptive or radical. Several studies have shown that innovations which fall under either one of these two categories, exhibit similar and meaningful patterns in their innovation processes (Kotsemir & Abroskin, 2013). Such patterns can help deduce generalizable conclusions and guidelines on how to deal with each innovation category.

3.1.1 Incremental innovation

The main goal of incremental innovation is to introduce a small improvement to an already existing product or service. Its core philosophy is rooted in the theory of "learning economics", where the process of learning is regarded itself as a process of innovation (Norman & Verganti, 2014)

Incremental innovation enables companies to continue claiming their current competitive position and/or improve it gradually and continuously over time. It also has an immense cumulative effect, if executed continuously. Hence, it is regularly implemented as part of the normal business cycle of companies which need to constantly provide new features for their end users (Coccia, 2017).

Incremental innovation has the advantage of being generally well understood by companies. The latter often have well-built processes that enable its systematic execution and delivery at a

fast pace. This also means that organizational structures are optimized to match the requirements of executing incremental innovation (Hui & Qing-Xi, 2006)

Finally, this form of innovation does not force companies to expand and collaborate beyond their traditional network, as the needed competencies can usually be found either internally or within their close-knit ecosystem of partners.

3.1.2 Disruptive-radical innovation

The concept of radical innovation was first introduced by the economist Joseph Schumpeter. It was then further studied, and popularized by Clayton in his 1997 seminal work, where he established the difference between disruptive and radical innovation. Radical innovations are best defined as a discontinuous event that comes as a result of research and development efforts. It often introduces fundamental technology changes, to the point where an old one gets overridden (Christensen, 1996).

While radical innovation focuses on technology breakthroughs, market research is another dimension which can be used to understand and classify innovation. This concept is known as disruptive innovation, also has defined by Clayton (1997) as “a market phenomenon where innovation creates a new market and value network and eventually disrupts an existing market and value network, displacing established market-leading firms, products, and alliances” (Christensen, 1996, p. 45)

From the above two definitions, it looks rather clear that radical and disruptive innovations are two orthogonal concepts. A disruptive technology may or may not be due to a fundamentally discontinuous and radical technology, while a radical innovation may or may not lead to market disruption.

When an innovation is both disruptive and radical, then it exhibits the following characteristics:

- It challenges and disrupts established business models.
- It introduces fundamental technology changes, to the point where an old one gets overridden.

While the potential of such an impact is tremendous, radically disruptive innovations are challenging for enterprises. Indeed, “innovating enterprise' s organizing capability is difficult, and to adjust it is costly” (Nelson & Winter, 2004, p. 105)This is especially true for large incumbent companies, which have more internal inertia to fight off in order to adapt their strategy and processes to such fundamental changes.

3.2 Incumbents and radical innovation

“Whether or not large established companies can develop and commercialize radically disruptive innovations (RI) is a moot point. The fact is, they need to. Mature firms depend on radical, breakthrough innovation to provide the next platform for growth as mature businesses become commoditized and loyal markets become saturated”(Chesbrough, Vanhaverbeke, & West, 2006a, p. 98). Therefore, radical technology innovation should not be viewed as merely an optional strategic decision for incumbents to generate extra revenue. It can definably be a risk factor which would need to be mitigated. In this case, the mitigation strategy is accepting the risk, embracing its consequences and turning it into an opportunity. The next sections will discuss whether incumbents are capable of responding properly to radical innovation.

3.2.1 How do big firms deal with radically disruptive innovation?

The majority of evidence suggests that incumbents face many internal organizational challenges when radical innovations enter their markets, and are mostly incapable of managing it properly (Adams, Bessant, & Phelps, 2006). The main reasons behind that are as follows:

- Incumbents have a mature lucrative core business, with a set of corresponding efficient processes which need little disruption in order to continue performing at the same level. In a sense, these optimizations become a source of inertia and rigidity that is difficult to overcome(Leonard-Barton, 1992).
- Radical innovation often requires a multi-year investment before becoming truly profitable. However, incumbent need to meet equity markets on a regular basis. Hence, they tend to ignore investments in radical innovation or drop it too early (Chesbrough, Vanhaverbeke, & West, 2006)
- Radical innovations require the understanding of fundamentally new technologies. Incumbent lack such deep expertise and have to look outside of their walls to acquire and integrate the necessary competencies (Hill & Rothaermel, 2003).
- Incumbent can face significant organizational challenge to execute radical innovations even when they become aware of radical innovation and acquire the necessary competencies to manage it. Indeed, radical innovations are not only a technical transformation; bur also structural and managerial one.

While the above-mentioned reasons argue that incumbents are by definition incapable of managing radical innovation, there have been other studies arguing for a slightly nuanced position. They consider that incumbents are capable of managing radical innovation, but that

they don't spend enough time and effort in developing its competency. Proponents of this view maintain that all the seemingly inherent shortcoming of incumbents can be overcome by a mature radical innovation competency. Therefore, a lot of subsequent studies have focused on investigating factors which influence the development of the radical innovation competency of incumbents (Kogabayev & Maziliauskas, 2017)

In the next section, the study introduces one such framework which has proven to be successful.

3.2.2 Engagement frameworks with radical innovation

It is currently prevalent among incumbents to focus their overall corporate resources on their core incremental business, and just rely on an individual champion to sporadically start a radical innovation strategic initiative. This non-systemic approach is neither efficient nor sustainable. It is rather a one-off approach. At the pace at which technology innovation is happening, this is a sure recipe for failure and irrelevance:

In order to remedy this situation, a number of engagement frameworks have been proposed, the following is one which has proven to be particularly useful (Chesbrough et al., 2006a, p. 53):

- Discovery
- Incubation
- Acceleration

3.3 Radical innovation engagement framework

3.3.1 Discovery

The main goal of discovery is to discover radical innovations or bring them to the attention of the company from external sources. Hence, this phase is explorative by nature. It focuses on “activities that create, recognize, elaborate, and articulate radical innovation opportunities” and the competencies required for executing it are conceptualization, exploration, and research (Chesbrough et al., 2006b). Such competencies can be achieved in one of two ways:

- Within industrial research and development laboratories
- Collaboration with external academic or industrial entities.

3.3.2 Incubation

The main goal of incubation is to qualify the radical innovation opportunity and mature it into a business use case. The following are examples of questions that need to be clarified at this level:

- How is the discovered radical innovation relevant to the business?
- What changes to the market can it bring?
- What will the new business model look like?
- What is the market response to a prototype of this technology?

Therefore, the incubation phase calls for competencies that are experimental in nature. The activities carried out within this phase are experiments to test the technical potential and maturity of the innovation, as well as its market readiness and value creation capability minimize the risk and uncertainty of the market and technical. Such experiments aim to minimize the risk exposure of the company to market and technical uncertainties (Chesbrough et al., 2006b).

3.3.3 Acceleration

The main goal of acceleration is to turn the tested use case into a profitable running business, with stable development, sales and operations processes. Therefore, the activities of this phase focus on exploitation. This can be done by investing in building repeatable technology foundations, as well as maturing and closing qualified market opportunities (Chesbrough et al., 2006b).

Incumbents who reach this phase are usually more comfortable in executing it, as achieving this phase necessitates acquiring the missing competencies in the previous two phases. They can also finally start relying on their traditional strengths of efficient execution.

Therefore, we can conclude that acceleration is successful when the incumbent is capable of achieving repeatable profit from the innovation. At this point, the radical innovation can even become part of the core company's business portfolio.

3.4 Value chains

The concept of value chains was first discussed by Michael Porter in 1985, as part of his seminal book entitled the competitive advantage. A value chain is thus defined as “a series of

interconnected value-creating activities, and differences of the value chains in different firms create fountain for competitive advantage of firm” (Michael Porter, 1985, p. 19)

The value chain processes usually belong to either the supply or demand chain. It is, however, important to note that “there is no difference between the demand and supply chain when it comes to the chain of organizations involved but regarding the processes considered” (Hilletofth & Ericsson, 2010). In other words, demand and supply chains can be understood as two different ways of analyzing the same value chain. The value chain perspective is what we get when companies align and harmonize their supply and demand chains simultaneously.

3.4.1 Supply chains

Supply chains are efficiency centered. They are composed of the set of all processes needed to satisfy the demand of end users. They are usually managed within the supply chain department, using ERP tools. Examples of its processes are procurement, manufacturing, shipping, distribution, orders, and returns. (Jüttner, Baker, & Christopher, 2004)

3.4.2 Demand chains

At a high level, we can conceptualize demand chains as being the set of all processes that companies understand its end users, as well create demand for its products and drive their growth. Demand chains are usually managed within marketing and services departments, using CRM tools. (Hilletofth & Ericsson, 2010). Examples of such processes are market research, market segmentation, marketing and branding, promotion, after-sale services and support.

3.4.3 The practice gap

While value chains can be quite complex in industries such as manufacturing, it is crucial to ensure that every part of it creates an added value to end customers. One way to achieve this, is through having consolidated supply and demand chains. However, most companies do not implement such an approach. Often time, companies manage supply chains and demand chains separately to the point where one can clearly classify businesses as either supply-driven or demand-driven. However, none of these models can achieve an optimal value chain. Indeed, “without demand and supply integration, the SCM can't capitalize on the customer needs information that marketing uncovers, and marketing can't implement new product or market development strategy that profitably increase the scope of its offerings” (Hilletofth & Ericsson, 2010, p. 212).

3.4.3.1 Inconvenience of a supply-driven value chain

By definition, supply-driven companies are able to build strong and efficient supply chain processes. This allows them to minimize the cost and time of their supply chain greatly.

Such a focus influences business models, which place great focus on competing through price and delivery flexibility, while the demand chain simply exists to market for such features.

Traditional SCM is driven by planning and communication. The future demand is estimated based on the past and current demand, and information is pushed to the involved stakeholders hoping to get the relevant information on time to respond to changes, delays or errors. (Hilletoft & Ericsson, 2010).

While this business model helps companies drive prices down and/or increase profitability depending on their pricing model, it limits them to competing through price solely. However, customer satisfaction is more complex and is rarely just a factor of price. Unless they start having supply-demand chains, such companies often struggle on the longer-term regarding customer dissatisfaction, as their product development eventually falls short of end-users' expectations (Hilletoft & Ericsson, 2010).

3.4.3.2 Inconvenience of a demand-driven value chain

Demand-driven companies focus their resources on activities such as market research and evaluation, demand generation and branding. Such a demand focus naturally influences the business model and strategy of these companies. In this context, supply chain becomes a mere set of processes which exist to simply execute such a vision.

In demand chain management (DCM), “the customer’s interest is at the core of the chain. DCM allows for an increased flexibility by requiring all stakeholders to have a real-time visibility of what consumers want and purchase” (Hilletoft & Ericsson, 2010, p.15). All parties of the demand chain have therefore to be tightly connected within a network. Contrary to SCM, which optimizes the flow” and might be based on incomplete and inaccurate market assessments, DCM requires companies to have a complete and accurate view of the market to proactively choose optimal production decisions. (Jüttner et al., 2004) As such, the information flow in DCMs is pull-based rather than push-based: since the stakeholders do not need to wait for a notification but can actively query the state of the chain management.

However, studies have shown that being overwhelmingly demand driven results in an inefficient process which can lead to increased and unmanaged delivery costs and times. Eventually, this becomes counterproductive, as uncertainty in delivery, for instance, leads to market share losses. Usually, such uncertainties are very hard to be balanced out even by a strong company brand.

3.4.3.3 The theory-practice gap

The majority of studies which investigated the value chain disintegration between supply and demand processes have put forward different theories to explain it. Below are some of these reasons:

- Lack of case study research on the benefits of coordinating SCM and DCM.
- Lack of guidelines on how it can be achieved.
- The available enterprise grade software reinforces this disconnect as they provide equally disconnected ERP systems to manage SCM and CRM systems to manage marketing and services.

