Drivers and barriers for blockchain adoption in organizations

A master thesis in Information Systems on organizational adoption of blockchain. An AHP study on the significance of drivers and barriers for blockchain adoption identified through a systematic literature review

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Foreword

This thesis concludes our efforts at the Department of Information Systems at the University of Agder where we are enrolled in the MSc programme in Information Systems. As we've worked together at the university since our second year on the Bachelor programme, it's been an honor to finish this chapter of our journey together, and on a topic that both interests and inspires us.

Blockchain technology has been a major part of our lives since the summer of 2017. We consider it a privilege to have been able to take a deep dive into the technology and the related advantages and disadvantages in our thesis.

We would like to thank and acknowledge all the helpful individuals and organizations that have enabled us to complete this thesis.

First, we would like to express our utmost gratitude to our excellent advisor, Associate Professor Polyxeni Vasilakopoulou at University of Agder, for continued assistance and feedback in planning, designing and conducting our research and thesis. Your input and our workshops together have been invaluable.

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- Digin
- Blockchangers AS

Thanks to the attendees and speakers at relevant conferences and seminars who were helpful and glad to provide feedback and answer our survey:

- Oslo Blockchain Day
- Software 2019
- The digital conference
- Practical use of blockchain
- The Southern Norway Oil and Energy Conference

We would also like to thank our questionnaire pilot tester for valuable feedback and assistance in improving the survey design and format.
Finally, we wish all the best to everyone who answered our survey which helped us complete this thesis, and that the results of our thesis will serve as a resource in your future endeavors.

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Abstract

This thesis focuses on blockchain technology in business and aims to identify the most prominent drivers and barriers for blockchain adoption in business organizations.
Through a literature review, drivers and barriers associated with blockchain were identified in previous research, along with limitations in prior research that motivated us to perform our study.

We researched the relevant significance of the identified drivers and barriers by collecting data through a survey and analyzing them with a specialized quantitative method. We designed a survey with pairwise comparisons for both drivers and barriers, and analyzed our findings with the analytical hierarchy process (AHP) which is a structured approach for deriving priorities among diverse elements. The survey targeted domain experts and was distributed through conferences, business networks and clusters as well as to relevant individuals identified through LinkedIn and personal professional networks.

The survey responses collected were evaluated for judgement consistency to ensure the quality and reliability of the findings, consolidating data from the responses that passed the consistency requirements, the findings show that reliability and immutability are the two most prominent drivers, while knowledge and technical maturity are the most prominent barriers for blockchain adoption in organizations.

Interestingly, if all responses are taken into account (including those of low judgement consistency) the results for the barriers are significantly altered. Specifically, knowledge is ranked as the least important barrier when all responses are included in the analysis. Nevertheless, it moves up from the last position to the first after filtering for consistency. On the drivers´ side, there are only minor differences between the filtered and non-filtered results.

There are significant avenues for further research. The drivers and barriers can be studied within specific industry contexts. We expect this to be possible soon as blockchain becomes more widespread. Today, there are still limited experiences with blockchain technologies, resulting to small numbers of domain experts and this prevented us from performing industry-specific analyses. Furthermore, qualitative case studies on organizations that abort blockchain initiatives can help in exploring why this happens. Finally, further research could be performed for analyzing the key barriers and drivers and finding ways to overcome barriers and further enhance the drivers.

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1. Introduction

2017 was the year where cryptocurrency caught the eye of the public, and we saw the expansion of "ICOs" (Initial coin offering), increasing from 29 ICOs raising $90 million USD in 2016, to 875 ICOs raising over $6.2 billion USD in 2017 (Icostats, 2019). The underlying infrastructure enabling cryptocurrency is called blockchain.

The emergence of this technology, which brings cryptocurrencies and smart contracts among other features, is starting to disrupt several industries and business models (Cong & He, 2018). It's being applied for decentralized record keeping and transactions, in areas such as supply chains, contract platforms, social networks, and more.

So, what exactly is blockchain being used for today, and what causes organizations to adopt it and implement infrastructural technology changes? And on the other side, why are other organizations not adopting blockchain?

The research question for this thesis is:

> *What are the most prominent drivers and barriers for blockchain adoption in organizations?*

1.1 Background

In short, blockchain is a distributed ledger technology (DLT), in the form of a distributed transaction database (Beck, Avital, Rossi & Thatcher, 2017). The blockchains' data is secured by cryptography, and it is governed by a consensus algorithm.

The technology is quickly evolving from merely being a digital record to becoming the backbone for advanced digital services, for instance by the introduction of smart-contracts. Smart-contracts are essentially digital contracts with a defined set of rules and parameters that are automatically executed without any risk of fraud or downtime. For example, one might have a contract that states: X currency units are transferred from A to B, when the condition Y is met (Buterin, 2014). This enables trustless transactions to be performed automatically, without an intermediary; they are tamper-proof with immutable data. This possibility of creating and implementing reliable and trustworthy distributed systems (or ledgers) will have a big impact on organizing interpersonal and interorganizational relationships. If the technology delivers the expected potential, we may be able to experience an unmatched level of objectivity and trust (Beck et al. 2017).

The changes that this new technology can lead to in organizations will be radical. This disruptive technology may drastically change how organizations collaborate, as we might see less use of intermediaries in supply chains and for financial transactions.

The prior research for blockchain and smart contracts mainly started evolving in the 1990's, led by computer scientist Nick Szabo. Szabo presents that the costs of doing international business are high, and it's increasingly dominated by jurisdiction, security and trust: the cost of developing, maintaining and securing relationships

(Szabo, 1997).
In retrospect, Nick Szabo's work explained the foundation of what we now know as blockchain, cryptocurrencies and smart contracts, years prior to the creation of the technology and the first implementation of it by Satoshi Nakamoto in the form of the digital currency Bitcoin (Nakamoto, 2008).

Blockchain offers a lot of opportunities but also presents established organizations with several challenges, and it's uncertain how they should respond and adapt to this innovative technology. Our interest to investigate them led us to conduct this study.

1.2 Motivation

The major difference between other emerging technologies such as Augmented Reality (AR), Virtual Reality (VR), Artificial Intelligence (AI), machine learning, digital twins, etc., and blockchain, is that blockchain is a new infrastructural technology and not a service in and of itself. Changes in infrastructural technologies are very challenging and more complex, and adoption seems slower as a result.

The technology acceptance model, TAM (Davis, 1989) has played a significant role in explaining how users perceive and accept new technology (Venkatesh & David, 2000). The model has pointed to the important role of perceived usefulness and ease of use for the acceptance of technology. It has also been supported empirically, as explained by the following quote:

"In particular, substantial theoretical and empirical support has accumulated in favor of the Technology Acceptance Model (TAM) (Davis 1989, Davis et al. 1989). Numerous empirical studies have found that TAM consistently explains a substantial proportion of the variance (typically about 40%) in usage intentions and behavior, and that TAM compares favorably with alternative models such as the Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB) (see Venkatesh 1999 for recent review)" (Venkatesh & David, 2000)

Lin et. al. (2007) believed there was a need for another dimension to the model, and subsequently added readiness into the TAM to also account for TR (technological readiness) which they define as follows:

"TR refers to people's propensity to embrace and use new technologies for accomplishing goals in home life and at work (Parasuraman, 2000). "(Lin et. al., 2007)

There are several variations of TAM like Lin et. al. (2007) with their "TRAM" and Vekatesh & David (2000) with their TAM2 which also incorporates additional theoretical constructs spanning social influence processes (subjective norm, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use).

These frameworks are proven helpful in explaining user acceptance of technology but are not developed to explain organization's inclination towards adopting new technology. Such an analysis would require different factors and a different approach.

The “IT Business Value Model” by Melville et. al. (2004) explains how information technology impacts business value, and finds that IT is valuable, but the extent and dimensions is dependent upon internal and external factors like complementary organizational resources, trading partners, competitive market and the macro environment. This brings a holistic level of IT business value related to overall business characteristics.

Through this thesis, we aimed to gain more knowledge about the specific factors influencing blockchain introduction in business organizations by building upon literature specific to this type of technology and by collecting and processing expert opinions. Our goal is to assist organizations in creating value through adopting this technology in the future, as well as to provide a foundation for future research.

1.3 Contribution

We researched the relevant significance of drivers and barriers that were identified in prior research by collecting data through a survey. We designed the survey using pairwise comparisons for both drivers and barriers and analyzed our findings with the analytical hierarchy process (AHP) which is a structured approach for deriving priorities among diverse elements. The survey targeted domain experts and was distributed through conferences, business networks and clusters as well as to relevant individuals identified through LinkedIn and personal professional networks. The survey responses collected were evaluated for judgement consistency to ensure the quality and reliability. The key findings show that reliability and immutability are the two most prominent drivers, while knowledge and technical maturity are the most prominent barriers for blockchain adoption in organizations.

The findings of our research will potentially be a useful resource for organizations considering implementing the technology in some form, as well as a foundation for future research. Overall, with our study we aim to contribute a new piece in the body of knowledge about blockchain in the IS field.

1.4 Thesis structure

The thesis is structured into 6 main chapters with corresponding sub-chapters. Chapter 1 introduces the thesis, research topic and key concepts. Chapter 2 is a literature review on organizational blockchain adoption identifying prominent drivers and barriers. Chapter 3 explains the research method and data collection procedures. Chapter 4 presents the data collection results, analysis and findings. In chapter 5 we discuss the outcomes of our analysis linking them also to prior research and present the closing remarks which concludes the thesis while presenting possible avenues for further research.

1.5 Key concepts

“Blockchain”, “adoption”, “drivers” and “barriers” are terms used widely with different interpretations and understandings. In our thesis we will use the following definitions:

Blockchain is the technology that emerged through the introduction of Bitcoin (Nakamoto, 2008) and has since seen several other areas of utilization. It’s a distributed ledger with shared ownership, and can be either public, private or hybrid (e.g. in a consortium) that allows for transacting, record keeping and, in some cases, used in accordance with so-called “smart contracts”. (Buterin, 2014)

Adoption is the stage after considering, implementing and introducing the technology to use. Blockchain is considered adopted by an organization if it has gone forward with either implementing a solution using blockchain, utilizing some blockchain in its operations or having infrastructure that uses blockchain to any extent.

Drivers are the helping the technology to be introduced. They are positive reasons and potential upsides related to the technology. The drivers positively impact the motivation towards blockchain adoption. They can also be viewed as driving forces, pros or activators.

Barriers are the potential negative sides about implementing the technology and are reasons for not introducing the technology. The barriers negatively impact the motivation towards blockchain adoption. They can also be viewed as show-stoppers, cons or inhibitors.

2. Related research

The theoretical foundation of this thesis is a systematic literature review that was performed to identify prior research on barriers and drivers for the adoption of blockchain in organizations. Specifically, the findings of the literature review were used to identify the five most prominent drivers and five most prominent barriers that we used as the basis in our research.

This systematic literature review wishes to map the landscape of blockchain research in the IS field. The use cases for blockchain are mainly categorized under data management, data verification and financial uses. Some examples are inter-organizational data management, identity verification and key management, supply chain management, content or product timestamping, contract management, value transfer and lending, and computational power outsourcing (Zīle & Strazdiņa, 2018).

The conceptualized and applied implementations and use cases for blockchain are varied but well defined through existing literature and previous research. However, we are yet to see a mainstream adoption of the technology, despite its promises and varied properties within several areas of business.

Gausdal et. al (2018) conducted research on applying blockchain technology in the maritime industry, based on Norwegian companies. They have produced a summary figure of drivers and barriers to digital innovation in this context, and through a literature review of existing research.

Factor/Code	Driver	Barrier	Consistency Findings—Literature
Cost	X	X	Consistent
High level of regulation of the industry	X		Consistent, but the findings added show that this factor also speeds up the innovation process
The information-intensive feature of the industry	X		Identified in both places, but more emphasized in the literature rather than in the findings
Intention to work more efficiently using modern information technology opportunities	X		Not previously identified in the literature
Limited and slow Internet speed offshore		X	Not previously identified in the literature
Low level of digital diffusion within the supply chain		X	Reduced benefit because other companies in the chain are not using it; a lack of developed systems and software; deficiency of knowledge related to benefits and opportunities. Some large companies and start-ups are early adopters, and SMEs in general seem to be latecomers, which was not identified in the literature.
Reluctance to investment, risk-taking, and innovative leadership		X	First part is consistent, last part—reluctance innovation leadership—is more emphasized in the findings
Old fashioned, non-pioneering culture and conservative old-aged decision makers		X	Consistent, very clear findings
Old fashioned, non-pioneering, engineering and technology-oriented culture with a low focus on efficient business processes		X	Not explicitly identified in the literature on SMEs in this industry before

Figure 1: Summary of drivers and barriers to digital innovation (Gausdal et. al., 2018)

Some of the more consistent barriers are reluctance to investment and risk-taking, as well as conservative decision makers. The cost variable is identified both as a driver and a barrier.

Blockchain and DLT is on the rise, and we are yet to see a mainstream adoption and widespread implementation of blockchains in organizations. This may be caused by all the challenges of performing an infrastructural change project at this scale. By reviewing literature on the topic, we can pave the road for further innovation and raise awareness of new business opportunities while being critical to the overzealous interest where the technology is proposed to be implemented due to the 'hype' we've seen so far, and not because of the potential benefits and unique properties of a blockchain.

2.1 Review approach

When conducting our systematic literature review, we followed the three phases outlined by Kitchenham et al. (2009) which consists of three main-phases: Planning, Conducting and Reporting.

When selecting the publications for our literature review it was important for us to first establish some guidelines for what we were searching for. We used the work of Kitchenham et. al (2009) and Okoli & Schabram (2010) for methodological guidance.

2.2 Planning

Initially, we set the goal of the literature review, which is to map the current landscape of research on blockchain technology within information systems, with a focus on drivers and barriers for the adoption of blockchain technology.

Our main aims of the literature review are to gain more information around:

> *1: How has IS research addressed drivers and barriers for the adoption of blockchain technology?*
>
> *2: How does current research depict drivers and barriers related to blockchain technology?*
>
> *3: Which drivers and barriers are most prominent in current research related to blockchain technology?*

2.2.1 Databases

For our literature review, it was important both to find literature relevant to our specific topic, but also to delimit the searches to be relevant for the IS research field. To achieve this, we have used the following databases to find the basis for our study:

Scopus

Web of Science

Oria

When searching the databases, it was important to be specific enough to find the literature needed to explore our research question while at the same time be able to find articles with enough citations and quality. We also wanted to focus on the technology as opposed to its first use-case of the cryptocurrency Bitcoin (Nakamoto, 2008) and as previously stated focus on the research field of IS so we focused on. IS journals and conferences:

2.2.3 Selected Journals and Conferences

The eight basket journals:

- European Journal of Information Systems
- Information Systems Journal
- Information Systems Research
- Journal of AIS
- Journal of Information Technology
- Journal of MIS
- Journal of Strategic Information Systems
- MIS Quarterly

Major IS conferences

- ICIS
- ECIS
- AMCIS
- PACIS
- MCIS
- SCIS
- HICSS

2.2.4 Inclusion and exclusion criteria

When conducting a systematic literature review, it is important to have clearly defined criteria towards what is expected to be included in a desired article as well as criteria that make the articles irrelevant. These criteria should be well-developed before conducting the search to guarantee replicability and make sure the findings are a direct result of the initial desired research. This will also enable us to prioritize. (Creswell, 2009).

Inclusion criteria:
Research that includes sections on drivers and/or advantages as well as barriers and/or limitations for blockchain technology
Blockchain use-cases
English
Any time

Table 1: Inclusion criteria

To be in line with the focus of this study and the research questions, the articles need to reflect the real-world situation concerning blockchain adoption so, we defined a set of exclusion criteria.

Exclusion criteria:
Papers focusing heavily on cryptocurrencies as opposed to the blockchain technology
Heavy technology focus
Heavily focused on specific implementations/projects

Table 2: Exclusion criteria

To be able to discover the actual drivers and barriers for organizational adoption of blockchain, we consider it important to shift the focus away from cryptocurrencies towards blockchain technology and a broader use-case directed focus. The reasoning for the exclusion of heavy technological papers is mainly the same; we are looking for organizational contexts with tangible advantages and challenges. Finally, we also excluded papers that are heavily focused on specific implementations / projects as those can be too context-specific and difficult to generalize.

2.2.5 Selection and quality assessment approach

When selecting from a relatively large selection of papers, we had to define ground rules for how to review each result in from a search. By being consistent in the approach, we were able to avoid different approaches resulting in an inconsistent selection strategy. We also saved a lot of time by being able to follow efficient guidelines as opposed to reading every result. The guidelines we developed are:

1. **Scanning the title**
    - Here we exclude the publications if they were focusing on Bitcoin, or cryptocurrencies in general as well as if they were too heavily focused on technology/specific implementations.
    - We look for use-cases or overviews of them, which is an inclusion criterion

2. **Reading the abstract**
    - We read the abstract to make sure it fits our research question and search for barriers/drivers or their synonyms.
    - We want to include publications focusing on business or economic development

3. **Skimming the contributions/findings/conclusions**
    - We skim to ensure the relevance of the findings in the context of our research.

2.3 Conducting

2.3.1 Search process

It was important to us to perform the literature review in a structured and systematic manner. The following model illustrates the approach we used to search the databases and extract publications.

Figure 2: Literature selection process

2.3.2 Search process illustrated & forwards/backwards search

Here is an example of a search string we used in Scopus following the process:

(TITLE-ABS-KEY(Blockchain) AND ISSN (21629730 OR 13652575 OR 15265536 OR 15369323 OR 14664437 OR 07421222 OR 21629730) OR CONF (icis OR ecis OR amcis OR pacis OR mcis OR scis OR hicss))

This search gave us 34 results, whereas 6 of them were relevant to our proposed research questions after reviewing them in accordance with our criteria.

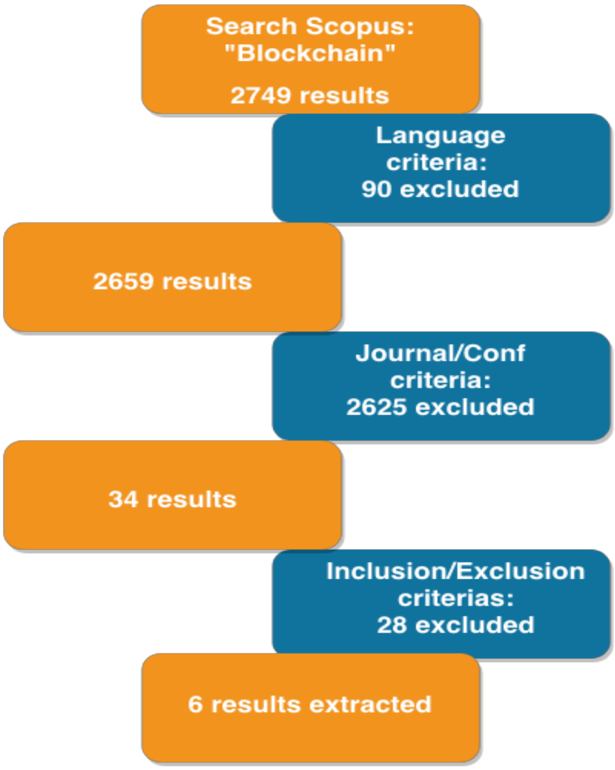

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Figure 3: Example of search process

In this example, the papers in we extracted were by Shang et al. (2018), Gomber et al. (2018), Fridgen et al. (2017), Schweizer et. al (2017), Hans et. al (2017) and Beck et. al (2016). We performed the same search in the other two databases increasing our results.

After this rigorous process we had a total of 14 articles. Through forward and backwards search we ended up selecting a total of four more articles, namely Beck & Müller-Boch (2017), Glaser (2017), Giraldo (2018) and Mohanta et al. (2018).

Two articles; Beck et. al (2018) and Lacity (2018) were also included due to tips from professors. We found them by searching directly in Google Scholar for their titles and included them in the review as they fulfilled our criteria and quality requirements.

The queries made with the different terms, databases, limitations, journals/conferences, results and number of extracted articles are illustrated in the following table.

No	Primary search term	Secondary search term	Database	Limitations	Journals/Conferences	Results	Extracted
1	Blockchain	N/A	Scopus	Peer reviewed, English, anytime	Any	2659	0
2	Blockchain	N/A	Scopus	Peer reviewed, English, anytime	All recommended by course IS420	34	6
3	Blockchain	N/A	Oria	Peer reviewed, English, anytime	Any	1974	0
4	Blockchain	N/A	Oria	Peer reviewed, English, anytime	All recommended by course IS420	11	0
5	Blockchain	N/A	Web of Science	Peer reviewed, English, anytime	All recommended by course IS420	6	1
6	Blockchain	N/A	Web of Science	Peer reviewed, English, anytime	Any	1193	0
7	Blockchain	AND "information systems"	Web of Science	Peer reviewed, English, anytime	Any	21	1
8	Blockchain	AND barriers	Web of Science	Peer reviewed, English, anytime	Any	14	2
9	Blockchain	AND limitations	Web of Science	Peer reviewed, English, anytime	Any	64	1
10	Blockchain	AND drivers	Web of Science	Peer reviewed, English, anytime	Any	13	1
11	Blockchain	AND advantages	Web of Science	Peer reviewed, English, anytime	Any	87	2

Table 3: Summary table of search process

2.4 Reporting

2.4.1 Table of articles

The result of our selection process is the following table of our 20 selected articles:

Author	Title	Year	Conference/Journal
Beck et. al	Governance in the Blockchain Economy: A Framework and Research Agenda	2018	JAIS
Beck et. al	Blockchain technology in business and information systems research	2017	Business and Information systems engineering
Beck et. al	Blockchain - The gateway to trust-free cryptographic transactions	2016	ECIS 2016
Beck & Müller-Boch	Blockchain as a radical innovation: A framework for engaging with distributed ledgers as incumbent organization	2017	50th Hawaii International Conference on System Sciences
Fridgen et. al	A solution in search of a problem: A method for the development of blockchain use cases	2018	AMCIS
Gatteschi et al.	Blockchain and Smart Contracts for Insurance: Is the Technology Mature Enough?	2018	Future Internet
Gausdal et. al	Applying blockchain technology: Evidence from Norwegian companies	2018	Sustainability
Giraldo	X-BORDER PLATFORMS: THE IMPLICATIONS OF DISTRIBUTED LEDGER TECHNOLOGY	2018	ECIS 2018
Glaser	Pervasive Decentralisation of Digital Infrastructures: A Framework for Blockchain enabled System and Use Case Analysis	2017	50th Hawaii International Conference on System Sciences
Gomber et. al	On the Fintech Revolution: Interpreting the Forces of Innovation, Disruption, and Transformation in Financial Services	2018	Journal of Management Information Systems
Hans et. al	Blockchain and Smart Contracts: Disruptive Technologies for the Insurance Market	2017	AMCIS
Kostrikova & Rivza	Opportunities and Barriers for Application of Distributed Ledgers in the Context of EU Digital Single Market Strategy	2017	European International Studies (EIS) - 11/2017
Lacity	Addressing key challenges to making enterprise blockchain applications a reality	2018	MIS Quarterly Executive
Li et al.	Toward a blockchain cloud manufacturing system as a peer to peer distributed network platform	2018	Robotics and Computer-Integrated Manufacturing
Mohanta et al.	An Overview of Smart Contract and Use cases in Blockchain Technology	2018	9th ICCCNT 2018

Nowiński & Kozma	How can blockchain technology disrupt existing business models?	2017	Entrepreneurial business and economics review
Risius & Spohrer	A Blockchain Research Framework What We (don't) Know, Where We Go from Here, and How We Will Get There	2017	Business and Information systems engineering
Schweizer et. al	Unchaining Social Businesses – Blockchain as the Basic Technology of a Crowdlending Platform	2017	38th ICIS
Shang et. al	Tracing the Source of News Based on Blockchain	2018	17th ICIS
Yli-Huumo et. al	Where is current research on blockchain technology?	2016	Public library of Science

Table 4: Table of selected articles

2.4.2 Overview of identified publications

When we look at the metadata of the publications, one interesting takeout from the selection process is the date of publication. As seen in the following table, the research is very recent. A total of 18 of the 20 publications chosen are from either 2017 or 2018. The remaining two publications are from 2016.

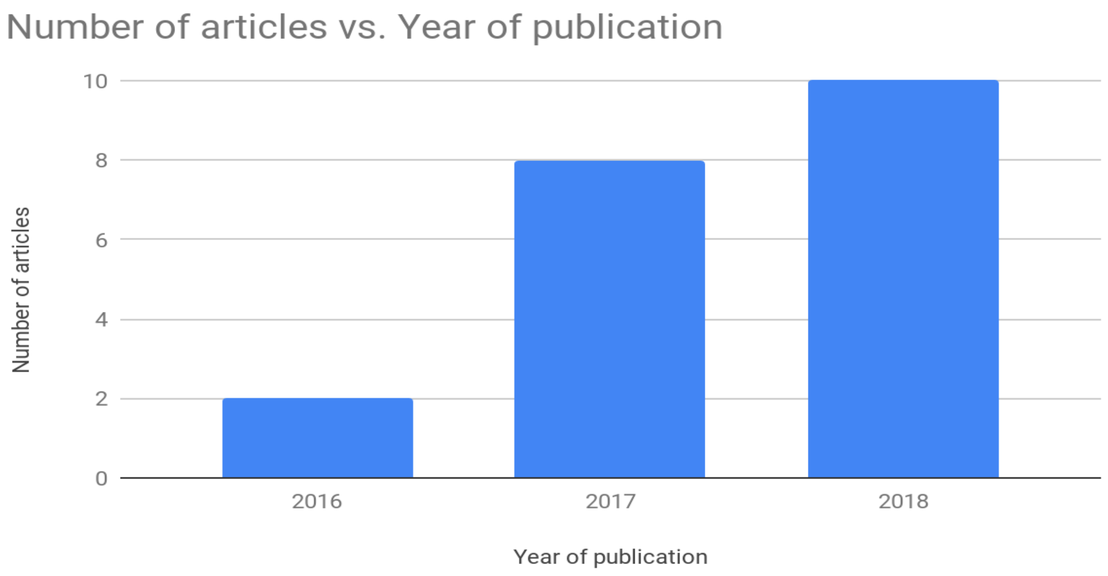

Figure 4: Number of articles per year of publication

Another interesting aspect is the categorization of the publications, there is a variation in the research design and methods applied, however there is a clear majority of studies based on case studies. This is not a surprise, as case studies are relevant for developing in depth understanding for a newer phenomenon and research topics such as this.