While technology might be indeed a reason which exasperated the problem, the focus in this study is on investigating how blockchain technology can now contribute to solving it.

3.5 Blockchain technology

3.5.1 A bit of history

In 1975, Xerox PARC researchers presented their vision of a “paperless office”, where most workflows and documents would be digital. Around 1990, this vision became a reality and it had been accelerating even since (Gupta, 2017). Today, modern day economies are morphing towards being information/knowledge driven and are becoming exponentially dependent on storing and sharing digital assets.

However, at the global open scale at which networks such as the internet operate, it is imperative to find a way to share digital assets between end users, even for the ones who don't have a pre-established trust relationship (Gupta, 2017). This problem is an old age computer science question, which is usually referred to as the “two Generals Problem”, and it highlights the difficulty of coordination and trust of communication over an unreliable channel.

- The first and most widely deployed solution is centralized trusted third parties. By definition, their main reason of existence of TTPs is to enforce rules and policies,

coordinate between distant heterogeneous groups, and achieve consensus for their communication (Pass et al., 2017). The security assumptions of this architecture is largely based on trust that these central authorities will operate as expected. Such examples of centralized digital services are DNS servers, banks, notaries, and auditors. However, these centralized solutions are not always the best option, as they represent a single point of failure. Furthermore, they often operate of a faith-based trust that they are trustworthy. This technical centralization reinforces and mirrors the centralization of social and governance powers, which are in the hands of few select institutions.

- As a response to the shortcomings of centralized systems, further research has focused on finding distributed peer-2-peer solutions that can enable us to reach consensus for our digital communication over untrusted channels, without the need for a trusted third party (Pass et al., 2017). The disruptive power of such solution is well recognized, as it can essentially allow us to restructure the internet, and by extension society and governance, in entirely new ways which challenge the current hierarchical structure. However, finding this solution has proven to be a difficult task for a long time. One of the main challenges encountered by researchers is how to “ensure that participants receive the resources they are expecting: two participants making the same request may receive entirely different resources or may receive the same resource when this is not permitted”(Benton & Radziwill, 2017, p. 35) .Later on, this question will come to be known as the double spend problem.

Blockchain novelty and main contribution is solving the double spend problem through a distributed peer-2-peer system, which relies on mathematical puzzles to achieve consensus over the trustworthiness of the communication. The importance of such an innovation cannot be overstated, as we are shifting from a faith-based trust in central entities, to such distributed peer-2-peer code/mathematics-based-trust. Indeed “Instead of a hierarchical structure managed by a set of humans interacting in person...via the legal system, a decentralized organization involves a set of humans interacting with each other according to a protocol specified in code, and enforced on the blockchain” (Botsman, 2017).

However, it is interesting to note, that even blockchain inventor, the anonymous Satoshi Nakamoto, did not recognize the disruptive power of blockchain. This is because, he offered mainly a mechanism to achieve a specific goal, which is achieving consensus for specific cryptocurrency transactions called bitcoin, by solving the double spend problem without invoking any trusted third parties.

Today, blockchain has moved way beyond bitcoin, which is considered now just one of many applications/services which can run on top of the blockchain backbone. Indeed, “the realization that the underlying technology that operated bitcoin could be separated from the currency and used for all kinds of other inter-organizational cooperation, catapulted the blockchain to prominence” (Benton & Radziwill, 2017, p. 65) .

3.5.2 Blockchain primer

In this project, we are going to focus on the potential of blockchain within the manufacturing value chain. Hence, the next sections will explain blockchain components which are relevant to understanding the uses case which will be discussed in this study. Any blockchain detail which is outside of the scope of this project, will not be expanded on.

One way to conceptualize blockchain projects is by using the framework proposed by Brenig, Schwarz, & Rückeshäuser, where they make a distinction among blockchain platforms, applications and services (Brenig, Schwarz, & Rückeshäuser, 2016)

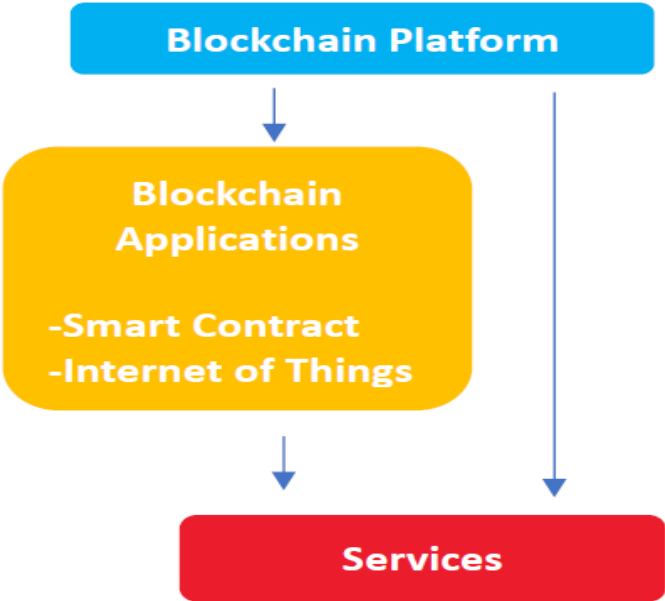


Figure 4: Blockchain Platforms, applications and services (Brenig et al., 2016)

- Blockchain platform is the backbone infrastructure. It implements all blockchain components which eventually enable nodes to communicate and reach consensus about the shared transaction in a peer-2-peer distributed manner.
- Blockchain applications represent applications implemented on top of blockchain platforms business, “being connected by a technical link to a specific blockchain, to provide additional functionalities not initially available” (Brenig et al., 2016)

- Blockchain services can be mapped directly to business requirements. They also abstract the technical underlying details of blockchain and don't require a technical link to the blockchain platform.

3.5.3 Blockchain platform

The Blockchain platform is the infrastructure that acts as the technical backbone for Blockchain applications. A Blockchain can be defined as the combination of a distributed ledger, shared amongst a P2P network of nodes, and which uses a distributed consensus algorithm to guarantee the data's integrity (Glaser, 2017).

3.5.3.1 Cryptographic digital signatures

Public key cryptography is a core technology in blockchain. It is used as the basis for node identities, and more fundamentally as a means to generate a signature for transactions. A user Alice can write a transaction by signing it by its private key, and it can read and validate other nodes' transactions using their corresponding public keys (Gupta, 2017).

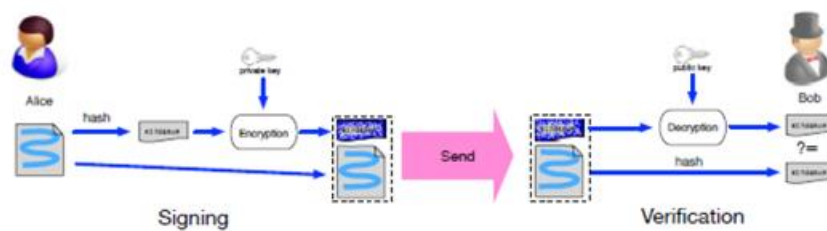


Figure 5: Digital Signature Mechanism (Zheng, 2016)

3.5.3.2 Distributed ledger

A blockchain is a continuously growing list of records/transactions, grouped as a set of blocks, which are linked and secured using cryptography. While transactions are traditionally maintained by centralized third parties, the blockchain ledger maintains them in a completely distributed manner (Gupta, 2017).

Each block contains the detailed list of transaction record similarly to a conventional public ledger (Lee & Lee, 2015). Furthermore, each block is composed of a block header and a block body. The block header contains information about the previous and following blocks header hashes and the time stamp. While the block body is composed of the transactions and the collection of transactions that have inputs and outputs.

Because the blockchain ledger is stored in a distributed manner on every node of the network, then a mechanism is needed to ensure that all these nodes trust have the same version of the ledger, and that it has been indeed immutable. Such mechanism is what we refer to as consensus.

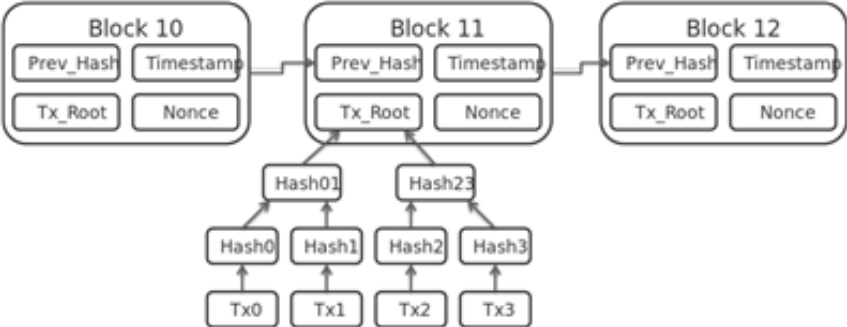


Figure 6: Distributed Ledger Mechanism (Lee & Lee, 2015).

3.5.3.3 Consensus algorithm

The consensus algorithm is the heartbeat of blockchain. It is a distributed algorithm that is run by a subset of nodes, traditionally called miners. It ensures that all the network nodes have the same immutable version of the blockchain ledger. This is fundamentally different from all other previous algorithms of achieving integrity, which relied on some form of centralization and trust in third parties. In fact, the way consensus algorithms bootstrap trust in the ledger without needing any trusted third parties is considered to be blockchain’s core innovation.

There are currently a number of proposed consensus algorithms, where each optimizes a certain metric (latency, power consumption, scalability). Such examples are:

- Proof of Work,
- Proof of Stake,
- Proof of elapsed time.

3.5.4 Blockchain for business

Blockchain first application was cryptocurrency, where it was not only desirable, but mandatory to have the network open to everyone to join, send and receive transactions. Such blockchain networks are referred to as public blockchain.

However, now that blockchain is being increasingly used within businesses environments, new privacy and access control requirements have emerged.

The below figure outlines the main 4 four components of blockchain networks. Having already discussed the shared ledgers, we will focus subsequently on analyzing smart contracts as well as the new trust and privacy requirements business blockchain.

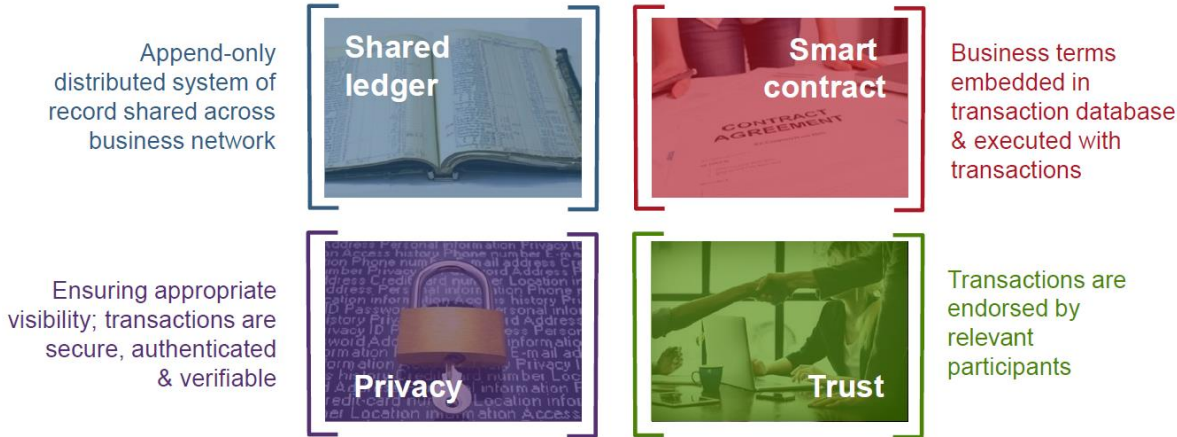


Figure 7: Blockchain for Business (IBM, 2017)

3.5.4.1 Trust and Security and the 4 P’s

Open blockchain platforms such the ones on which bitcoin runs have a number of characteristics which prevents them from being adopted as they are into enterprise business projects, for the following reasons:

Platform Membership:

- Mass adoption was an important feature for early open blockchain platforms. Thus there are no restrictions on who should join the network. Furthermore, as many of the early public cryptocurrencies wanted to mimic cash properties, identities of the nodes were anonymous.
- For most business use cases, access to the blockchain should be granted based on strict access control policies, which should validate the identity of the requesting node, and verify that it belongs indeed to the business network.