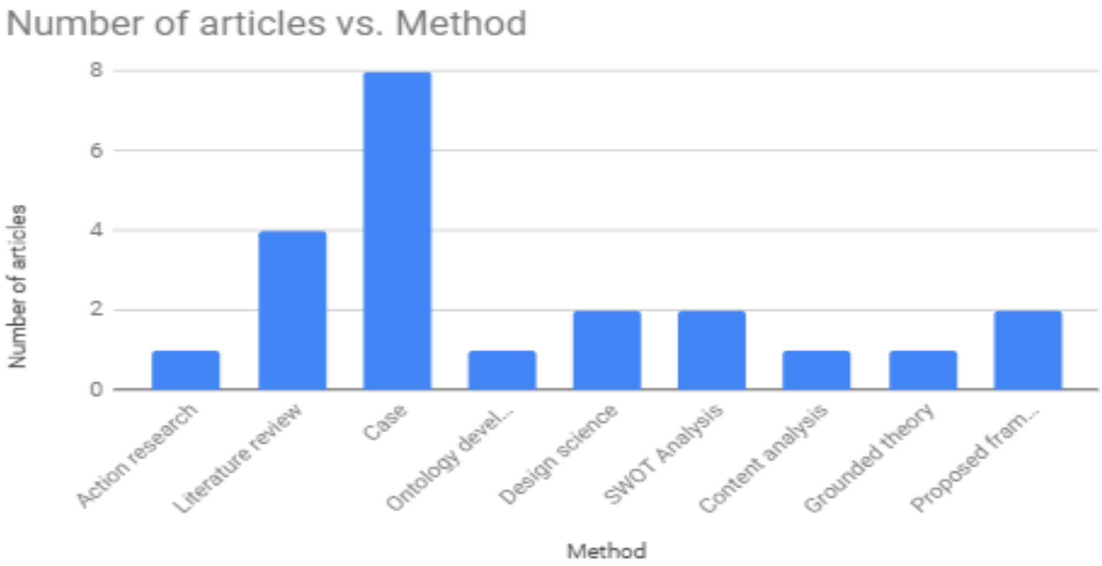

Figure 5: Number of articles per method

Some articles used several research designs and approaches, which means that there are more than 20 entries in this table.

As defined in the systematic guide for literature reviews (Okoli & Schabram, 2010), after extracting the data we need to analyze the findings. Our method of analyzing the data was to cross-reference the different articles to locate the various drivers and barriers discussed in the literature. The drivers and barriers identified are presented in the subsections that follow.

2.4.3 Drivers identified

When looking at the properties and technical aspects of blockchain there is no surprise that cost savings and the automation of financial transactions is identified as a driving force for blockchain in most of the publications. The figure (6) below retrieved from Lacity (2018) showcases how cross-organizational transactions are performed with a trusted third party (TTP) to the left, and with blockchain to the right.

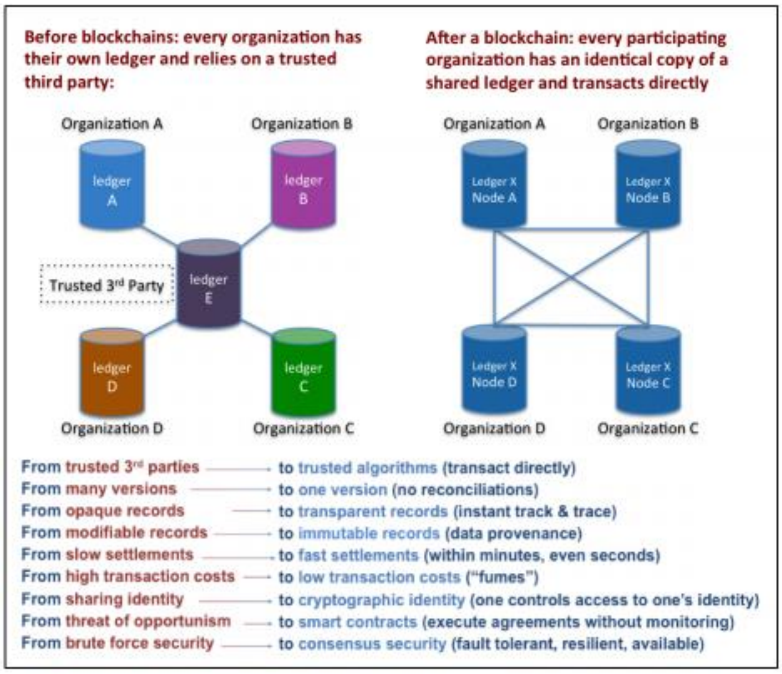

Figure 6: Multiple Centralized Systems vs. a Shared Blockchain Application (Lacity, 2018)

*"Enterprises of all types are increasingly interested in blockchain technologies because of the promise of significant business value. Blockchain solutions provide the ability to transact directly with trading partners, eliminate the need for reconciliations, track and trace assets instantly, ensure the provenance of data and settle transactions quickly and cheaply" (*Lacity, p. 19, 2018)

This potentially has a big impact on efficiency, especially when there are interorganizational relationships and transactions between the different organizations involved.

Regarding supply chains, blockchain's applicability enables organizations to have an encrypted and immutable ledger of transactions, which can be shared within a selected network, as illustrated in figure 6, due to the peer-to-peer proof of work concept, which may eliminate third parties and saving money through reduced cost (Gausdal et. al, 2018).

Decentralization in terms of distributing authority, ownership, control, etc., is a well-documented characteristic of blockchain. In a blockchain initiative covered by Beck & Müller-Boch (2017), decentralization is mentioned as an important factor behind the initiative. In modern organizations everybody is to a certain degree informed and has an opinion, everybody is sort of an expert in their own field, which makes it more complicated to run the company and respond agile to issues. Meanwhile technologies like blockchain is given more emphasis, due to the decentralizing properties (Beck & Müller-Boch, 2017).

Another truly innovative character of blockchain is its openness and capability to pervade multiple layers of digital ecosystem infrastructure. Pervasiveness can span through several layers due to smart contracts' capabilities in form of autonomous rule and process representation (Glaser, 2017).

In addition, TTPs have some serious limitations that blockchain is looking to solve. One of these is the low transparency of transactions. TTPs have ownership and control the ledger centrally, while providing little to no openness to other entities (Lacity, 2018).

An often debated characteristic of blockchain technology is security, and Mohanta et al. (2018) points out that automated smart contracts on a blockchain may both increase security as well as lower costs.

Consolidating the findings presented above we identify 5 key drivers:

• Cost saving & automation of financial transactions Cost savings is here defined as cost savings as a result of utilizing blockchain technology in the organization, as well as indirect savings through automation and autonomy of transactions through smart contracts. • Efficiency Efficiency was a prevalent factor in the literature and is defined here as an umbrella for the following terms: autonomy, smart systems, bypassing or replacing third-parties and intermediaries. An example is the use of smart-contracts to perform payments and handle transactions based on pre-set parameters and rules with the efficiency gains such actions bring. A concrete example is automatic handling of payment for delayed shipments (e.g. discounted price, increased quantity in next shipment). • Decentralization Decentralizing ownership, responsibility and authority from specific groups, individuals or organizations. No centralized power controlling or owning data, No single point of failure in terms of security. Not able to bribe or bypass one person to gain control or influence. Blockchain cannot be bribed or blackmailed. • Transparency/openness Defined here as the intent to be able to have transparent actions, transfers and transactions internally or between organizations. The ability to be open without losing security, building trust in the network. Another important aspect outlined here is easy traceability of transactions and assets. • Security Achieving higher degree of security due to blockchains features which increases trust due to immutable records and therefore irreversible transactions. Terms like redundancy and fault tolerance are also included within this definition.

Table 5: Identified drivers from literature

2.4.4 Barriers identified

While blockchain shows potential and brings properties that promises to improve several business models that we see today, there are, as always with new technologies, barriers that slows down mainstream adoption and full-scale implementations.

"At present, however, there is a huge gap between promised business value and actual business value delivered. Before the full business value of blockchain solutions can be realized, the technology needs to mature to address issues such as scalability, performance and interoperability. Enterprises need to work together to define standards, and regulators need to clarify compliance requirements" (Lacity, p. 19, 2018)

Beside these technical immaturities, there's also the lack of diffusion (Gausdal et. al, 2018). Partners, trading collaborators or other members of the organization's supply chain may not have implemented blockchain yet, and coordinating such large-scale changes will need a lot of time and require a big investment. The business value of blockchain may not be realized before we see diffusion across several organizations or throughout a larger network. This is to some extent a paradox, where it's a barrier for adoption, but the only way to overcome it is to adopt the technology. The initial investment might provide little to no business value before others follow.

The cost of implementing such a new technology, and the new operational costs for consumers, is also identified as a limiting factor. Today, companies usually run and pay for servers and the cost of performing actions are usually hidden from the users. With a decentralized approach such as blockchain, the fees and costs will be split, and will be more visible to the users, which might hinder a wider adoption and make users choose centralized options (Beck et. al, 2016)

Implementing a new technology at an infrastructural and such a fundamental level brings in a lot of risk. It requires an organization to adapt or develop new competencies to perform differently. Blockchain is assumed to trigger significant changes through the introduction of new business models and practices. Radical changes like this are particularly difficult for established organizations (Beck & Müller-Bloch, 2017).

A challenging paradox is the consensus algorithm of blockchain. Currently speed and scalability are limited as block times are quite slow, to ensure security and data validity. If transaction speed is improved at the current state, it will be at the expense of security (Yli-Huumo, et. al, 2018).

The increase and wish for transparency is a double-edged sword, as the increase in transparency will bring new challenges in terms of privacy. While personal data and transaction information previously was hidden and controlled by one centralized actor, this may now be distributed across the network (Risius & Spohrer, 2017).

Consolidating the findings presented above we identify 5 key barriers:

• Security This was identified as a negative factor in several publications, mainly due to the risk of a public blockchain possibly being altered should majority control be claimed by one party. Another reason for this as a barrier is the lack of user account recovery should a user lose its cryptographic key. Interesting future research topic. • Privacy An issue that the increased traceability and transparency in combination with transactions being connected to identities. Data previously "invisible" and controlled by central authorities is now distributed and visible. Can cause privacy concerns. • Scalability The current transaction speed and potential for growth in existing blockchain-networks are too low to handle the potential traffic that mainstream adoption would bring. • Interoperability and diffusion Blockchain solutions have low interoperability with existing systems, and there are currently no interoperability platforms to enable communication between different blockchain implementations. Lack of diffusion causes promised value to be higher than the actual value returned from blockchain investments. • Cost, risk, environmental concern The cost of implementation, increased risk due to cost compared to potential low direct value generation. Risk can also be considered due to lack of diffusion throughout value chains. There are also environmental concerns due to power consumption and carbon footprint. • Maturity With maturity we have chosen to include both governance and technical maturity, as these were prevalent together. Within technical maturity, our definition is technical properties not meeting the demands. Examples of this are: slow transactions, instability, inferior security, underdeveloped consensus and algorithms. Regarding maturity on a governance level, legislation and regulations are the most prevalent issues being pointed out.

Table 6: Identified barriers from literature

The drivers and barriers identified in prior literature are presented in the concise matrix that follows. The matrix is helpful for identifying the most prominent drivers and barriers.

	Drivers					Barriers					
	Cost saving & transaction automation	Efficiency	Decentralization	Transparency/openness	Security	Security	Privacy	Scalability	Interoperability and diffusion	Cost, risk, environmental concern	Maturity
Beck et. al (2018)	X	X			X		X	X		X	X
Beck et. al (2017)			X	X	X		X			X	
Beck et. al (2016)	X	X			X			X		X	X
Beck & Müller-Boch (2017)	X		X	X	X						
Fridgen et. al (2018)		X									X
Gatteschi et al. (2018)	X	X	X	X	X	X	X	X	X	X	X
Gausdal et. al (2018)	X	X			X				X		X
Giraldo (2018)	X	X	X					X			
Glaser (2017)	X	X	X	X				X	X		X
Gomber et. al (2018)	X	X		X	X	X		X			X
Hans et. al (2017)	X	X	X	X	X		X	X	X	X	X
Kostrikova & Rivza (2017)	X	X	X	X	X	X		X		X	X
Lacity (2018)	X	X			X			X	X		

Li et al. (2018)	X		X	X	X	X					
Mohanta et al. (2018)	X	X	X	X	X	X	X	X		X	X
Nowiński & Kozma (2017)	X	X	X		X	X			X		X
Risius & Spohrer (2017)	X			X		X	X	X		X	X
Schweizer et. al (2017)	X	X	X	X		X		X	X		X
Shang et. al (2018)			X	X	X						X
Yli-Huumo et. al (2016)						X	X	X			

Table 7: Concept matrix of drivers and barriers in papers reviewed

2.5 Implications for the next steps

Through our selection process of literature, the first thing to note is the limited research on the topic in general, not just within IS-journals. We ended up with literature selected from varied research journals beyond IS through forward and backward search.

The most surprising finding we made is that security was identified as a barrier in several publications. Previously, the general understanding has been that security is one of the most solidified strengths of blockchain and it has been regarded as an important driver for adoption.

It’s difficult to pinpoint whether this is related to the security of the technical properties of blockchain, or whether it’s a biased sense of insecurity based on technological immaturity, lack of knowledge, or uncertainty regarding unclear regulations. It seems to be a combination of the above, as well as a general fear of the nature of public blockchains.

As for interoperability and diffusion, this is likely tightly connected to the maturity of the technology. Blockchain is still new, and proven implementations have yet to develop interoperability platform(s) to allow communication between different blockchains or communication to and from legacy systems. This immaturity makes current diffusion through value chains a challenge. We are not likely to see the promised value gain from blockchain before we see a higher level of diffusion. This can be a slow process until we see the promised value proven in practice.

The identified driving forces of blockchain are consistent through the theory in the different journals. The most definite ones being increased efficiency, cost savings/automation of transactions, decentralization and transparency.

These driving forces are also widely used as arguments for the technology, but the papers focusing too much on the advantages seem pale in comparison to the more reflected ones which takes a realistic approach towards the situation. Even though there are many potential advantages by adopting the technology, an organization will have to do a thorough SWOT analysis before deciding to adopt, and we consider it unrealistic to base that analysis on any of the articles who had an overly positive attitude towards the technology without critically reviewing its shortcomings.

There is currently a big gap in knowledge within the IS-field on the drivers and barriers for blockchain adoption, and for blockchain as a whole. We observed a lot of case studies, frameworks and analyses of either specific projects or proposed solutions. These serve as a somewhat weak foundation that cannot be generalized, and we therefore need to solidify the research.

The implications of this literature review are that we have identified a clear gap in IS-research on the motivational factors (drivers) and showstoppers (barriers) for blockchain adoption in organizations.

The main direction forward is now to further explore the drivers and barriers identified and investigate which of them matter the most ranking them in terms of significance. For this purpose, we decided to collect quantitative data from a survey and perform an AHP analysis to determine the relative weight and importance of the identified variables.

There are a set of questions we want to answer in our research:

1. What is the status of blockchain adoption in organizations?
2. What drives organizations to adopt blockchain?
3. Which barriers prevent organizations from adopting blockchain?

3. Method

This further investigation of drivers and barriers was designed as a quantitative research with data collected through a survey with pairwise comparisons designed based on the analytical hierarchy process (AHP). AHP is a structured approach for deriving priorities among diverse elements. The survey targeted domain experts and was distributed through conferences, business networks and clusters as well as to relevant individuals identified through LinkedIn and personal professional networks.

The reasoning of our approach is that to answer our research question we need to measure and analyze the relative importance of several criteria, well suited for quantitative methods and AHP.

3.1 Plan for empirical data collection and analysis

The plan for the empirical data collection and analysis was developed during the early phases of the thesis as we were revising and continuing the work on the initial literature review from an earlier course in the masters programme. As we started implementing the plan, we updated it and had several iterations.

The main activities for empirical data collection and analysis are listed below.

1. Survey design
    1. Designing questions, testing the survey design, etc.
2. Identifying distribution channels
    1. Where we should distribute the survey, who we should contact (individuals, organizations, clusters, business networks)
3. Survey distribution
    1. Sending the survey through the selected channels with continuous follow-ups
4. Categorize responses and metadata
    1. Categorize responses from the survey by our selected parameters
5. Analyze findings
    1. From the survey, perform the AHP data analysis and end up to findings

The chart below shows the timeline.

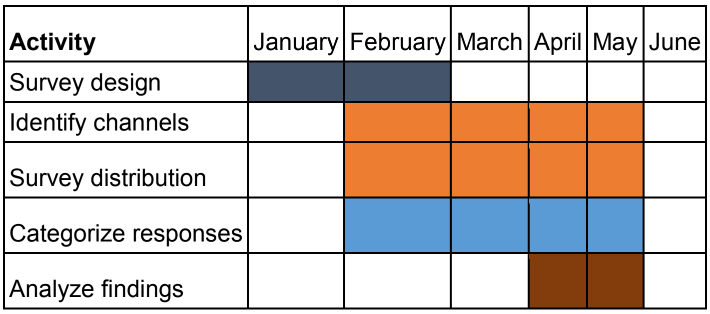

Figure 7: Master thesis survey timeline

January: The focus was to design the first iteration of the questionnaire and identifying the distribution channels we would use while also working on the literature review.

February: We worked mainly on continued design and a new iteration of the survey, while distributing the survey and revising the literature review in parallel.

March: Overlapping back to February, respondents were continuously categorized as they responded while following up and reminding potential respondents.

April: Started analyzing the preliminary data and reporting these in the thesis while setting up a flat file with all metadata related to the responses. Setting up the structure and writing on the thesis was also important in this period.

May: Focus on following up the potential respondents to get as many responses as possible while analyzing the data and performing consistency validation while writing the finishing chapters of the thesis.

3.2 Survey design

From research literature we identified and listed 4 of the most prominent drivers and barriers of blockchain adoption.

The most prominent drivers for blockchain are:

- Cost savings & automation of financial transactions
- Security
- Efficiency
- Decentralization

The most prominent barriers are:

- Maturity
- Scalability
- Cost, risk, environment
- Privacy & security

Out from this, we separated some of them to more specific factors, and ended up with 5 drivers and 5 barriers for the AHP analysis.

3.2.1 Drivers

Transaction Automation

This driver represents the benefits and potential cost savings of automating transactions either within the organization or between organizations. This would in most scenarios be done using so-called “smart-contracts” (a computer program that directly controls the transfer of digital currencies or assets between parties under certain conditions).

Decentralization

This driver represents the benefits of decentralizing and ensuring distributed control among actors. For instance, in a supply chain, the different actors can share ownership and responsibility of updating and verifying records.

Transparency

This driver represents the benefits of enabling transparent actions, transfers and transactions internally or between organizations that will be auditable by the parties involved.

Reliability

This driver represents the benefits of having a system that is consistently up and running and trusting that it always performs the same actions given the same conditions. Minimal downtime and maximum predictability are key here.

Immutability

This driver represents the benefits of ensuring the ability to verify that data has not been altered. Trust can be increased with this feature.

3.2.2 Barriers

Scalability

This barrier represents the drawbacks of not being able to handle additional traffic in a seamless manner.

Interoperability

This barrier represents the drawbacks of not having interoperability with various systems, either internally or externally.

Cost

This barrier represents the drawbacks of the cost of implementation and the financial risk involved in implementing the technology.

Technical maturity

This barrier represents the drawbacks of lacking technical properties demanded by users/customers.

Knowledge

This barrier represents the drawbacks of lacking knowledge about the technology, its applicability, potential benefits and disadvantages.

3.2.3 Survey structure and contents

The survey had an estimated completion time of 6 to 8 minutes and consisted of 6 pages.
The first page introduces the topic and contents of the survey. The second page gathers relevant data about the respondent, e.g. demography, industry, position, etc. For screenshots of the full survey see attachment 1 - survey.

The third page is where we started to measure the criteria for AHP, starting with a pairwise comparison of the identified drivers. The identified drivers were defined and clarified on top of the page, followed by a brief explanation of the intensity of importance scale (1-9).
Following, there were 10 sliders with a pairwise comparison of drivers, with 18 values (1-9 on each criteria), and the page ending with an open input for other suggested drivers. The fourth page was structured identically for barriers.

The fifth page wraps up the contents asking participants for further input or comments on the survey, and the last page contained nothing but a “thank you” notice to the respondent.

3.2.4 Survey validation and customization

During the design of the survey and several iterations of it, we experienced limited functionality in the chosen service, SurveyXact, for our desired purpose. SurveyXact is the survey tool provided by the University and ensures full anonymity for all the responses collected (for instance, ip addresses are not stored). Ensuring anonymity was important for the survey and the related application that was made to NSD. Nevertheless, SurveyXact proved cumbersome to use as there was no features in the program to scale the sliders to that the text/factors would appear on the endings regardless of screen dimensions, so we had to manually program that in HTML using the advanced tool for creating surveys.

Neither was there a way of validating that the sliders were moved, or a way to make them start on the center value of 1. The way to solve this was to find the question variable name in the survey editor, and then add a second hidden question with an activation rule based on the value of the slider variable. The slider had a default position outside the visible 1-9 range on each side (with a value of 19), which acted as the activation value for the hidden question, which then prompted the respondent to “Please position the slider for (criteria X) v (criteria Y) in the desired position”. The hidden question validation rule was set so that it was never validated, so the only way to validate and continue through the survey was to position the slider in a desired position to deactivate the hidden question. See screenshots in attachment 2 - survey validation.

In addition, the dataset exports of the survey were not compliant with the data set desired to export for AHP, which required manual data extraction and input in a separate spreadsheet.

3.2.5 Survey pilot test

To check the data validity and receive feedback on the survey, we performed a live pilot with an engineer with the role of product owner in an energy production company.
The respondent was observed while he completed the survey, and the excerpt shows the result from the respondent reaction, questions asked, and the respondent thinking out loud to himself (Attachment 3 - Survey pilot test). Based on the pilot test and feedback we received we did some adjustments to the first page by clarifying the expected time, and highlighted the relevant definitions and number scale to inform the respondents in an easier way.

3.2.6 Survey distribution

In the process of selecting distribution channels we considered homogeneity as homogeneous respondents are desired since they permit more exact theoretical predictions than may be possible with a heterogeneous group (Calder, B. J. et. al., 1981). In our thesis it was important for us to analyze the different views on the technology both on an aggregated level but also to see whether the different subgroups (industries) had variations.

The survey was distributed to management personnel, middle managers, consultants and engineers. We define management personnel as managers of specific business units in an organization (e.g. finance, acquisition, production, stocking) as they have domain knowledge of their respective fields and therefore can offer the most reliable data and precise insight on the topic.

We used relevant conferences, business clusters, personal networks, and LinkedIn targeted messages and “InMail” features to reach relevant people in our population.

We contacted several clusters for help with distributing the survey, and got it distributed through four relatively large clusters:

- The chamber of commerce in Kristiansand
- Digin - The ICT cluster of southern Norway
- Blockchangers community (slack and Facebook)
- Norway's Bitcoin and Blockchain association (on Facebook)

We collected business cards and relevant respondents at the following conferences:

- Southern Norway’s oil and energy conference
- Practical use of blockchain technology
- Smart health digital conference
- Software 2019
- The digital conference
- Oslo Blockchain Day

As illustrated in figure 7, the survey distribution began in the end of February and continued until our last accepted answer the 24th of May. While following up and contacting more potential respondents we also worked in parallel with processing the data as they were available.

3.3 Research approach - AHP

The analytical hierarchy process (AHP) is a multicriteria analysis method used to derive ratio scales from paired comparisons. AHP has found its widest applications in decision making, planning and resource allocation (Saaty, 1987). It is one of the most popular and most powerful techniques for decision making. AHP is generally used to derive priorities based on different sets of pairwise comparisons (Forman & Peniwati, 1998). When applying AHP to a problem one needs a hierarchic structure to represent the problem, and pairwise comparisons that highlights the relations within this structure.

The following model illustrates the hierarchical model in the context of our research, where the overall objective of the research question is twofold. 1) identify the most prominent drivers, and 2) identify the most prominent barriers. These main goals are parent elements of the criteria defined as drivers and barriers, respectively.

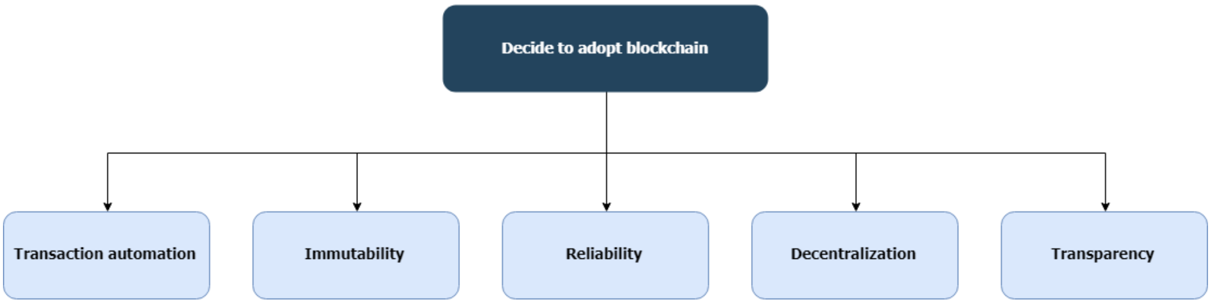

Figure 8: Model for drivers

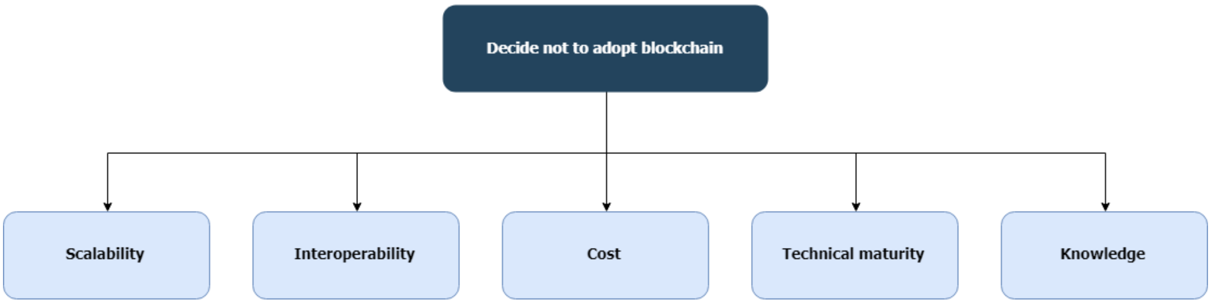

Figure 9: Model for barriers

The fundamental scale for making pairwise comparisons among the criteria ranges from 1 to 9. With basis in the definitions from (Saaty, 1987) we defined the scale for the comparisons as it follows:

Intensity	Definition
1	Equal importance
3	Moderate importance of one over the other
5	Essential or strong importance over the other
7	Very strong importance over the other
9	Extreme importance over the other
2,4,6,8	Intermediate values between the judgements, when compromise is needed

The rationale of using AHP is connected to the population this study is targeting and the research topic. We are looking for expert opinions and personnel with domain knowledge on the topic. So, we are not addressing a wide population but rather a small group of experts from which we need to extract knowledge.