Transaction Reading Rights

In an open blockchain, any member node has the right to read and validate all transactions. However, some business uses cases might require that only a node within department A should be able to read and verify transactions belonging to department B.

Transaction Writing Rights

Writing transactions to the blockchain is a fundamental step in all open blockchain. In fact, while any node can write into the blockchain, it needs to become a miner to do so. What this means is that the node would be required to spend some of its computational power on solving a mathematically hard puzzle, before being able to construct the blocks which can be accepted by the rest of network as valid.

The economics of this process are very subtle, and it leads to a highly self-regulating network: If fact, if a dishonest miner tries to cheat the system, there is a high probability that the rest of the network will not use his bogus transactions, because by doing so, they lose economic rewards. As long as the network maintains an honest majority, then integrity of the ledger is preserved. While the mechanism is very robust, it is also very expensive in terms of the computation power it requires (Gupta, 2017).

Nevertheless, the economics of most business blockchain can be very different. Since the nodes can have known identifies, they can assume a higher trust in one another. Hence, nodes within a business blockchain can choose to not rely on expensive consensus algorithms, such as proofs of work. They can instead use policies which explicitly only allow a subset of trusted nodes write into the ledger. This significantly reduces the cost of running and maintaining the business blockchain integrity.

3.5.4.2 Business Blockchain classification

The characteristics which differentiate open blockchain from business blockchain have given rise to a matrix of possible blockchain configuration. They are formally defined in the below table:

Platform membership	Reading Access and Creation of Transactions	
	Everyone	Restricted
Everyone	Public & Permissionless (e.g., Bitcoing, Ethereum)	Private & Permissionless No market application
Restricted	Public & Permissioned (e.g.: Ripple, IBM Hyperledger)	Private & Permissioned (e.g.: Chain, Bankchain)

Table 5: Business Blockchain Classification

3.5.4.3 Smart Contracts

Points of friction and bottlenecks arise in business networks when an action is dependent on a set of prior conditions to be met before it can be executed. For instance, when a plane gets delayed, customers don't automatically get their compensation. They have to first process the claim, provide their plane ticket and bank account details, then wait for a considerable amount of time before they receive payment. What if we could automate this process and trigger a payment to the customers as soon as a 4-hour plane delay is verified, without having to rely on any third party to process and verify the policy conditions? (Benton & Radziwill, 2017)

Smart contracts solve these problems by encoding the terms of traditional contracts in a computer readable language and running them on a blockchain. As the conditions encoded in the contract are met, the contract can self-execute and run its corresponding output script (Gupta, 2017).

Smart contracts are trusted to execute properly for the same reasons that ledger is trusted to maintain immutable transactions, which are enforced by the distributed consensus algorithm of blockchain.

3.6 Evaluation frameworks

Disruptive radical technologies are always accompanied with an initial hype. Blockchain is no exception to this rule (Steinert & Leifer, 2010). In fact, as Blockchain is a highly nuanced technology innovation, the risk of taking on the wrong project can be high. Hence, the aim is

to have a systematic evaluation framework which can map blockchain properties to business requirements.

Most of the literature reviewed focuses on unidimensional evaluation frameworks, mostly centered on the technical drivers. We can also find a smaller number of frameworks which take into consideration the strategic and economic aspect of the technology.

3.6.1 Technology-driven frameworks

In this section, we introduce an applicability framework where the authors present a critical technical analysis of whether blockchain is indeed the appropriate technical solution for a business case. They present their findings as a hierarchical decision tree. This framework is the first structured methodology which can be used to decide which blockchain type is the most appropriate depending on the application scenario (public, private, permissioned, permission less) (Wüst & Gervais, 2017).

This evaluation framework focuses on trust as the main driver. It uses a sequential decision-making process in order to progressively eliminate business use cases whose trust requirements don't require the use of blockchain, as they can perfectly be solved using centralized databases. For instance, if you are the only one writing to update the data, then blockchain is definitely an overkill solution to ensure the integrity of your data. Examples of questions which are considered in this framework are:

- Are there multiple writers?
- Are all writers known?

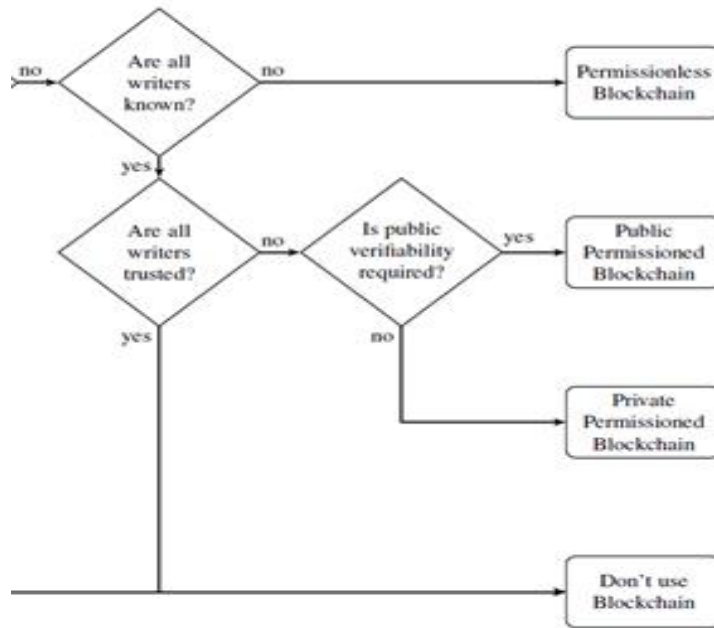


Figure 8: Overview of a Blockchain Applicability Framework (Wüst & Gervais, 2017)

This framework is of particular relevance to this study, because it uses applications from finance and supply chain to test its validity, and then reports its findings for both. The authors argue that the framework has yielded more non-conclusive results when applied to supply chain use case. They also explain that of the inherent disconnect between the physical flow of products and their digital flow, abstracts away many trust assumptions which are difficult to model. This is unlike blockchain projects within the financial sector, where all the assets are digital.

3.6.2 Business-driven frameworks

In order to complement the first evaluation framework and overcome its limitations, the literature was surveyed with the aim of finding a less technology-driven framework, which can be applied to industries with a physical/digital flow gap.

In fact, the framework developed by Jansen (2017) is an excellent candidate. On the one hand, the it applicability evaluation is led by a discussion of the business drivers. A technical discussion of the blockchain components which can map the business requirements on the use case then follows. On the other hand, this framework focuses specifically on improving traceability of supply chain, which explicitly accounts for the physical/digital flow gap (Jansson, 2017).

This framework is not structured as a decision tree, but rather as a discussion canvas.



	1. IDENTIFY	2. CREATE	3. EVALUATE
STRATEGIC	<p>DRIVERS FOR TRACEABILITY</p> <p>Identify why traceability should be improved. The driver could be one of the following:</p> <ul style="list-style-type: none"> Better SCM Quality Assurance Efficient Recalls Standards & Regulations CSR 	<p>PROPERTIES OF BCT</p> <p>Discuss if the properties of blockchain seem relevant for the business objectives:</p> <ol style="list-style-type: none"> Distributed DB Peer-to-Peer Pseudonymous Irreversible Programmable <p>SET UP THE SCOPE</p> <p>Set the scope, by briefly discussing the evaluation tools in step three</p>	<p>SUITABILITY</p> <p>Evaluate suitability based on data evidential- and retention requirements</p>  <p>APPLICABILITY</p> <p>Evaluate applicability based on degree of novelty and complexity</p> 
TECHNICAL	<p>AREAS OF IMPROVEMENT</p> <p>Identify what capabilities are needed to satisfy the driver:</p> <ol style="list-style-type: none"> Identifying Capturing Linking Sharing 	<p>TECHNICAL SPECIFICATION</p> <p>Draft a blockchain application addressing an area of improvement, considering:</p> <ul style="list-style-type: none"> Readers and writers Validators Consensus mechanism Owner and maintainer of code 	<p>FULFILMENT</p> <p>Evaluate fulfilment of blockchain properties, areas of improvement, and satisfaction of the driver for traceability</p> <p>TECHNICAL LIMITATIONS</p> <p>Evaluate the drafted application on:</p> <ul style="list-style-type: none"> Throughput Latency Security Size and Bandwidth Wasted Resources Usability

Figure 9: Overview of a Business-Driven Blockchain Framework (Jansson, 2017)

4 BLOCKCHAIN APPLICABILITY EVALUATION FRAMEWORK

The aim of this chapter is to provide the foundation and necessary tools for carrying out applied blockchain research. This is mainly achieved by developing an evaluation framework which can be used to assess the applicability of blockchain to manufacturing business use cases.

4.1 Innovation classification

In light of the literature review presented in section 3.1 about classifying technology innovation, we find that blockchain is both a radical and a disruptive innovation.

On the one hand, Blockchain is a radical innovation since it introduces a fundamentally new technology change. In fact, blockchain tackles an old age computer science question, which is about establishing secure communication over untrusted channels in a pure P2P distributed manner. There exists even an impossibility theorem which formally proves why such a solution does not have a problem. Blockchain is radical because it brought a complete new twist to the problem. While recognizing that, indeed, the theorem is correct, blockchain modified the problem constraints; and introduced unconventional elements from game theory and economics into the solution. What we have at our hands today, is a technology innovation which surely is robust enough to work in practice, but that academics are still having a hard time formalizing.

On the other hand, by virtue of being a peer-2-peer distributed solution, blockchain allows untrusting entities to securely communicate with one another without the need for a trusted third party (TTP). This ability to disintermediate TTPs is why blockchain is a true disruption. A lot of business models and industries exist today in order to fulfill the role of a TTP when consumers are sending transactions to businesses; in exchange for a fee. When we make an international bank transaction, the bank mediates this exchange and charges a fee in exchange for its services. Besides having to incur such an extra cost, consumers also have to deal with a number of inefficiencies in the whole system. Blockchain allows us to bypass all of these points of friction, and execute our transaction securely, as trust and integrity are intrinsically built in this distributed system.

4.1.1 Initial framework dimensions

From this classification exercise, one can conclude that any framework aiming to evaluate blockchain applicability, should at least capture the 2 dimensions of market drivers and technology drivers.

4.2 Evaluation framework

As a radically disruptive innovation, blockchain can be overwhelming to comprehend even to the experienced ones. However, the promise it holds to disrupt and reshape many industries, created a state of continuous hype and misunderstandings around it. This is especially true for industries which are just starting to embrace blockchain, such as the manufacturing industry. In fact, while the technology is definitely promising, it certainly cannot solve all of the industry's problems as it is hyped-up to be.

Hence, this study develops an evaluation framework which can help manufacturing firms assess whether blockchain is the right solution to their business problem. The framework can achieve the following two goals:

1. Minimize the risk of manufacturing companies taking on a pointless blockchain project.
2. Accelerate the adoption of useful blockchain projects.

4.2.1 Design approach and framework quality

In order to ensure the quality and accuracy of the evaluation framework, an iterative process was used during in which new input was collected at every step. The framework was then updated accordingly:

1. I review the literature review for existing blockchain evaluation frameworks. Combined with my understanding of blockchain and manufacturing value chains, as well as initial dimensions identified above, I produced an initial framework draft 1.0
2. I conduct interviews with a blockchain expert and an IoT expert, then updated the framework as per their feedback.
3. I forward the framework to the blockchain expert in order to confirm that all the feedback has been captured properly.
4. A final version of the framework is produced.