To analyze the collected data, we performed this AHP analysis on a spreadsheet developed by Klaus D. Goepel (2013). The excel contains the algorithms to calculate the scores. We consolidated the data for all respondents including the outcomes of the AHP analysis and the metadata into a master spreadsheet for further analysis. For spreadsheet overview see attachment 4 – Spreadsheet from AHP analysis, and attachment 5 – Master excel data file.

3.3.1 Survey data collection process

For the data collection and processing of the data, we first defined a plan and subsequently worked according to the plan.

The first two phases were for preparation aiming to structure the data collection as well as secure its quality. Ensuring the quality of the survey before distribution was paramount to avoid using respondents for a survey we would have to rework.

The numerous iterations of the survey ensured that the data we collected was relevant and reflected our research problem.

It was then important to have a clearly defined approach to the distribution of the survey, where we identified clusters, conferences, organizations and individuals within the different industries that were desired to respond to our survey.

When the survey was finally distributed, we worked continuously with following up the potential respondents to ensure as many answers as possible and asked for suggestions to who we should contact if the one we contacted didn't feel comfortable answering.

Phase two and three were the most demanding ones as they required a lot of traveling to conferences, many phone calls, emails and personal approaches to get enough data.

The process is visualized as follows:

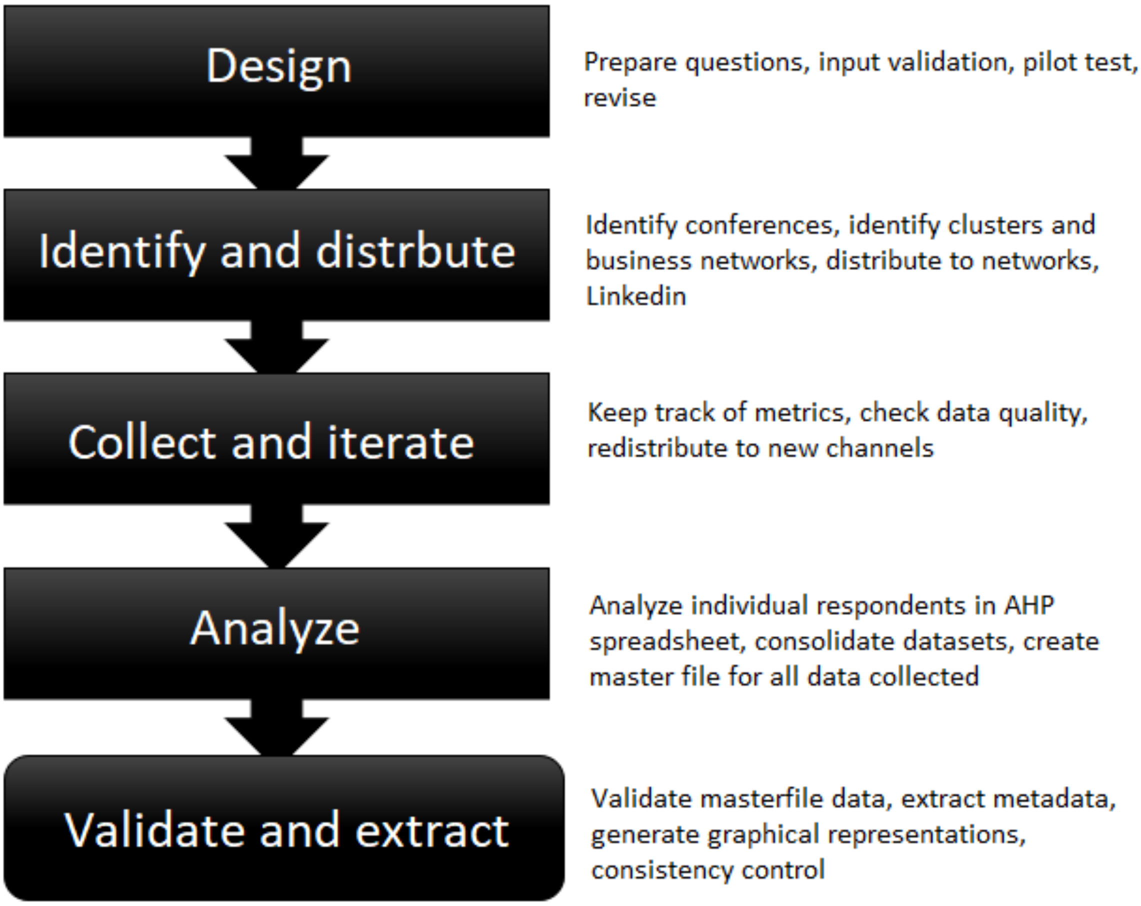

Figure 10: Collection approach

3.3.2 Aggregation of data

Aggregation of several respondent judgements in AHP are commonly done in one of two methods: the aggregation of individual judgments (AIJ) and the aggregation of individual priorities (AIP) (Forman & Peniwati, 1998). In other words, with AIJ the judgements per each factor are aggregated while with AIP the priorities are aggregated. The choice of method is based on whether the respondents are assumed to be a synergistic unit or a collection of individuals.

For this study our group members act as individuals so, AIP is the chosen method for data aggregation. As our respondents are domain experts across several industries, geographical locations and roles within the organizations, we cannot consider them as a synergistic unit. If the study was rather on a group of individuals within the same organization and without the broad demographic we have, AIJ could have been suitable.

For AIP, one may take either a geometric mean or an arithmetic mean. The geometric mean is more consistent with the meaning of both judgments and priorities in AHP, so this is the preferred mathematical procedure. If the respondents have different weights or priorities, one can also calculate a weighted geometric mean of priorities (Forman & Peniwati, 1998), but in this study each respondent has equal weight.

The geometric mean is the n root of the product of n numbers, expressed as:

$$\left(\prod_{i=1}^{\eta} \alpha 1\right)^{\frac{1}{\eta}} = \sqrt[\eta]{\alpha 1 \alpha 2 \cdots \alpha \eta}$$

Formula 1: Geometric mean

This calculation of the aggregate priority for each criterion (driver and barrier) were implemented in a spreadsheet and given as a percentage score. The geometric mean across criteria were then normalized.

3.3.3 Consistency calculation example

The consistency ratio (CR) is an important indicator to ensure data validity and quality. By checking for consistency among the responses, we can exclude respondents that are inconsistent or contradictory to themselves.

The CR shows if and to which degree a respondent has been consistent in the pairwise comparisons. We start by using of a matrix of the pairwise comparisons, example:

1	Participant 1						0		00.01.1900	
	1	2	3	4	5	6	7	8	9	10
1	1	1/4	1/6	1/4	1/8	0	0	0	0	0
2	4	1	1/5	1/3	1/8	0	0	0	0	0
3	6	5	1	1/2	1/4	0	0	0	0	0
4	4	3	2	1	1	0	0	0	0	0
5	8	8	4	1	1	0	0	0	0	0
6	0	0	0	0	0	1	0	0	0	0
7	0	0	0	0	0	0	1	0	0	0
8	0	0	0	0	0	0	0	1	0	0
9	0	0	0	0	0	0	0	0	1	0
10	0	0	0	0	0	0	0	0	0	1

Figure 11: Participant matrix (Goepel, 2013)

This shows the pairwise comparisons for criteria 1 to 5 from the respondent and their relationships.

We start by calculating the geometric mean for each criterion.

$$\left(\prod_{i=1}^{\eta} \alpha 1\right)^{\frac{1}{\eta}} = \sqrt[\eta]{\alpha 1 \alpha 2 \cdots \alpha \eta}$$

Formula 2: Geometric mean

1	Participant 1					0		00.01.1900	
	1	2	3	4	5	6	7	8	9	10
1	1	1/4	1/6	1/4	1/8	0	0	0	0	0
2	4	1	1/5	1/3	1/8	0	0	0	0	0
3	6	5	1	1/2	1/4	0	0	0	0	0
4	4	3	2	1	1	0	0	0	0	0
5	8	8	4	1	1	0	0	0	0	0
6	0	0	0	0	0	1	0	0	0	0

	Geometric mean
1	0,26
2	0,51
3	1,30
4	1,89
5	3,03
SUM	6,99

Figure 12: Geometric mean calculated

The geometric means are then normalized, to find the eigenvector of each criteria, the sum adding up to 1.

1	Participant 1					0		00.01.1900	
	1	2	3	4	5	6	7	8	9	10
1	1	1/4	1/6	1/4	1/8	0	0	0	0	0
2	4	1	1/5	1/3	1/8	0	0	0	0	0
3	6	5	1	1/2	1/4	0	0	0	0	0
4	4	3	2	1	1	0	0	0	0	0
5	8	8	4	1	1	0	0	0	0	0
6	0	0	0	0	0	1	0	0	0	0
7	0	0	0	0	0	0	1	0	0	0

	Geometric mean	Eigenvector	In %
1	0,26	0,038	3,8 %
2	0,51	0,072	7,2 %
3	1,30	0,186	18,6 %
4	1,89	0,270	27,0 %
5	3,03	0,433	43,3 %
SUM	6,99	1,00	

Figure 13: Eigenvector calculated

To find the CI, we need to get the lambda-max (ƛmax). We find this value by taking the summarized value of multiplying the sum of each column by its eigenvector.

1	Participant 1					0		00.01.1900	
	1	2	3	4	5	6	7	8	9	10
1	1	1/4	1/6	1/4	1/8	0	0	0	0	0
2	4	1	1/5	1/3	1/8	0	0	0	0	0
3	6	5	1	1/2	1/4	0	0	0	0	0
4	4	3	2	1	1	0	0	0	0	0
5	8	8	4	1	1	0	0	0	0	0
6	0	0	0	0	0	1	0	0	0	0

	Geometric mean	Eigenvector	In %
1	0,26	0,038	3,8 %
2	0,51	0,072	7,2 %
3	1,30	0,186	18,6 %
4	1,89	0,270	27,0 %
5	3,03	0,433	43,3 %
SUM	6,99	1,00	

Sum values	23,00	17,25	7,37	3,08	2,50
Multiplied by vector	0,87	1,25	1,37	0,83	1,08

Figure 14: ƛmax calculated

ƛmax= 5,41

If ƛmax=η we have a perfectly consistent matrix.

To calculate the CR, we divide the consistency index (CI) with a random index (RI).

With ƛmax we can calculate the consistency index (CI) given by:

$$CI = \frac{\lambda max}{\eta - 1}$$

Formula 3: Consistency index

Where η is the number of criteria being compared.

$$CI = \frac{5{,}41}{5-1} = 0{,}\,10210489$$

Lastly, to calculate CR, we divide the CI value with a random index (RI). The RI is the CI of a large sample of purely random judgements of corresponding values. A lookup table (8) with RI values below are derived from Saaty (1980).

Matrix size	**Random consistency index (RI)**
1	0.00
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

Table 8: Random index derived from Saaty (1980)

We then calculate the CR of a respondent by dividing the individual CI with the corresponding RI:

$$CR = \frac{CI}{RI}$$

$$CR = \frac{0{,}10210489}{1{,}12} = 0{,}09116508$$

Formula 4: CR

Saaty (1990) sets the limit of CR <0.10 (10%). Several other studies indicate that the consistency ratio may be set higher without it affecting the overall outcome of the study. Apostolou & Hassell (1993) analyzed 61 respondents with individual CR of <0.10, and 65 respondents with consistency ratios of > 0.10. Their results indicate that the global weights difference of the samples are not significant.

Pecchia, Bath, Pendleton & Bracale (2011) increased their CR threshold to 0.2 without it significantly affecting the results. Battistoni, Fronzetti Colladon, Scarabotti & Schiraldi (2013) also found that the inclusion of non-consistent respondents did not significantly influence the results.

These findings provide evidence that we can accept and include responses with consistency ratios over 0.10 without affecting the overall findings. Based on these findings we expanded the CR threshold from <0.1 to 0.2 (20%) for our analysis.

4. Analysis of collected data

4.1 Survey result

The survey was distributed through Norwegian business node networks and through attending conferences. The initial response rate was low, so additional respondents were identified through LinkedIn and personal networks and was distributed to relevant people both nationally and internationally.

4.1.1 Response distribution

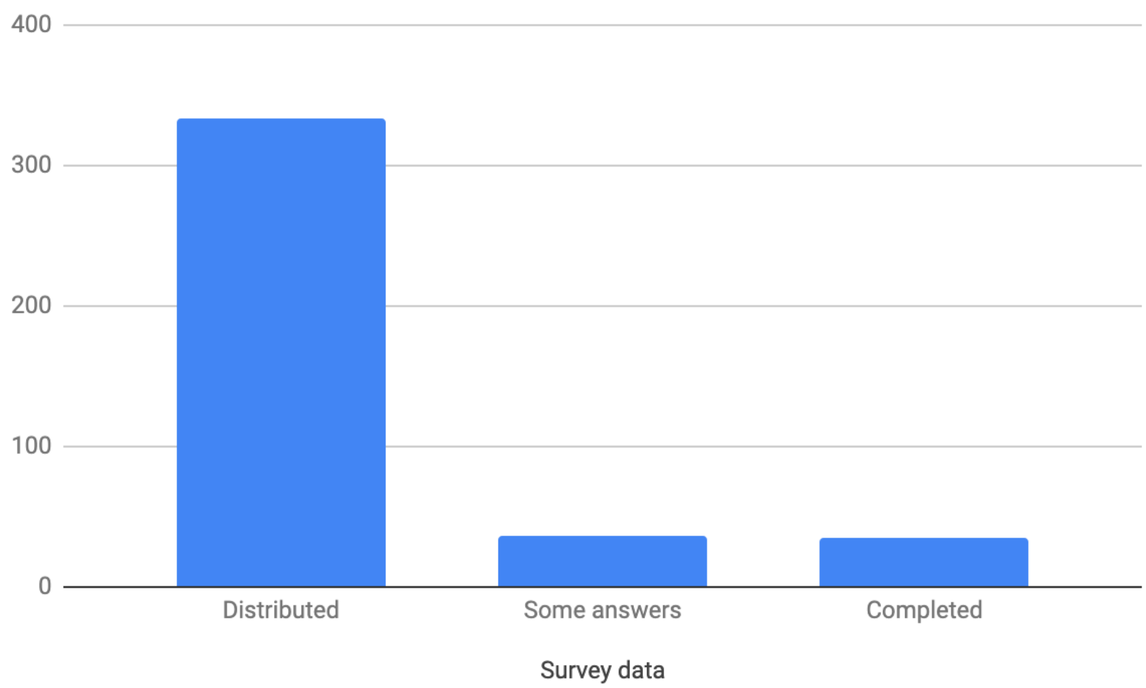

Figure 15: Response distribution status

As seen in the chart above a vast majority of the 405 respondents that we distributed the survey to:

- 333 (82%) opened the survey but did not answer
- 37 (9%) provided partial responses but did not finish
- 35 (9%) completed the whole survey

This shows us that there was a significant number of individuals that opened the survey but did not proceed in answering which indicates that there were very few individuals that considered themselves knowledgeable and experienced enough to respond. This is expected when applying AHP, as the targeted respondents are very specific and limited experts.

4.1.2 Industries

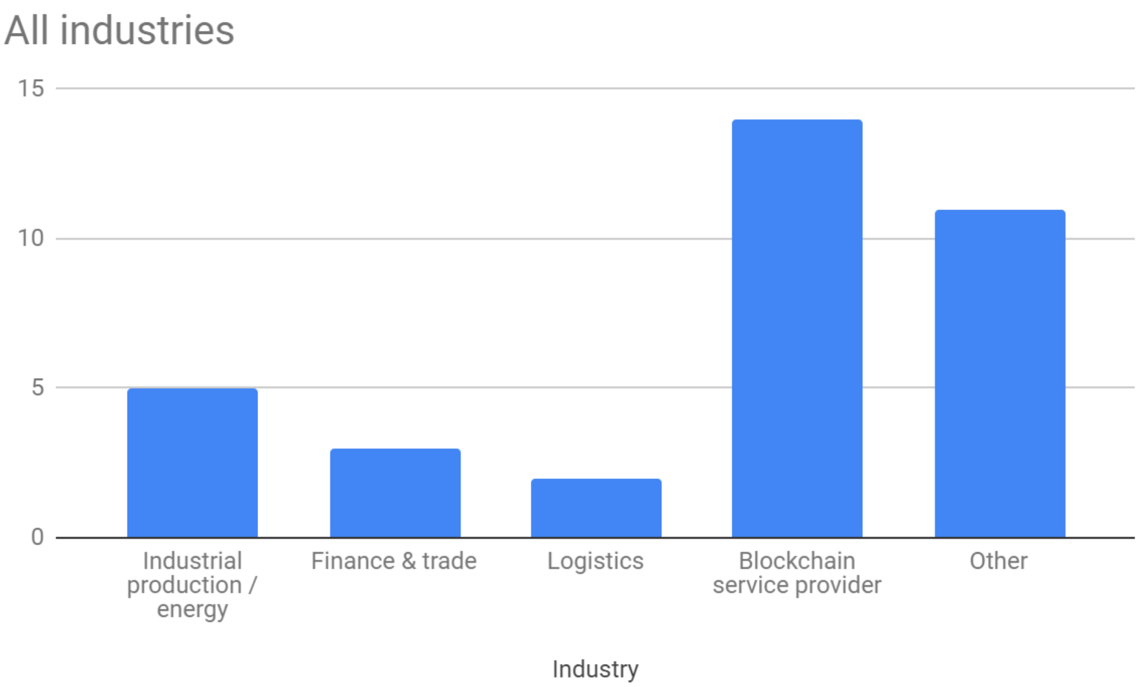

Figure 16: All industries

A majority of the respondents are blockchain service providers or consultants, the second biggest category falling under the group of industrial production and energy.

The “other” category contains the following entries:

- Government
- Education
- Professor
- Media
- Academia
- IT and IT consulting

4.1.3 Positions

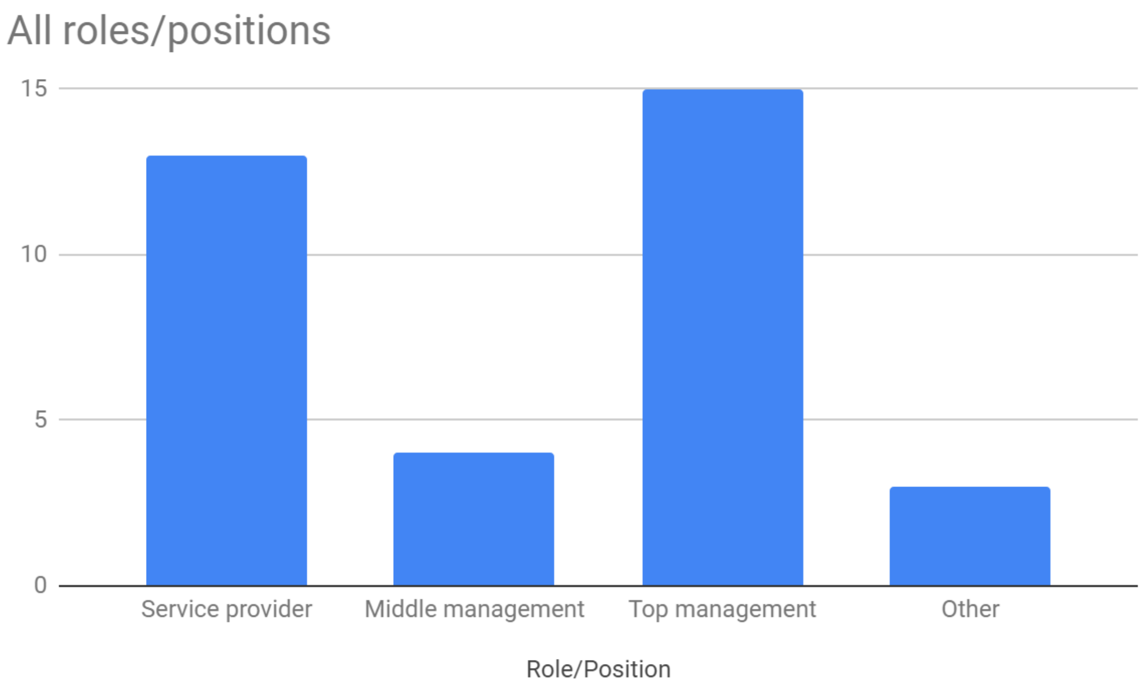

Figure 17: All roles and positions

There is an even distribution between top management and service providers, while middle management comes in the lower end.
The other positions registered are:

- Architect
- Leader of startup
- Academic
- CEO

We see CEO and the leader of startup positions entered under “other”, but these two falls under the top management category and is presumably an entry error from the respondents.

4.1.4 Blockchain project status

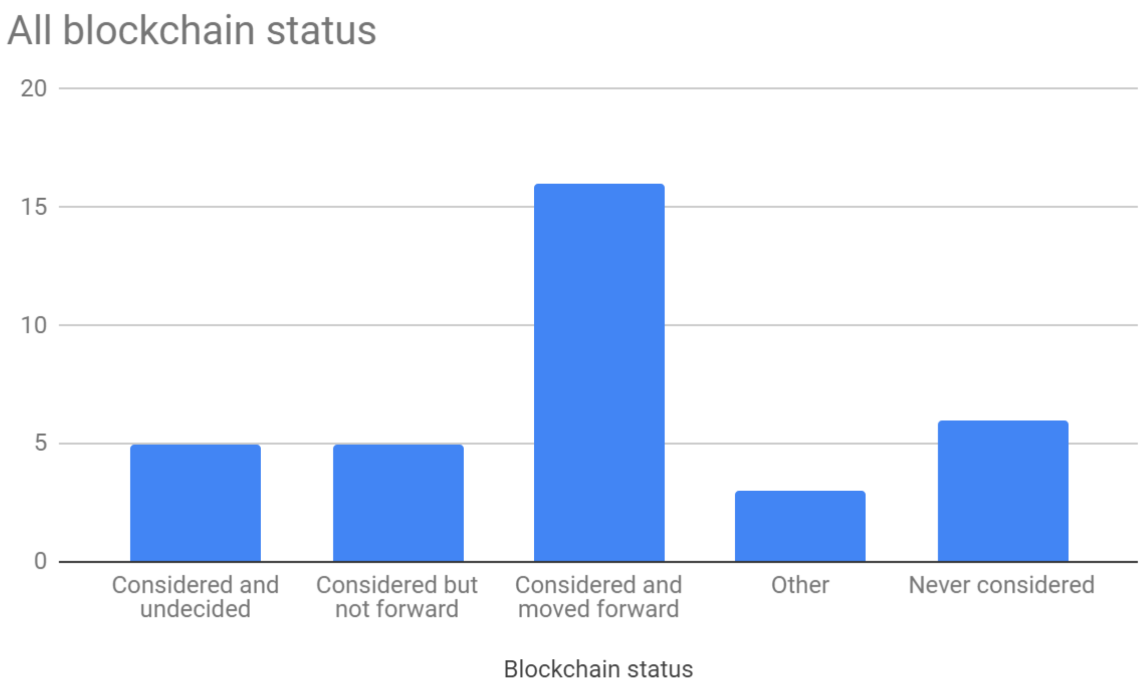

Figure 18: All blockchain status

Most of the respondents, 34.6% said they considered blockchain and moved forward with the project, while the second largest groups never considered blockchain at all. The “other” category contained the following entries:

- Planning to run blockchain nodes for profit
- Not sure
- Don’t know
- Developing blockchain platforms and solutions for others

4.1.5 Demographics

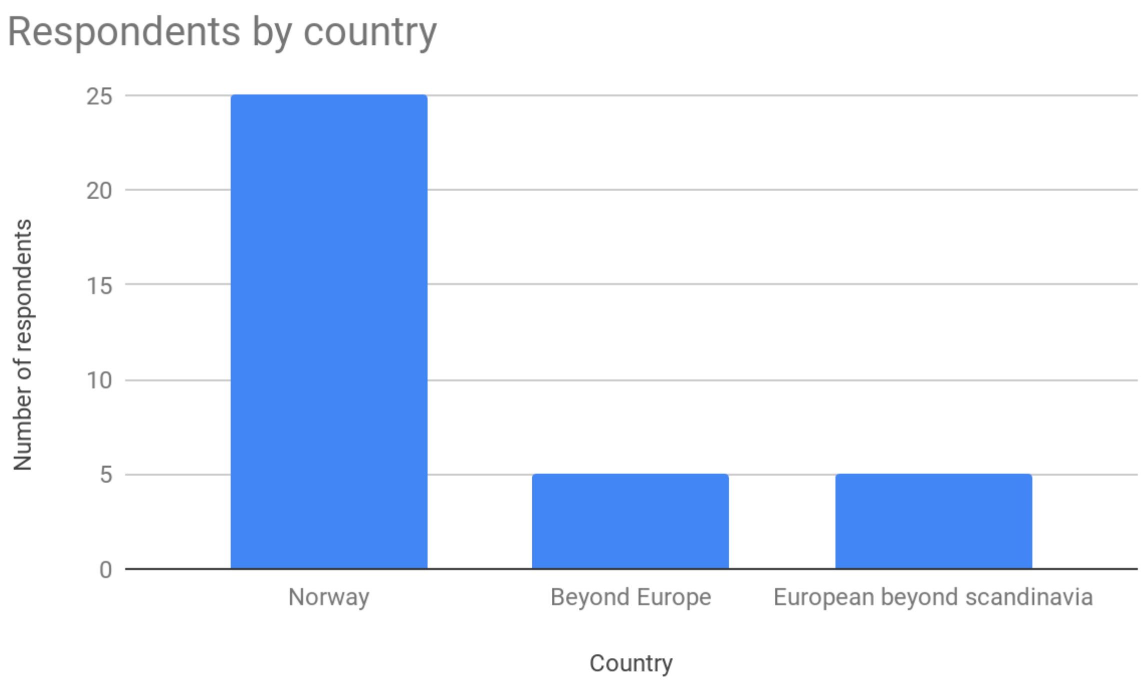

Figure 19: All respondents by country

The vast majority of respondents, 25, conduct business in Norway, while 5 and 5 respectively operate in Europe beyond Scandinavia and beyond Europe.