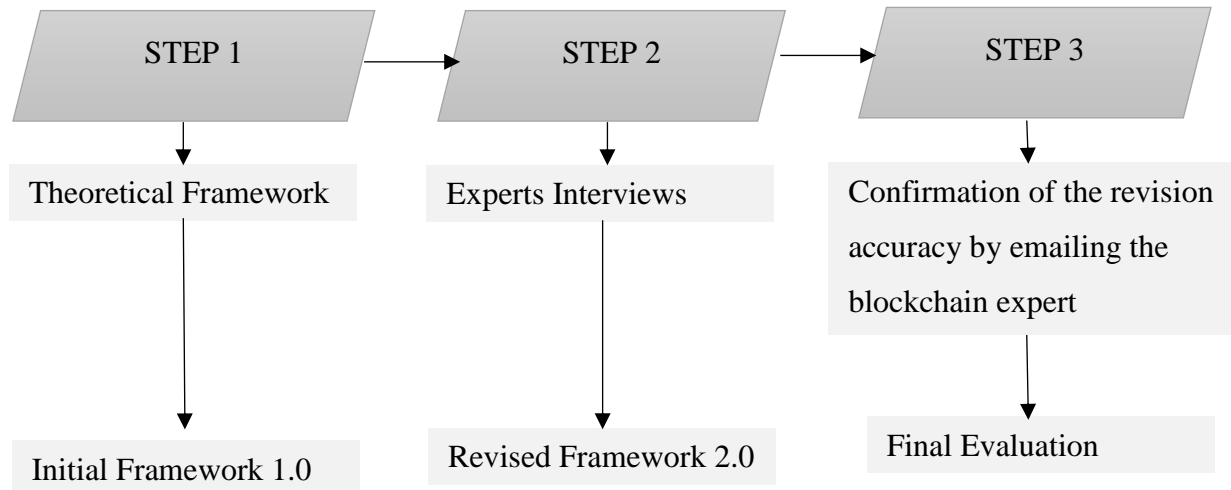


Figure 10: Design approach

4.2.2 Form theoretical background into evaluation framework 1.0

Through the study of the available blockchain evaluation frameworks, an overview of the shortcomings and strengths that are commonly encountered was developed. It is summarized below:

Strengths:

- Multi-dimensional: good balance between business and technology drivers.
- Organized as active questions within a decision tree format
- Focused on a specific industry and capture its specificities
- Nuanced outcome of the framework results.
- The framework's results motivate further discussion.

Weaknesses

- Unidimensional: overwhelmingly technology focused.
- Organized as descriptive statements with an explicit drive for decision making
- Does not have an industry focus and are too generic
- Binary results from the framework (applicable, not applicable)
- The framework's results are an end to a goal.

Guided by the above strengths/weaknesses analysis, as well as my understanding of blockchain and manufacturing, the following evaluation framework was built as an initial draft:

Dimension	Question
Business	Are you part of a manufacturing value chain?
	Can you Identify if any aspect of your value chain needs to be improved and why? <ul style="list-style-type: none"> • SCM. • Marketing. • Efficient recalls. • Marketing. • Social responsibility. • PR and transparency. • Cash flow.
Technical	Do you need to store data persistently?
	Do you have data which needs to be updated by different writers?
	Is it feasible to use an always-on trusted third party to manage your shared data?
	Do you require high performance?
	Can you express your business rules as transactions?

Table 6: Initial Evaluation Framework

4.2.3 Expert interviews

As detailed in the methodology section, this round of interviews was conducted with the following participants: specific business needs

Title	Industry	Place	Length
IoT consultant	Internet of Things	Skype	30 min
Fitrayti CEO	Blockchain	Face To face, The Simula Gründergarasjen, Oslo	90 min

Table 7: Interviewees in Phase 1

While the exact interview guide for this step is available in appendix 1, this section will focus on explaining the rationale behind the questions' choice.

In fact, all the interview questions are related to its objectives. They are as follows:

- **Clarity:** ensure that the framework questions are easily understood. Hence, direct questions about this property were asked in the interviews.
- **Completeness:** investigate if there are any dimensions other than strategic and technical that the framework should include.
- **Effectiveness:** What is the certainty that should be attributed to the outcome of this framework?
- **Applicability:** Does this framework capture the specificities of manufacturing value chains problems?
- **Technical soundness:** Are there any technical aspects that should be considered to mitigate the risk of falling into a pointless blockchain project?

4.2.3.1 Results and Analysis

4.2.3.1.1 Generalities

Both experts expressed a positive opinion towards developing such a blockchain applicability framework, as they also agreed that the current blockchain ecosystem is over hyped. The blockchain expert also thought that it is a good idea to develop frameworks which are targeted toward industries other than finance. She thought that there is a lack of understanding of blockchain in industries where there is a physical flow of produced which mirrors the digital one captured by blockchain.

The IoT expert expressed concern over who can be the target audience of such a framework. He suggested that the framework should be used by a team composed of a technical and a business person.

Furthermore, both experts expressed that the outcome of such a framework should not be binary. It should rather provide more confidence in either decision (applicable or not applicable), and that further discussions are necessary

Finally, the IoT expert suggested adding a third column where sample answers for an applicable blockchain use case could be inserted.

4.2.3.1.2 Governance as a missing dimension

The blockchain expert suggested adding a third dimension to the framework. According to her, data management is a central part of blockchain solutions. However, this area is increasingly regulated, especially within the EU region, with the advent of GDPR. Hence, she suggested adding questions in the line of:

- Do you have to rely on a trusted party for compliance purposes?
- Are there any restrictions concerning the jurisdiction and geographical areas in which customers' data can be stored?

Furthermore, she also expressed concern over the fact that blockchain is still a very new technology in some markets, and that official entities might choose to have regulations against using it to process some type of data.

4.2.3.1.3 Strategic Business

The IoT expert expressed that this section should be carried out as a discussion and not binary decision-making process. The blockchain expert suggested moving the strategic dimension to the bottom of the list. This is not because the strategic dimension is unimportant. However, she does not want to take the risk of an executive pushing his/her desire to roll out a blockchain project to influence and pressure the technical people into agreeing.

Furthermore, the IoT expert wanted to explain the value chain drivers in more details, as he had trouble understanding what is meant by just supply chain management for instance.

4.2.3.1.4 Technical

Both interviewees appreciated the explicit focus of the framework on mitigating pointless blockchain projects. Furthermore, the blockchain expert suggested that there is still some room for improvement. She argued that while it is a good first step to inquire about whether a centralized database is enough to solve the business problem, we should not forget that traditional distributed databases should can also be a viable solution to consider, before moving into blockchain. Hence, an additional question line of the following is desirable:

- Are the writers trusted?

4.2.4 Final evaluation framework

Taking into consideration the above feedback, the evaluation framework was revised. The following is a summary of the changes we made:

- Added a governance dimension and researched the EU data governance issues, so as accurate questions could be formulated?
- Reordered the framework dimensions, so it starts with the technical evaluation, followed by governance, and finally business strategy.
- Added technical questions which assess the feasibility of distributed databases.
- Improved the wording and clarity of questions.

After having incorporated these changes into the framework, I shared a copy of it by email with the blockchain expert. As she was globally satisfied with this new version, and only commented on wording, I have opted to introduce below the final applicability evaluation framework.

Dimensions	Questions
Technical	1.Do you need to store data persistently?
	2.Do you have data which needs to be updated by different writers?
	3.Do you trust the writers?
	4.Do other members of the value chain keep separate duplicate copies of the same data?
	5.Is there a dependence/interaction between the transactions you need to record?
	6.Do you need low deployment cost?
Governance / Legal	7.Do you have to rely on a trusted party for compliance purposes?
	8.Are there any restriction concerning the jurisdiction and geographical areas in which your data and your customers data can be stored?
	9.Do you need to modify past data and keep no trace of such modifications?

	10. Are there any laws which are hostile to blockchain based application, either in your country, or in the country of business of any of you value chain partners?
Business	11. Are you part of a manufacturing value chain?
	12. Have you developed a mapping of your physical products into digital ones?
	13 Can you Identify if any aspect of your value chain needs to be improved and why? <ul style="list-style-type: none"> • Decrease the lead time. • Track product as it moves from manufacturer to customers. • Decrease supply cost. • Track provenance of supply materials. • Improve understanding of market and customers. • Implement a better customer service. • Social responsibility. • PR and transparency. • Cash flow.

Table 8: Evaluation Framework

4.2.5 Results interpretations

The results to some questions of the framework can be interpreted differently to one another.

- If you answer yes to any governance/legal question (Q7-Q10), then the framework recommends putting this project on hold temporarily until the regulations enable to deploy your project.
- If you could not identify any business strategic drivers for that business use case, then the framework recommends rethinking your motivations for the project. Only move ahead with its implementation if you can find a valid business driver for it.
- If you answer no to question 1, then you don't need any data management solution at all.
- You don't need blockchain if you answer no to any question from Q2 to Q5:
 - Consider using a centralized database if you answer yes to Q2.
 - Consider using a distributed database if you answer yes to Q3.
 - If you answer no to Q3, then you have a strong case for blockchain.

- If you further answer yes to Q4 and Q5, then you should have more that blockchain is the right solution from a technical perspective.
- If you answer yes to question 6 and you do need low deployment costs, then you carefully plan for the financial implications of taking on a blockchain project. In fact, the technology currently requires higher deployment and maintenance cost, give the relatively short time it has been in the market.

4.2.6 Guidelines for using the framework

In order to take full benefit of this evaluation framework, following guidelines are suggested:

- This framework is best used by a team of at least two people, who possess complimentary technical and business skills.
- Approach the strategic dimension of this framework as an invitation for discussion.
- The results to the questions should not always be a clear yes or not. Feel free to explain any nuanced position you have.

5 EKORNES VALUE CHAIN EXPLORATION AND ITS BLOCKCHAIN USE

The aim of this chapter is to identify Ekornes business use cases which can be solved using blockchain. The focus is on use cases which improve the company's value chain, and help it achieve better integration between its supply and demand processes.

5.1 Chapter organization

The main purpose of this chapter is to answer the second research question: *RQ1. What are the main blockchain business use case solutions one can identify within Ekornes value chain?*

The chapter's organization also mirrors the progress of the sub-research questions; hence the chapter flow can be described as follows:

- Report the findings of the interviews in a way which describes the Ekornes value chain
- Analyze the Ekornes value chain, identify its potential growth areas, and formulate business use cases based on that.
- For each identified business use case:
 - Assess whether blockchain is a suitable solution. The evaluation framework developed as part of this study is used to guide our assessment.
 - Discuss the design of an appropriate blockchain-based solution to the business said use case, by focusing on the blockchain components which are relevant to it.

5.2 Interview and participant observation findings

Most of the findings reported in this chapter came directly from the interviews conducted as per the interview guide two. These interviews were conducted with representatives of all relevant Ekornes departments (supply chain, marketing, finance, manufacturing, IT, digitalization), as well representatives from DSV, the transport service provides Ekornes works (Full list of interviewees in the methodology section). The findings are also supplemented by observations collected from informal meetings, and direct observations.

5.2.1 Manufacturing

As described by the manufacturing manager and witnessed by myself during one of the site visits, the Ekornes manufacturing factories are highly efficient and automated facilities where a sofa can be produced in 8 hours. As a matter of fact, in 2012 Ekornes became Norway's most highly automated company. With the installation of industrial robot no. 100, it had 10 per cent of all the industrial robots in existence in Norway.

However, every single interviewee pointed out that the time it takes between a customer placing an order and receiving it is 8 weeks on average and can take up to 12 weeks sometimes.

The manufacturing manager further explained that Ekornes products are highly customizable as they depend on the specific customer preferences of dimensions, material, color and shape. Hence, the main manufacturing strategy used is make-to-order (MTO), where Ekornes waits for a sure order with clear specifications to arrive from the retailers, before triggering the manufacturing process.