4.1.6 Organization size

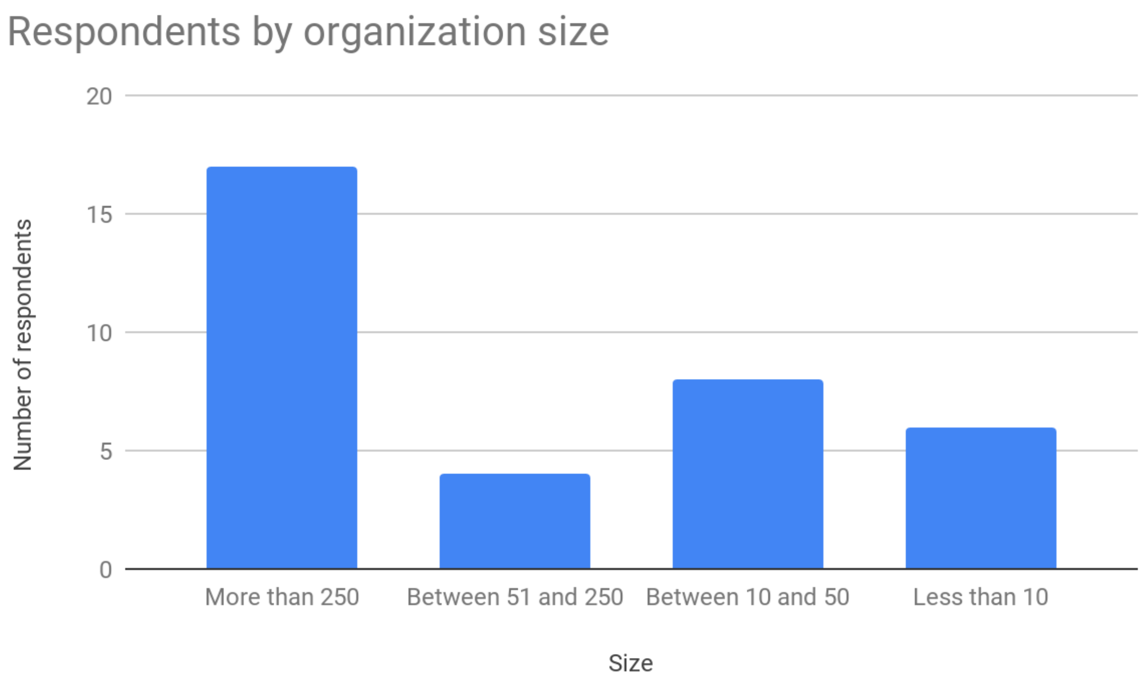

Figure 20: All organization sizes

Most respondents are from larger organizations with over 250 employees, while the second most prominent category is between 10 and 50 employees. The size of the organizations reflects our distribution channels, as many of these conferences are attended by both the large organizations and startups/scaleups.

4.1.7 Additional metadata

In addition to the key barriers and drivers that the respondents were asked to rank, we designed the survey to enable collection of input from respondents for them to identify drivers and barriers that we did not cover or identify from literature.

Additional mentioned drivers
• Standardization of blockchain solutions
• Security tokens
• Blockchain as a service
• Easy and cheap international money transfers - *(Transaction automation)*
• Cost
• Performance - (*Transaction automation)*
• Security - *(Reliability, immutability)*

Table 9: Additional mentioned drivers

In the parentheses we are connecting the mentioned drivers to the criteria defined in the thesis and survey. We see some new drivers here that we cannot directly connect to the defined drivers; standardization of blockchain solutions, security tokens, blockchain as a service and cost.

Some of these mentioned drivers are hard to define, as they are on a superficial and high level. What we mean by this is that, e.g., standardization of blockchain solutions is not a driver in and of itself, nor is security tokens or blockchain as a service.

The top-level functionality is to a certain extent irrelevant in this context. As an example, you apply a security token for an underlying reason (e.g. reliability, transparency, transactions) to reach a goal. The security token is no benefit in and of itself.

Regarding cost, this is a driver that is identified in prior research and documented through the literature review, however it was not prominent enough in research to be selected as one of the five drivers for the further research.

Additional mentioned barriers
• Cross-compatibility with other systems in the industry - *(interoperability)*
• Fear, uncertainty and doubt (FUD) - *(knowledge, technical maturity)*
• Fear of choosing the wrong platform - *(knowledge)*
• Scams
• Scary with new technology - *(technical maturity)*
• Finding the right consultants - *(knowledge)*
• Not sure where to implement the technology - *(knowledge)*

Table 10: Additional mentioned barriers

Most of the additional barriers relate directly to one or more of the defined barriers. However, one new barrier is identified, scams.
The comment is however not detailed enough to define exactly what is meant by the statement or in which context it applies.

4.3 Criteria data results

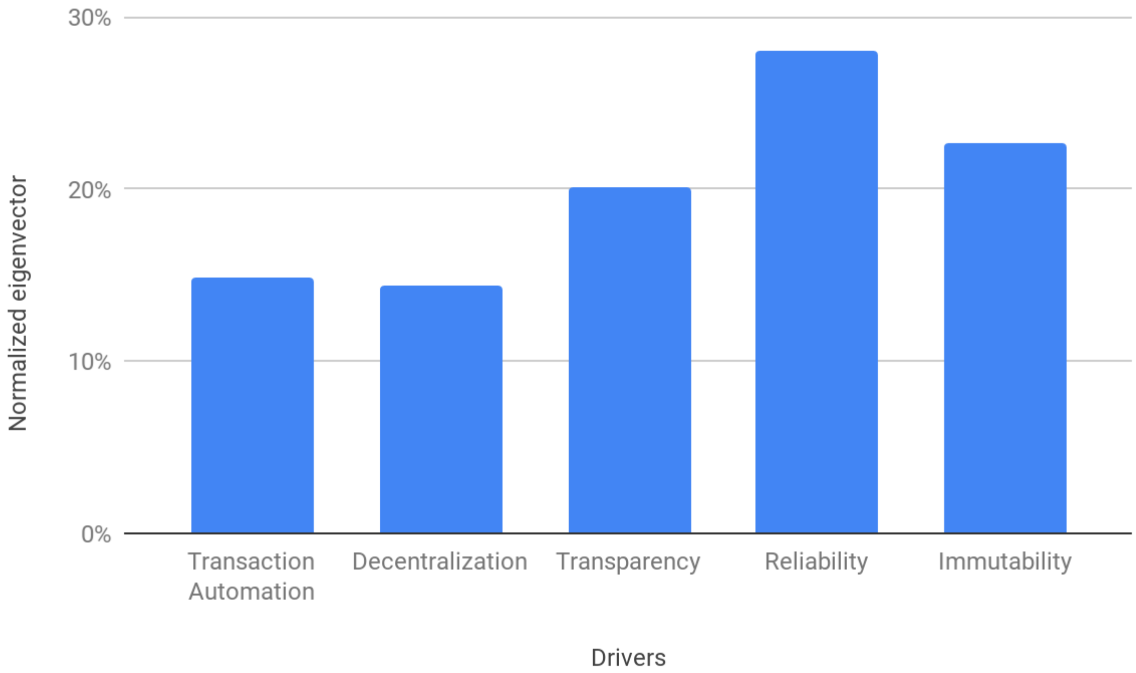

Figure 21: Driver priority rankings

Driver rankings, consolidated and normalized
1. Reliability 28%
2. Immutability 22,7%
3. Transparency 20,1%
4. Transaction automation 14,9%
5. Decentralization 14,4%

Table 11: Driver rankings all

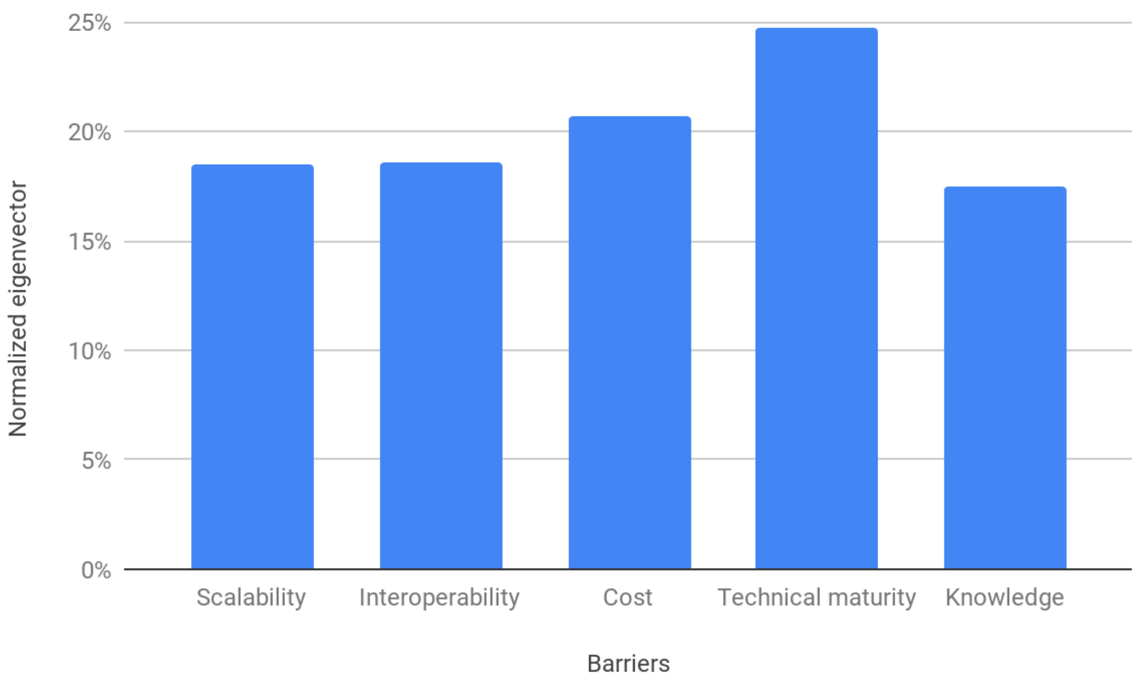

Figure 22: Barrier priority rankings

Barrier rankings, consolidated and normalized
1. Technical maturity 24,8%
2. Cost 20,7%
3. Interoperability 18,6%
4. Scalability 18,5%
5. Knowledge 17,5%

Table 12: Barrier rankings all

4.4 Validity and consistency

The previous presented results had not been filtered according to the requirements of consistency that we apply to this study. As a next step. all respondents' answers were analyzed for consistency, and any dataset surpassing CR <0.20 were removed from the following further analysis as illustrated in the following figure (23):

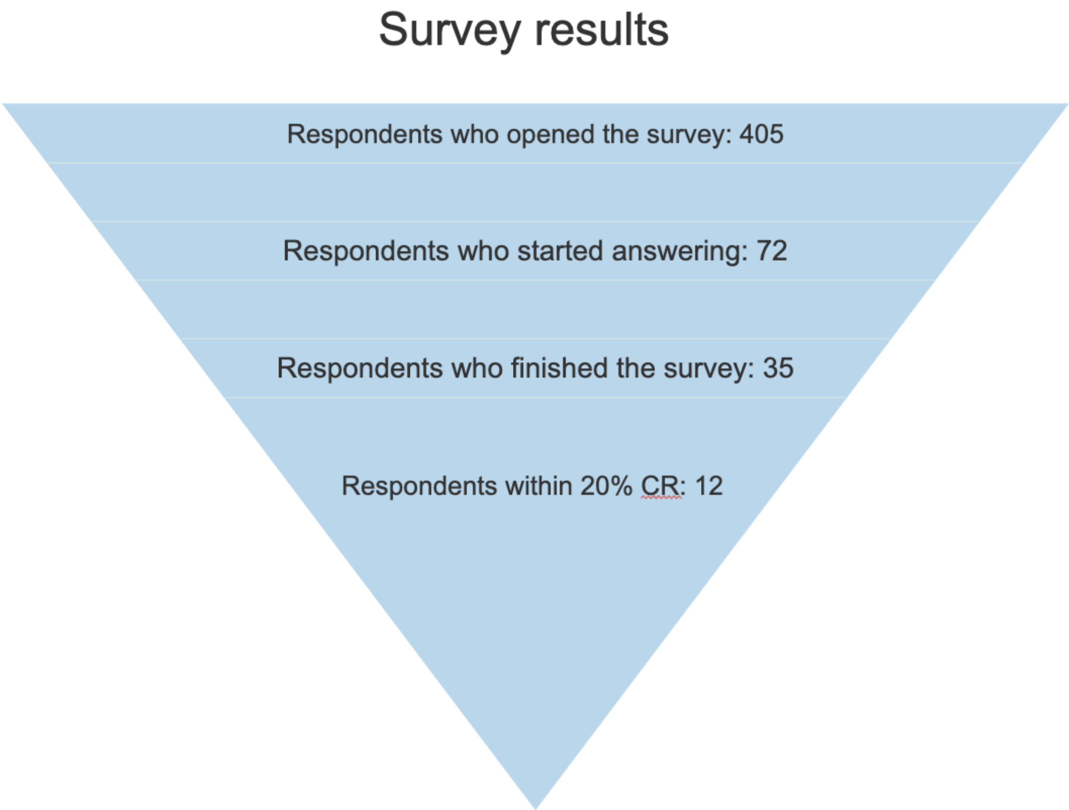

Figure 23: Respondents funneled through consistency

The number of consistent respondents is low. There could be several reasons for this. It is possible that people are still uncertain and do not yet have fully developed ideas because of limited experience and exposure to blockchain technology.
It could also be due to people being unfamiliar with the type of questions we asked and that they are not able to keep track of previous responses, and as a result be unaware that their answers were inconsistent.