The supply chain Director explained that while the MTO strategy greatly helps in saving warehousing costs, it also dramatically increases the lead-time. At the same time, they have observed that some product specifications are more popular than others are. Therefore, Ekornes started few years back relying on pre-manufacturing a subset of products before customers place their orders, which can be either fully-assembled or semi-assembled form. These products are then stored at warehouses within the Ekornes manufacturing facilities, or at regional warehousing hubs, where they can be closer to retailers and thus to customers (e.g.: the Hamburg regional warehouse). It was however noted that such a strategy causes the company significant losses when they first started implementing it. Due to a clear market understanding, Ekornes ended up with manufactured products which never got picked up by customers.

Furthermore, Ekornes works on optimizing their mix of manufacturing strategy, by updating their prediction models as often as possible.

5.2.2 Ekornes end user relationship

The supply chain director as well as the marketing lead agreed that one of Ekornes priorities today is its relationship with consumers, or the lack of it thereafter. Ekornes has adopted since its early days a B2B strategy, where they essentially only maintain a direct relationship to retailers, who subsequently own all end users' interaction through their points of sale. Indeed, Ekornes relationship to its consumers is completely disintermediated.

Furthermore, the customer service and planning manager pointed out that retailers today don't share any information about consumers with Ekornes. They simply forward the product specification and wait for its delivery, so as they can then deliver it at their turn to the end users.

5.2.3 Shipping and transportation

The supply chain director expressed that the proper management of the transportation process is crucial to Ekornes value chain. He believes that the dominance of MTO manufacturing strategy, combined with a lack of market visibility and understanding have complicated shipment planning.

As also described by the manufacturing manager, as orders arrive at Ekornes manufacturing facilities, the following activities should be carried out:

- Estimate the time it would need to manufacture the product, which sometimes depends on the delivery of raw materials.
- Decide on the volume and time of the needed delivery.
- Communicate the transportation need to partner shipping companies
- Negotiate the shipping details with the shipping partners
- Deliver the order to the regional warehouse hubs if available at the retailer geographical regions.
 - Coordinate the delivery/pick up with the retailer.
- Alternatively, deliver the order directly to the retailer warehouse.

We also interviewed representatives from DSV, one of the transport service providers Ekornes works with. They reported that they continuously raise inefficient coordination issues with Ekornes, as they have little visibility about their ordering process. This leads to either delayed shipping of increased costs. DSV expressed great interest in developing better coordination processes moving forward,

5.2.4 Marketing

As a matter of fact, the story of Ekornes relationship with consumers was further emphasized by other marketing employees. They explained how delegating customer relationship management completely to retailers for many years has created an information asymmetry between what Ekornes knows about consumers and what retailers know. Indeed, the interviewee today have a better understanding of the market needs, customer segments, and

customer expectations than Ekornes. They also understand the value and competitive advantage of such information, and they are thus very reluctant to share it today.

According to the interviewee, this situation was acceptable when retailers were generating enough sales and revenues. However, the Ekornes situation is dramatically different today. At the time of conducting this thesis, Ekornes was still going through a decade-long pattern of decreasing sales and revenue margins, as the market share was being lost to other global competitors, especially with the advent of the digital economy age.

The marketing and customer service and planning managers explained that all marketing efforts in the past have been focused around communicating with retailers and PR. Today, Ekornes wants to take back ownership of their market, and start exploring other sales channels, especially digital ones.

The marketing and supply directors agreed that Ekornes has a lot to catch up on in this area, and that this topic is a sensitive one to retailers. In fact, some of them interpret any attempt by Ekornes to explore other B2C sales channels as a direct competition and threat to their existence. The marketing teams expressed that retailers are a very important part to the Ekornes ecosystem and that the goal is not to displace them by to find more lucrative way to work alongside them.

The marketing director has also talked about their first B2C project which was launched in 2017, Indeed, Ekornes now has started offering their products for sales through websites such as Ali Baba. At the moment of writing this thesis, this initiative has not been particularly successful in generating revenues nor in helping Ekornes achieve a better consumer market understanding and visibility.

5.2.5 IT and digitalization

The IT director explained that Ekornes has been using enterprise grade software to manage its processes since its inception. In fact, Ekornes relies heavily on ERP software to manage its supply chain lifecycle, and on CRM to assist with marketing and demand generation processes.

However, our interview has pointed out that Ekornes coordination processes with their extended value chain partners is very inefficient. In fact, he reported that many Ekornes retailers still use pan and paper to record and process customer orders, while the rest use centralized IT infrastructures which stop at the borders of their organizations. This has made it very difficult to automate the process of getting this information in time and sharing it with the rest of

stakeholders, namely shipping companies. He also explained the important role of ERP software to his department, and that he doesn't want it to become redundant through some other digitalization solution I might proposed as part of this study. He emphasized indeed that he is very satisfied with the level of mastery they have reached in properly managing the ERP system, as well as the different data sources it uses.

The interview with the digitalization director gave us a lot of insight into the role of digitalization in product development. In fact, the director reported that while manufacturing processes are indeed highly developed, their product development has not been driven by digitalization. Unlike other competing furniture manufacturers, Ekornes sofas for instance are lagging behind in terms of sensor technology. This is a topic that the director is particularly keen on as she believes it can drive the competitiveness of the products.

Finally, the director discussed how they want to improve the digital flow of their products to closely match its physical flow. Today, Ekornes does not have a way to digitally identify and track its sofas. The director thinks this should be his priority over the next period.

5.2.6 Raw material sourcing

Ekornes maintains several long-term business relationships with its suppliers, as having real time cost efficient raw material delivery is crucial to a healthy value chain. Given the MTO strategy, the suppliers can sometimes be a bottleneck point. However, the supply chain director believes that their relationship with suppliers is at a much better place than their relationship with retailers

Furthermore, Ekornes also has processes in place which allows it to resell some raw materials it doesn't use to other local and regional manufacturers.

5.2.7 Customer service and product design

The customer support manager raised the issue of furniture damage as it is a major point of friction between Ekornes, retailers and shippers. In fact, it is very difficult to determine who is responsible for which damage, and the manager expressed great enthusiasm about possible solutions.

Furthermore, the interviewee discussed that while Ekornes does provide after sales services such as damage repair to its customers, especially ones with premium insurance policies, it is

usually up to the retailers to interact with customers about such issues and assess the situation first before Ekornes has the chance to learn more about the issues.

5.2.8 Finance

The finance director expressed that the cash balances is not always very healthy, because of recurrent delayed payments from retailers, and their desire to honor their financial obligations to their suppliers on time. He explained that this situation makes it more difficult to plan for investments.

5.2.9 Perceived points of frictions and growth opportunities

- All the interviewed expressed interest in achieving the following:
 - More visibility over the end user
 - Better visibility over product journey
 - Reduce the lead time
 - It is one of the factors that affect the lead time. Currently the average lead time of transportation at Ekornes is around 9 weeks. According to a report that was made by Fira, the UK's largest furniture association, 86% of the furniture firms around the world were able to achieve less than 8 weeks lead time.
- Better understanding of the market
- reduce the manual entry errors that can happen when the order is transferred from the retailer to Ekornes
- Ekornes is always looking for new ways to deliver high quality products, knowing that customer preferences and behavior differ depending on the markets it is targeting and can change within time.

5.3 High level analysis

The interviews result clearly point out that of Ekornes has a largely supply driven perspective on its value chain. While this view might have been good enough in the early days of Ekornes, where the market was not globalized and managing end user relationship through retailers was enough, it clearly is no more the case today.

Furthermore, we can also conclude that Ekornes demand processes are severely under-developed. While this should be concerning to any manufacturing company, it should be

particularly alarming to Ekornes who are producing luxury/premium products, where brand recognition and customer service should be core to their business model.

In fact, Ekornes are struggling the typical problems that the lack of a proper demand chain strategy creates. For instance, most high-end furniture manufacturers have gone a long way in integrating sensors into their products and turning them into smart furniture. However, the lack of Ekornes visibility over its end customers, cause them to miss his differentiation opportunity. Ekornes have indeed tried to change the design and UI of their products more than once, but no tangible results. If you don't know your customers well enough, it is difficult indeed to capture their needs.

Our recommendation for Ekornes is to focus on finding ways to move from a pure B2B business and to diversify their sales channels to include B2B2C and/or B2C.

5.3.1 Supply-demand chains

Ekornes teams had all expressed awareness about the urgent need to improve the demand chain. However, the supply chain director is the one who expressed any understanding or initiative to integrate the supply and demand processes and coordinate them synchronously. Furthermore, the organizational structures in which the marketing team don't collaborate closely with supply chain management have made it so that no real steps have been taken to create synergies between the two teams. Hence, we strongly advocate for prioritizing digital solutions, which approach the value chain problem holistically. Furthermore, this point of view has to be clearly expressed in the business strategy.

Hence, we will focus for the rest of this chapter on identifying specific business use cases which help:

- Identify customer needs and what value they are looking for.
- Add value to customers through managing efficient supply processes
- Understand how supply and demand processes influence each other and draft solutions for how coordinate their activities across the full value chain.

With the above guidelines in mind, we identify in the next the mos.

For each of the potential business challenges, the following linear process is applied:

- Description of the business problem

- Analyzing the applicability of blockchain to the problem using the developed framework in phase 2.
 - If blockchain is not applicable, then discard the use case.
 - If blockchain is applicable, then describe the appropriate blockchain

5.4 Granular analysis

5.4.1 End-2-end visibility

5.4.1.1 Problem statement

As Ekornes products flow from suppliers to end users, so is its corresponding digital information. Several studies have shown that the flow of digital information is as important to the value chain as the flow of the physical goods, since different stakeholders rely on the accuracy and timeliness of such information to efficiently coordinate their tasks (e.g., preparing containers, manufacturing the product)

However, the findings revealed that many Ekornes retailers still rely on pen and paper to transfer such information, and on email/phone calls to resolve mismatches. Furthermore, Ekornes and the rest of the tech-savvy value chain members, rely on centralized isolated information systems, which only have value within the organization's walls. This huge exasperates the problem of long lead times. In addition, the lack of a mature digital flow process reinforces the information asymmetry between Ekornes and its retailers.

In essence, the end-2-end visibility use case means that we need a mechanism to identify, and track Ekornes products flow digitally as it moves from one value chain member to the other, in a way which maximizes its visibility across the whole value chain.

5.4.1.2 Analysis using the framework

In order to assess whether blockchain can be an appropriate solution for this use case, the evaluation framework developed as part of this study was used. For the sake of space, only, not all the questions are shown (e.g.: the governance questions have been abstracted away, as all its answers in this case are no).

Dimensions	Questions	
1. Technical	1. Do you need to store data persistently?	Yes: Digital product ID and state.
	2. Do you have data which needs to be updated by different writers?	Yes, as the product moves along the chain, different writers own the information.
	3. Do you trust the writers?	Any data coming from an outside source is untrustworthy.
	4. Do other members of the value chain keep separate duplicate copies of the same data?	Yes
	5. Is there a dependence/interaction between the transactions you need to record?	Yes
	6. Do you need low deployment cost?	Yes/No
2. Governance / Legal	No, for all questions in this section.	
	11. Are you part of a manufacturing value chain?	Yes
	12. Have you developed a mapping of your physical products into digital ones?	Yes, with limited visibility to my company

3. Business	<p>13 Can you Identify if any aspect of your value chain needs to be improved and why?</p> <ul style="list-style-type: none"> • Decrease the lead time. • Track product as it moves from manufacturer to customers. • Decrease supply cost. • Track provenance of supply materials. • Improve understanding of market and customers. • Implement a better customer service. • Social responsibility. • PR and transparency. • Cash flow. 	<p>Track product as it moves from manufacturer to customers.</p> <p>Decrease the lead time.</p>
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Table 9: Evaluation framework end-2-end visibility

5.4.1.3Blockchain use case solution

In order to solve the digital information flow problem, one can leverage the immutability and distributed features of blockchain.

In practice, Ekornes, suppliers, transport service providers, and retailers alike will be able to share a common blockchain ledger, in which they record in real time all the information they own about the product. Blockchain offers the following:

- Its immutability features will guarantee all stakeholders that the information they record is not going to be altered by any other entity.
- The distributed peer-2-peer feature of blockchain allows all entities to get real time access to all state changes of a specific product.

Such an implementation is very powerful, as it can dramatically improve the lead time of Ekornes product. For instance, as soon as a retailer receives an order from the customer, the later will record it on the blockchain. The distributed network will propagate this information to the rest of the value chain members. Ekornes can thus start its manufacturing process promptly, and flag it on the blockchain ledger. Transport service providers can also start planning their containers for shipping ahead of time. As the product is shipped, the retailer can prepare his warehouse and plan the customer delivery accordingly.

Furthermore, retailers taking part in such a solution, would have more incentive to record more details about customers in the blockchain. This can greatly contribute in giving Ekornes visibility over its market.

Other benefits of the solution are a decrease in documentation fraud and errors.

5.4.2 Transportation process

5.4.2.1 Problem description

Ekornes products are transported by air, land or water, where the latter is the most widely used route. In addition, “Ekornes want to achieve 70 percent of the transportation of all its products to be shipped by containers at the sea” said Shipping and logistics coordinator Jenny Sylvi Strøm.

While containers’ sea transportation is important to Ekornes Value chain, one should remember the complexities of such a process. In fact, a research study published by Maersk showed that shipping a single container can result in a stank of nearly 200 communications (Bill of Lading, Manifest, Discharge List, and others). Any unresolved friction points within this process can have an avalanche effect on the rest of the shipment and increase the lead time.

While the first use end-2end visibility use case traces products as they transit from value chain link to another (supplier, manufacturer, shipper, retailer customer), this section argues that it is important to zoom into the shipping process and track the products as it moves through it with much more granularity.

Examples of milestones which can be tracked within the shipment process are loading/unloading of containers, customs clearance, border crossing, and arrival at deck. Today, information about such activities is recorded by transportation companies in an isolated and scattered database and files,

This business use case would ensure the availability and the timeliness of shipping information to the rest of the Ekornes value chain.

5.4.2.2 Analysis using the framework

Dimensions	Questions	
1. Technical	1. Do you need to store data persistently?	Yes: Digital product ID and state.
	2. Do you have data which needs to be updated by different writers?	Yes: the container is handled by different entities.
	3. Do you trust the writers?	Any data coming from an outside source is untrustworthy.
	4. Do other members of the value chain keep separate duplicate copies of the same data?	No, but only because they don't have access to it.
	5. Is there a dependence/interaction between the transactions you need to record?	Yes
	6. Do you need low deployment cost?	Yes/No
2. Governance / Legal	No, for all questions in this section.	
3. Business	11. Are you part of a manufacturing value chain?	Yes
	12. Have you developed a mapping of your physical products into digital ones?	Yes, with limited visibility to my company
	13 Can you Identify if any aspect of your value chain needs to be improved and why? <ul style="list-style-type: none"> • Decrease the lead time. • Track product as it moves from manufacturer to customers. • Decrease supply cost. • Track provenance of supply materials. • Improve understanding of market and customers. 	Decrease the lead time. Decrease document processing

	<ul style="list-style-type: none"> • Implement a better customer service. • Social responsibility. • PR and transparency. • Cash flow. 	
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Table 10: Evaluation framework transportation process

5.4.2.3Blockchain use case solution

In order to provide a better visibility over the process of shipping at the granular level of the container, a blockchain would also build on the immutability of the ledger and then distributed architecture of the platform. By assigning a digital identity to each container, the system can automatically record the timestamp for every step completed.

In practice, as the container is moving through the sea from the port near the manufacturing facilities in Sykkylven to the Hamburg port where the retailer is located, the latter would be able to prepare and sign the necessary documents for the unloading for instance, as well as plan his warehousing capabilities accordingly.

The immutability of blockchain would ensure that everybody in the blockchain trusts that the timestamps recorded have not been altered, while its distributed feature will allow real time availability of this information to all the Ekornes value chain members.

In order to amplify the impact of this use case, this study proposes to leverage the smart contract property of blockchain. As the container is flowing towards to its destination, and millstone events are recorded and stored securely on the ledger, smart contracts can automate the process of signing documents and sharing them. Such a solution can reduce the lead time and reduce document forgery.

5.4.3 Identification of damages

5.4.3.1Problem description

Ekornes products are made out of a number of sensitive materials such as leather and wood. In order to maintain high quality standards of Ekornes products as they are shipped to customers, their transportation and storage conditions have to uphold to some standards. In fact, specific ranges of pressure and humidity are necessary for preserve the quality of the products, and by extension the luxury brand image of Ekornes.

However, there has been a steadily increasing pattern of reported product damages. Hence, we want to find a way to identify where the damage happens for 3 reasons:

- Not delivering faulty products to customers
- Avoiding the same damage happening in the future
- Assigning liabilities to the responsible entity

5.4.3.2 Analysis using the framework

Dimensions	Questions	
1. Technical	1. Do you need to store data persistently?	Yes: data collected by sensors
	2. Do you have data which needs to be updated by different writers?	Yes: sensors.
	3. Do you trust the writers?	No
	4. Do other members of the value chain keep separate duplicate copies of the same data?	Such data is not currently available
	5. Is there a dependence/interaction between the transactions you need to record?	Yes, in order to reconstruct the chain of events
	6. Do you need low deployment cost?	Yes/No
2. Governance / Legal	No, for all questions in this section.	
	11. Are you part of a manufacturing value chain?	Yes
	12. Have you developed a mapping of your physical products into digital ones?	Yes, with limited visibility to my company
	13 Can you Identify if any aspect of your value chain needs to be improved and why? <ul style="list-style-type: none"> • Decrease the lead time. 	Track provenance of supply materials.

3.Business	<ul style="list-style-type: none"> • Track product as it moves from manufacturer to customers. • Decrease supply cost. • Track provenance of supply materials. • Improve understanding of market and customers. • Implement a better customer service. • Social responsibility. • PR and transparency. • Cash flow. 	
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Table 11: Evaluation Framework identification of the damages

5.4.3.3Blockchain use case solution architecture

Deploying this use cases requires that Ekornes embeds smart sensors within its products. As the digitalization director pointed out that this is a priority project for Ekornes, we will assume for the rest of this section that Ekornes products are indeed equipped with such smart sensors

In fact, in the context of IoT blockchain has the potential to shine, as it has the potential to unleash a wealth of data and information to a wide range of entities. Indeed, as Ekornes products are moving through the chain, smart sensors can periodically send their recorded data to the ledger, which will then be propagated to the rest of the network.

It is also worth noting that special care has to be given to the design of this use case. Indeed, IoT devices are low on computing resources, hence traditional full-fledged blockchain nodes are difficult to run on most IoT devices. Luckily, recent technical advances within business blockchain have proposed solutions which mitigate the performance issues.

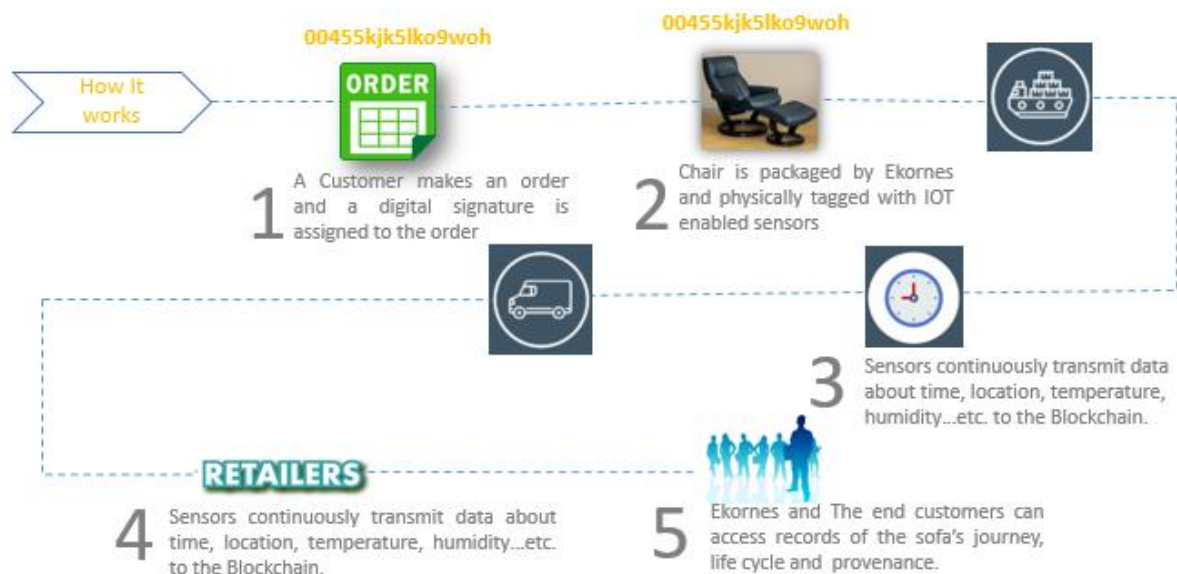


Figure 11: Illustration of how Ekornes can identify the Damage

5.4.4 Ekornes club

5.4.4.1 Problem description

So far in this analysis, we have focused our blockchain platforms accessible by just Ekornes suppliers, Ekornes itself, transport service providers and retailers. These solutions are certainly valuable as they contribute in decreasing the lead-time, and providing more visibility over customers' data, however, what we want to achieve true direct link between Ekornes and its customers through Ekornes Club. Hence, Ekornes club needs to offer customers services which they find valuable and which they don't have to go through retailers to have access to. Examples of such services are:

Market place trade

Ekornes products are expensive high-end furniture, which are supposed to last long and many people and enterprises which purchase them would consider them investments. Hence, it is a commodity that consumers might be interested in reselling. As part of this process, the new owner would want to transfer the insurance policy of the product to the new owner. This is a classical ownership transfer problem, which has become a common use case for blockchain across many industries.

This use case is particularly interesting for Ekornes demand chain and marketing efforts. Indeed, consumers who want to benefit from such a service, would need to register in the

application and provide information about their profile. As Ekornes acquires more knowledge about its market, the information asymmetry that it has with retailers will return to balance.

Ekornes club should be designed as a dynamic market place where Ekornes communicates value to its consumer without any sort of disintermediation. Hence, other services it can offer are:

- loyalty programs
- Product Provenance tracking to ensure the products’ materials are sourced ethically.

5.4.4.2 Analysis using the framework

Dimensions	Questions	
1. Technical	1. Do you need to store data persistently?	Yes: customers IDs
	2. Do you have data which needs to be updated by different writers?	Yes: different product owners transferring ownership
	3. Do you trust the writers?	Any data coming from an outside source is untrustworthy.
	4. Do other members of the value chain keep separate duplicate copies of the same data?	Yes
	5. Is there a dependence/interaction between the transactions you need to record?	Yes: change of ownership is a sequential process.
	6. Do you need low deployment cost?	Yes/No
2. Governance / Legal	No, for all questions in this section.	
	11. Are you part of a manufacturing value chain?	Yes
	12. Have you developed a mapping of your physical products into digital ones?	Yes, with limited visibility to my company

<p>3.Business</p>	<p>13 Can you Identify if any aspect of your value chain needs to be improved and why?</p> <ul style="list-style-type: none"> • Decrease the lead time. • Track product as it moves from manufacturer to customers. • Decrease supply cost. • Track provenance of supply materials. • Improve understanding of market and customers. • Implement a better customer service. • Social responsibility. • PR and transparency. • Cash flow. 	<p>Improve understanding of market and customers.</p> <p>Implement a better customer service.</p> <p>PR and transparency.</p>
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Table 12: Evaluation Framework Ekornes club

5.4.4.3Blockchain use case solution

Implementing the Ekornes club requires finding a mechanism that would allow Ekornes to associate a specific piece of furniture to a specific user when they buy it, and then capture from then on, all changes of ownership of that product. The solution should also ideally offer an automated way for the seller to transfer his insurance policy to the new owner.

Blockchain is an excellent solution to this problem, thanks to its 2 following features:

- Shared immutable ledger: one of the first proposed uses of blockchain were identity tracking. This is mainly because of the immutable nature of blockchain transactions, as well the different ways in which identity can be defined to satisfy any application’s anonymity requirements.
- Smart contracts: the process of transferring insurance policies from the old owner to the new one can be efficiently encoded as a smart contract, which can be subsequently executed as soon as the ledger shows an ownership transfer of the sofa to the new owner.

The potential of this solution can be augmented if Ekornes cross-compares the customers’ data collected during registration with other publicly available data on the same customers (e.g. public facing websites and social media presence).

Furthermore, one the main advantages of this solution is that it does not necessarily require the cooperation of other value chain members, including retailers. This is a fundamental change

from its Ekornes current B2B business model, where all interaction with consumers is mediated through retailers.

Finally, usability should be central to the design on Ekornes Club as it has the potential to become a one shop stop where Ekornes interacts with its customers and even pushes into it product care information and other promotional material. We suggest equipping every Ekornes piece of furniture with a QR code that consumers can easily scan using their Ekornes mobile application.



Figure 12: Illustration of How Ekornes Club can function.

5.4.5 Ekornes’ Coin

5.4.5.1 Problem description

Ekornes brand image is a very important reason why customers buy its products. Hence, Ekornes wants to reinforce its narrative as a cutting edge forward looking company.

Building on the idea of the Ekornes club, this study suggests that Ekornes can offer customers reward or loyalty points, in the form of crypto currency coins, referred to as Ekoin.

Ekoin is not supposed to be a public currency which is traded publicly, but rather a commodity coin that customers can use to buy and trade services within Ekornes value chain.

5.4.5.2 Analysis using the framework

Dimensions	Questions	
2.Governance / Legal	7.Do you have to rely on a trusted party for compliance purposes?	No
	8.Are there any restriction concerning the jurisdiction and geographical areas in which your data and your customers data can be stored?	Yes
	9.Do you need to modify past data and keep no trace of such modifications?	No
	10.Are there any laws which are hostile to blockchain based application, either in your country, or in the country of business of any of you value chain partners?	Yes

Table 13: Evaluation Framework

As highlighted in the framework, Ekoin might come in conflict with some governmental regulations regarding cryptocurrencies. Hence, this use case should be put on hold and reevaluated when the regulations change.

6 INCUMBENTS AND RADICALLY DISRUPTIVE INNOVATION

The aim of this chapter is to study how Ekornes as an incumbent manages the adoption of blockchain as a radically disruptive innovation. This will shed the light on the competencies needed to manage a successful radical innovation project, and the organizational challenges which may hinder it.

6.1 Motivation

‘‘Radical innovation requires a high level of market, technical, resource, and organizational uncertainty, which can potentially be converted into long project maturity durations and unpredictable development. Therefore, organizations need three sets of competencies to manage the particular fields of radical innovation, namely discover, incubate, and accelerate capabilities. As organizations decide to develop radical technical innovations, they are bound to stretch the boundaries of what they already know, and in doing so, accessing market partners and expertise in different environments enables the company in developing their capabilities for radical innovation’’ (Beck, R. , 2018, P.5392)

In this use case, we analyze how an incumbent supply chain company reacts to blockchain as a radical innovation, along the lines of the discovery, incubation, and acceleration.

6.2 Empirical data and analysis

As detailed in the methodology section, the findings of this study are aggregated from 2 main sources are aggregated results of the following:

- Interviews.
- Participant observation over the course of 5 months, mainly through informal meetings and direct observation.

6.2.1 Discovery

6.2.1.1 Discovery-Awareness

Among the 10 people we interviewed in Ekornes and DSV in the first round of interviews, only 2 showed any awareness at all about blockchain: the supply chain director and the IT manager.

The initial understanding of the supply chain director of blockchain was limited, as it was conflated with bitcoin and cryptocurrencies in general.

“I first heard about blockchain through bitcoin price news a couple years ago. A lot of people seem to be making money out of it. And banks are afraid of how it can affect their business and revenues”

Since having heard of bitcoin and blockchain years ago, the supply chain director became intellectually curious about these technologies but did not have any plans of investigating blockchain within the company as a formal project. This is mainly because he did not see its relevance to Ekornes. Being a manufacturing company, they had little interest in pure explorative technical research. It wasn't indeed until I approached Ekornes offering a collaboration on an academic study which will use Ekornes as a use case for potential blockchain uses cases, that the supply chain director expressed an initial interest, conditional to the technology being able to offer value to Ekornes specifically.

“I did not know that blockchain could exist separately from bitcoin, nor that it could be relevant to manufacturing. I am curious though about what it means for Ekornes value chain?”

6.2.1.2 From awareness to exploration

In order to move the project beyond awareness, we organized a presentation in which I introduced blockchain as a technology, as well as a high level overview of what use cases I might be valuable to Ekornes, given my initial limited knowledge about the details of the company's value chain. I also used examples of successful blockchain projects from other manufacturing companies to drive my point home

“I did not know that blockchain is this relevant to Ekornes. This is very much spot on what I am working on currently. We are looking for ways which can allow us to get visibility over our customers and trace our products. I definitely support collaborating with you over this project.”

And this is how the champion team for blockchain got started at Ekornes. It was composed of the supply chain director, the supply chain coordinator, and myself as an external collaborator.

The supply chain director put his executive power into work and allowed me to conduct interviews with every department within Ekornes.

6.2.2 Discovery-Exploration

During my interview with the “IT systems and applications director” I noticed that he had a slightly better understanding, as he was aware of the difference between blockchain and crypto currencies. However, he believed that blockchain is just another database management technology that he wasn’t very interested in.

We already have an established IT infrastructure to run Ekornes process. My team has made a significant investment in our ERP systems and transactional databases, and I don’t see why we should replace them.

On the other hand, while the digitalization manager didn’t express any particular awareness nor understanding of blockchain, he was adamant on encouraging such exploration efforts, as he recognized from my introduction to the technology that it entails investigating other digitalization questions he was interested in:

I am not aware of blockchain as a technology. However, we have been trying to increase the quality of our digital flow. I can see that at least we share the common concern of identifying and tracking Ekornes products as they move through the value chain.

6.2.2.1 From discovery to incubation

Now that the relevance of blockchain to the business has been recognized at least by the core project champion team, I needed to move this project beyond discovery and into incubation. Doing so is contingent upon developing business use cases which can show the potential of blockchain of Ekornes. Hence, it was necessary to first understand the details of how the Ekornes value chain operates. This was supported by the supply chain director, and various teams across Ekornes were very open to sharing this perceive.

After having acquired all these valuable information about Ekornes value chain, I used my blockchain knowledge to analyze the value chain and identify business use cases with their corresponding blockchain solutions, and a mapping to which specific Ekornes value chain problems they can solve.

Even with the executive back up of the supply chain director, I was still the only one responsible for analyzing the Ekornes value chain from using a blockchain perspective. However, the soundness of these use cases was cross validated closely with the champion team.

Even if I naturally believed in the potential and relevance of these use cases, I lacked lacking the executive power to deploy them. Hence, it was necessary to share them across Ekornes, in order to move them to an incubation phase. This was done by conducting a second round of interviews, whose goal was to capture which use cases will be chosen to go into incubation phase, and which will be discarded.

6.2.2.2 End-2-End visibility and identification of damages

The supply chain director recognized immediately the potential of these two use cases in helping his team have better oversight over the demand chain, and more control over the product.

Being able to have the sofa exist as a digital asset the moment a client places an order, and even before we have physically started manufacturing is both significant and powerful. I want to see it happen.

The IT department manager, on the hand was not very warm to neither of these use cases. He stated that they have tried to work in the past of some digitalization-related projects, but had many challenges, especially with regards to IoT integration. He believes this one might have the same faith.

While the rest of the interviewees recognized the relevance of these 2 use cases, they didn't express any explicit willingness to take it further.

Hence, both these use cases stated in a non-conclusive state where they were neither completely discarded neither championed by any particular team to move into incubation.

6.2.2.3 Transportation

This use case involved depends heavily on having a close collaboration and alignment between Ekornes and its transport service providers. Practically speaking, this means that if Ekornes want to use such a solution, they could either convince their current partner to deploy it as a joint project or draft a new agreement with another transport service provider which has such a use case deployed.

Ekornes wanted to investigate the first option, and hence we conducted an interview with DSV in their offices. Unfortunately, there was a clear lack of understanding for the technology, and little readiness to further investigate. Hence, this use case did not move into incubation.

6.2.2.4 Ekornes Club

The marketing team was very keen on this use case. On one hand, it was close in spirit to some ideas they have considered in the past. On the other hand, they recognized the power of a blockchain implementation in giving them a much better insight over their market and a direct link to customers.

Hence, the marketing team took an immediate executive decision to move this use case into incubation.

6.2.3 Incubation

The Ekornes club is the only use case which has been conclusively moved into incubation, championed by the marketing team. Therefore more, in order to help move the rest of the use cases from their non-conclusive state, and better evangelize for blockchain and its vision within Ekornes, I presented an overview of the work which I carried over the past nine months to the board of directors.

As my study with Ekornes came to an end around that time, we cannot comment of the executive direction that the company will take

6.3 Analysis

6.3.1 Radical innovation competency and incumbents

In light of the above reported findings, we find that Ekornes, as is the case of most incumbents, faces challenges which hinder its proper management and response to a radically disruptive innovation such as blockchain. Furthermore, we also noticed an underdeveloped systematic

radical innovation competency, as Ekornes relied internally on driving the project through a single person, the supply chain director. This conclusion is in line with what has been reported in other work which has studied radical innovation within incumbents. As a matter of fact, the latter usually have processes which have been optimized so much for quickly capturing and deploying incremental innovations, that their radical innovation competence becomes under developed.

The lack of an established internal radical innovation competency was especially noticeable during the discovery phase. Indeed, there were no formally defined roles or teams within Ekornes which would be responsible for creating and articulating radical innovation opportunities to the rest of the company. Such roles are usually found within research & development teams.

6.3.2 Open innovation and framework transitions

Even with an underdeveloped radical/disruptive innovation competency, Ekornes was able to progress through the stages of the radical innovation framework, thanks to its open culture which embraces the idea of “open innovation”. It is this context that this study has been carried out, as Ekornes and myself, as a university graduate student, entered into an agreement allowing me to explore the topic of blockchain in manufacturing value chains, taking Ekornes as a use case. Ekornes also took the initiative through this project to reach out to DSV in order to investigate potential of collaboration on blockchain.

The role of open innovation was especially important for ensuring successful transitions from Discovery-awareness to Discovery-exploration. Indeed, a key to such a successful transition is recognizing the relevance of blockchain to the company from a business perspective. For Ekornes, open innovation was the trigger for such an understanding of the technology, and as the supply chain director understood the potential of the technology within the company, he decided to strongly support me as an outside collaborator. This finding is in line with what has been reported in another blockchain case study carried out at a bank.

The role of open innovation was also noticeable in ensuring a successful transition from discovery to incubation. Empowered by the support from all the Ekornes departments, I performed the tasks of developing business use cases which showcase the potential business impact of the technology on Ekornes. Such a mapping of technology into business requirements was key in illustrating the true power and relevance of blockchain to the Ekornes manufacturing value chain

6.3.2.1 Systematic Open innovation

Through this study, we have observed that Ekornes has a culture which is very encouraging of open innovation, as well as a willingness at the executive level to develop and embrace radical technology innovations. While developing the latter can be quite a task, we recommend that Ekornes draws on its open innovation strength and capture it in systematic processes which can be iterated through regularly. What this means in practice, is that external competencies need to be identified, proper collaboration agreements need to be drafted, and regular touch points need to be held. Indeed, the innovation cycle is very fast paced, and taking a reactive approach to discovering and assessing innovations it is not enough anymore.

6.3.3 Organizational challenges

Besides the challenges which are common to most incumbents facing radical disruptive innovation, we noticed through this study that blockchain introduces unique challenges to incumbents. Indeed, blockchain is disruptive as an innovation because it solves the problem of trusted communication over an untrusted channel, in a P2P distributed manner. What this means is that all blockchain use cases, by design, involve more than one entity. Unlike the decision of deploying a centralized database which only takes one decision, a blockchain use case needs at least 2 entities to agree to use it. This feature of distribution influences how decision is made about whether or not to move a use case from discovery to incubation. In fact, we could observe this quite clearly in our study, where the Ekornes club got adopted immediately, while the rest of the cases remained in a pending state. Ekornes club is a use case which involved one internal department (Ekornes) with all their potential customers. Hence, taking the internal decision was faster.

Therefore, blockchain adoption would thrive best in businesses which foster close collaboration not only among their internal teams, but also across their value chain. Interestingly, an increased and a closer collaboration can also be a good impact of taking on a blockchain project. As we have observed in this case study, this project was a great ground for discussion among the different teams of Ekornes (supply chain, marketing, finance, IT...etc.) and between Ekornes and at least one member of its value chain.

7 CONCLUSIONS

This chapter concludes this study. It provides an overview of what has been achieved, as well as a critical reflection over how it has been achieved. It also provides an overview of the possible implications of such a work, and how future research can be built upon it.

7.1 Addressing the study research questions

The purpose of this study was to investigate the applicability and adoption of blockchain as a radical innovation, within incumbent manufacturing companies. Three main research questions were thus formulated, and their answers pursued over a period of 9 months. A qualitative use case study methodology was used, with Ekornes as a unit of analysis.

The first research question formulated was, *RQ1. Which dimensions should be considered, and which questions should be asked as part of a blockchain applicability framework?* It was answered in the first phase of this study, and its findings reported in chapter 3.

In fact, a novel blockchain assessment evaluation framework was developed as part of this study. It included 3 dimensions of analysis, which are technical, strategic and governance. While this framework is grounded in a solid literature review analysis, it is practical to use. In fact, it tackles heads on the real problems of an overhyped blockchain ecosystem, where one can notice many pointless blockchain projects proposed, and many relevant ones drowned by the noise of the hype. Finally, this framework has proven to be invaluable for the rest of the thesis, as it has been used as an evaluation tool to assess potential business uses cases within Ekornes.

Answering this first research questions gave the study its theoretical grounding and, and the next phases a tool to carry out more practical case study research.

Thus, the second research question formulated as “*R2. What are the main blockchain business use case solutions one can identify within Ekornes value chain?*” was tackled next.

Answering this question involved conducting interviews, performing theoretical analysis, and engaging in participant observation activities, facilitated by having been able to sit at the Ekornes headquarters for five months of this study.

The results of this phase are reported in chapter 4, and below is a summary of the identified business use cases which can be solved using blockchain.

- End-2-End visibility.
- Transportation process.
- Identification of damages.
- Ekornes club.

As part of answering this research question, the study focused on specific challenges within the Ekornes value chain, namely the non-coordinated supply and demand processes, and the disintermediated relationship of Ekornes with its customers. Hence, thanks to this use case study, one can proclaim that blockchain is indeed applicable and valuable to manufacturing value chains.

Finally, the third research question aimed at taking this study one step further. In fact, as useful as it is to identify blockchain business use cases, and even draft complete solutions for them, if the companies don't know how to properly manage this opportunity, then it would be a vain effort. Adoption of radically disruptive innovations such as blockchain are particularly challenging to incumbent firms, whose processes are optimized to work with incremental innovations. Ekornes being an incumbent manufacturing company itself, the study formulated the third research question to investigate: How will Ekornes respond to blockchain, specifically along the lines of the radical innovation competency framework of discovery, incubation, and acceleration?

With relevant use cases at hand, a second round of interviews was conducted within Ekornes to capture how they will respond to these use cases. Most importantly, sitting at the Ekornes offices provided a unique opportunity to conduct participant observation activities. In fact, a lot of invaluable data about the organizational challenges was captured through informal meetings and direct observation.

The analysis of the Ekornes case shows that incumbents do indeed struggle with managing radical innovation. However, if they embrace an open innovation approach, they can compensate for some of their shortcomings. This is especially true of discovering the radical technology, and understanding its relevance to the business.

Hence, the three main research questions have all been answered through this study. Combined, they fulfill the purpose of thesis by providing insight into both the applicability and adoption of blockchain within incumbent, beyond the hype

7.2 Study limitations

A critical retrospective look into the work conducted, revealed some limitations which need to be accounted for.

This study was conducted over a period of 9 months, amongst which 5 were spent working closely with Ekornes. While 9 months is a reasonable period for conducting a master thesis project, it might have been not long enough to observe and study all the organizational aspects influencing how an incumbent reacts to an innovation as radically disruptive as blockchain. This is especially true for Ekornes, a company which had very little to no blockchain competency before I started collaborating with them on this project.

Furthermore, after this study ended, it became public that Qumei, a chinese manufacturing company, made an all cash bid to buy majority shares in Ekornes, whose board has unanimously voted for the sale. This means that discussions about the topic must have been ongoing during the time the study was conducted. This is a limitation to the study because such a significant change might have influences the organizational dynamics observed.

Last but not the least, participant observation was one of the methods used for this study. While best efforts were made to maintain a medium involvement level, this might not have been the case throughout the whole study. There were indeed periods where I was very involved with Ekornes teams, and bias might have been reported as part of the findings.

7.3 Expected implications of the study

The research questions answered as part of this study were multi-faceted, and so are their expected implications.

7.3.1 Theoretical

This study is expected to enrich the literature available on supply-demand chains, by offering a case study of manufacturing incumbent using radical innovation to consolidate its supply and demand processes.

Furthermore, the applicability framework could be used as tool to mitigate the risk of companies falling into the pursuing a pointless blockchain project, while increasing their confidence of identifying the right one.

7.3.2 Practical

The identified use cases could potentially server as inspiration for companies with similar business problems to start considering blockchain.

7.3.3 Managerial

The insights developed about how a manufacturing incumbent such as Ekornes responds to blockchain, can help manager better prepare for undertaking such projects. Furthermore, the study's findings about the importance of open innovation can act a guiding principle for managers interested in improving their company's radical innovation competency.

7.4 Future work

There exists different research venues that can be explored in future work.

Blockchain commercialization: while blockchain is a promising technology for many industries, only few manufacturing incumbents have taken the time to closely study the opportunities it offers. Even fewer have identified a use case which they want to take into incubation and potentially into acceleration. However, as part of this study, Ekornes has made the executive decision to pursue the “Ekornes club” use case as a commercial opportunity. Future work could include a use case study of how incumbent commercialize radical innovation.

Open innovation and beyond: This study has showcased the importance of open innovation for incumbent companies that want to properly manage radical innovation projects. However, research suggests that companies benefit differently from adopting open innovation strategies, because their business models are not attuned for it. A future work could investigate the transitive relationship between radical innovation management, open innovation competencies and business models, within incumbent businesses.

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Appendix 1- Interview study guide for phase 1

Step One – Context:

This interview is part of an academic master thesis where I am investigating the applicability and adoption of blockchain technology within the manufacturing industry. Given the hype surrounding blockchain today, the study highlights that companies run the risk of deploying pointless blockchain projects for problems which can be solved much easily using other technologies. Companies also risk missing out opportunities to use blockchain when needed, because of all the noise and confusion surrounding the technology.

One of the goals of this master thesis is to develop a framework which can help manufacturing companies better navigate the blockchain ecosystem. After a careful review and analysis of the available literature review, I have developed this initial evaluation framework.

The goal of this interview is to assess the quality of this framework. Based on you feedback, I will revise a second version or the framework.

Step Two – Initial questions

- Can you give us more information about your professional background?
- What would you consider to be your main areas of expertise?
- How long have you been involved with blockchain technology and in which capacity?

Step 3 – Main questions

3General aspects

- How important do you think it is to have a blockchain evaluation framework?
- Are the questions of this framework well understood?
- This framework focuses on technical and business strategic drivers of blockchain project.
 - Can you discuss how relevant you think are these 2 dimensions to assessing the applicability of blockchain to a specific business use case?
 - Would you recommend using other drivers?

Technical drivers

- Are the questions in this section accurate?

- Can you discuss how reliable the results on this section would be in eliminating pointless blockchain projects?
- Can you discuss how reliable the results on this section would be in accelerating appropriate blockchain projects?
- What other technical aspects should we evaluate as part of this framework?

Strategic drivers

- Are the questions in this section accurate?
- What other strategic aspects should we evaluate as part of this framework?

Using the framework

- Who do you think should use this framework?
- How do you think the results of this framework should be interpreted?
- Are there any technical aspects you would consider mitigating the risk of falling into a pointless blockchain project?

Step 4: Summary

- Do you have any additional comments about this framework?
- Can we send you the final revised framework that will be built based on our interviews' results so as you can confirm that your feedback has been accurately captured?

Appendix 2- Interview study guide for phase 2

Step One – Context:

This interview is part of an academic master thesis where I am investigating the applicability and adoption of blockchain technology within the manufacturing industry. I am using Ekornes as a use a main use case, and this is why I have been sitting at Ekornes offices since December.

One of the main goals of this project, is being able to identify relevant business use cases in which Ekornes can use blockchain, especially with regards to its value chain.

The goal of this interview is to understand how the Ekornes value chain works, specifically from the perspective of your department.

Step Two – Initial questions

- Can you give us more information about your role at Ekornes?
- Can you give us more information the role of your department within Ekornes?

Step 3 – Main questions

Value chain

- Can you describe how Ekornes value chain works?
- What do you think is the main contribution of your department to the value chain?
- What do you think are the main challenges and friction points within Ekornes?
- What is your vision for improving Ekornes value chain?

Blockchain awareness

Have you heard of blockchain before? And If so? In which context?

Are you aware of the applicability of blockchain to manufacturing value chain?

Step 4: Summary

- Do you have other comments?
- Are you interested in learning more about blockchain? Are you willing to schedule a meeting in which I introduce the technology to you and to your team?
- I will come back for a follow up interview in which I can introduce the business uses cases which are relevant to your department.

Appendix 3- Interview study guide for phase 3

Step One – Context

This interview is a follow up to our previous interview where you shared your feedback about the Ekornes value chain, its growth opportunities and your vision for it. It is also a follow up to the presentation in which I introduced blockchain technology to you and your team, after you have expressed interest in learning about it.

As part of my master thesis, I have developed a set of Ekornes business use cases which can be solved using blockchain.

The goal of this interview is to capture your feedback regarding this use case.

Step Two – Initial questions

- Have you made any further research into blockchain after our previous interview and presentation? If so can you share your new insights?

Step 3 – Main questions

- Can you discuss how much relevant you think this problem is to the Ekornes value chain?
- Can you discuss the benefits, if any, of having a solution to this business challenge?
- Can you discuss the willingness of you to deploy a proof of concept or a product-ready solution based on this use case?
- Which other team do you think we should discuss this use case with?

Step 4: Summary

Do you think any advice on what should be done next to advance this use case into an incubation phase?