In a scenario where SurveyXact had functionality to facilitate for indicating inconsistencies towards the end users this would possibly mitigate some of the inconsistencies and cause the respondents to become aware of the problem and fix their answers before submitting.

4.5 Analysis of results among consistent respondents

4.5.1 Industries consistent

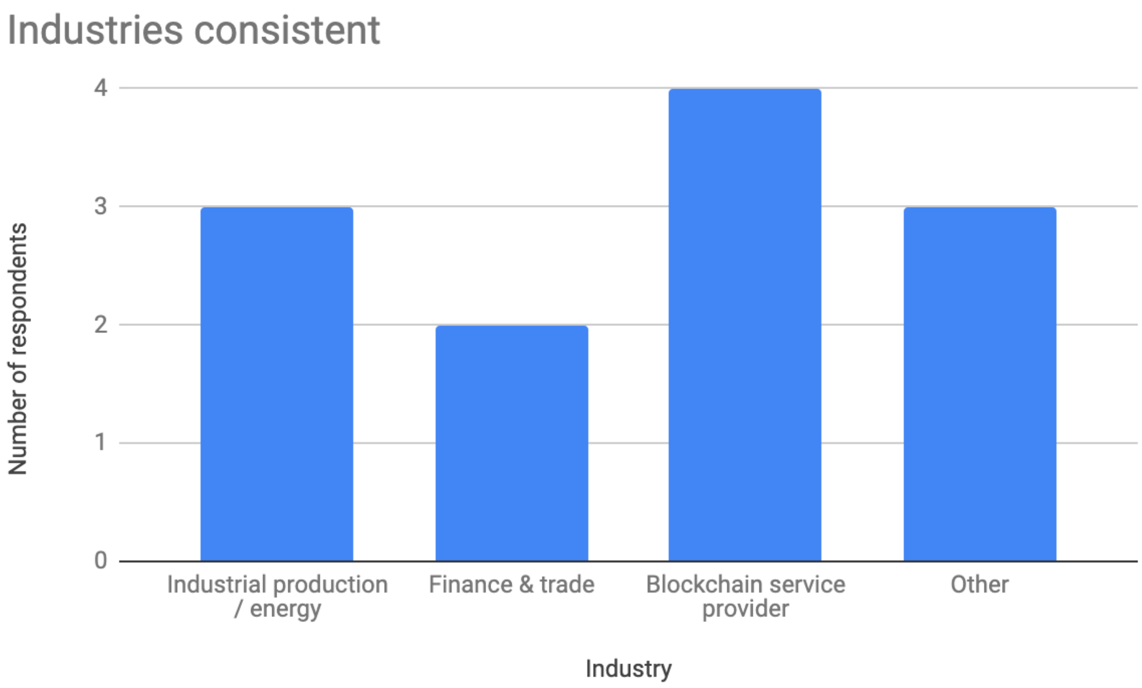

Figure 24: Industry distribution consistent

From the valid respondents, the majority is seen from blockchain service providers, industrial production and energy organizations. The “other” category contains various IT and technology consultancy agencies.

4.5.2 Positions/roles consistent

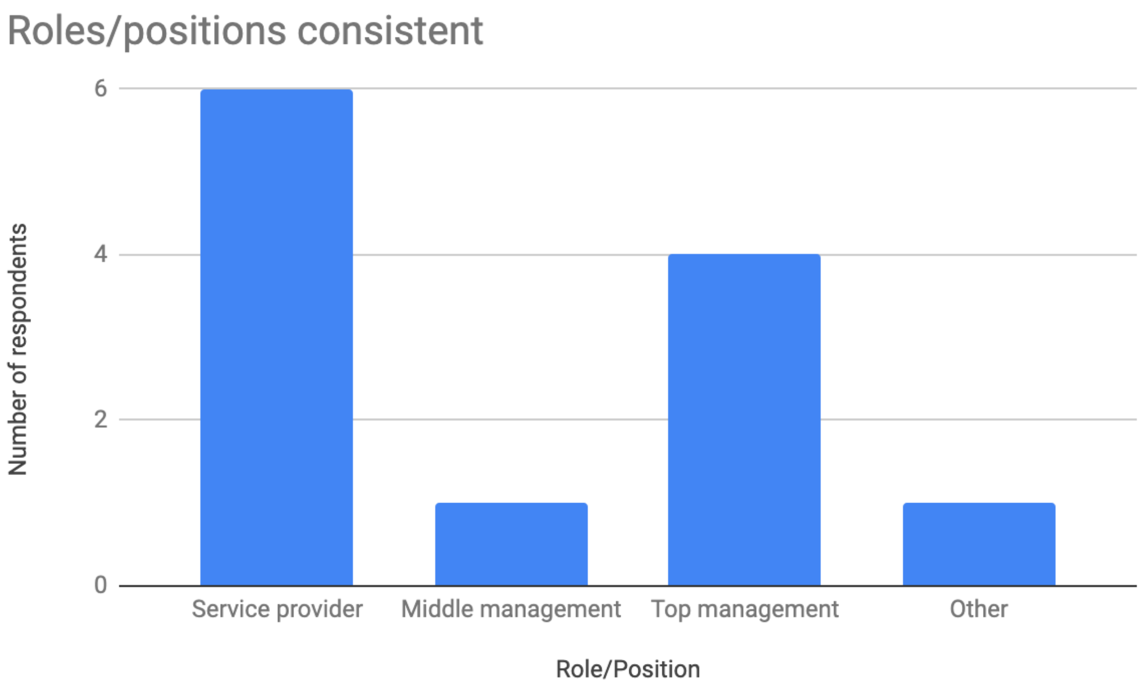

Figure 25: Roles/positions consistent

Most of the respondents are service providers, this category includes engineers, product owners, software developers and general consultants.

4.5.3 Blockchain status consistent

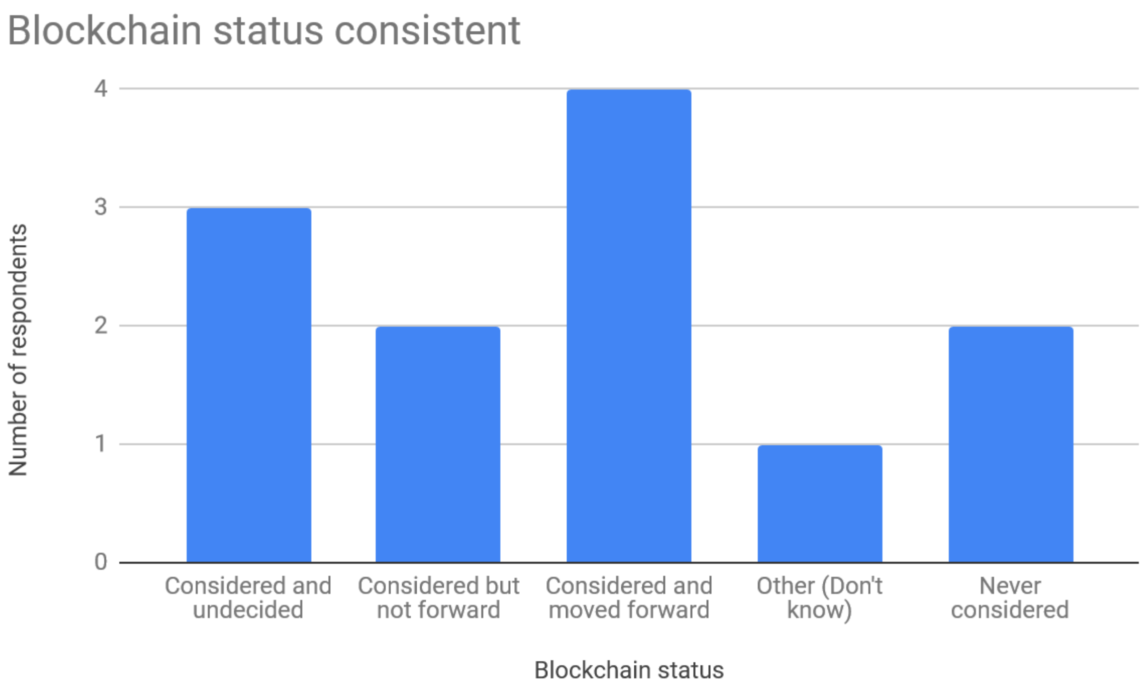

Figure 26: Blockchain status consistent

Most of the valid respondents, 4 out of 12, have considered and moved forward in adopting blockchain technology in one way or another.
8 out of the 12 respondents have considered using blockchain, the 2 “other” are not sure, and 2 said they never considered adopting blockchain.

Based on this status, it’s interesting to analyze the drivers for those who moved forward, and the barriers of those who started an initiative, but stopped.

4.5.3.1 Drivers for the completed projects

To identify the major driver for blockchain projects, we analyzed the responses from respondents that met the consistency requirement.

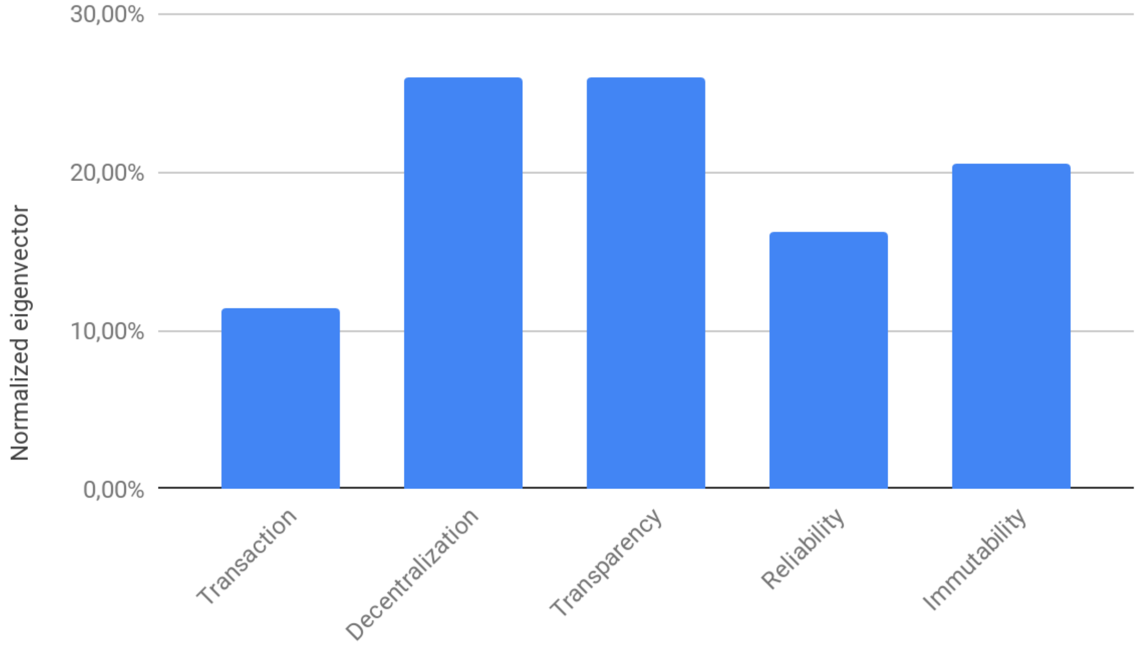

Figure 27: Drivers for completed projects

We see a significant change in the criteria weights when compared to the analysis of the unfiltered results. Reliability jumps far down from being the most weighted driver, to being ranked 4'th. Transparency and decentralization both take big leaps and are the two "triggers" for these continued projects.

Driver rankings, normalized and consolidated for completed projects
1. Transparency 26,0%
2. Decentralization 25,9%
3. Immutability 20,5%
4. Reliability 16,2%
5. Transaction automation 11,4%

Table 13: Driver rankings completed projects

4.5.3.2 Barriers for the cancelled initiatives

The following chart illustrates the analysis of the barriers for these respondents that met the consistency requirement.

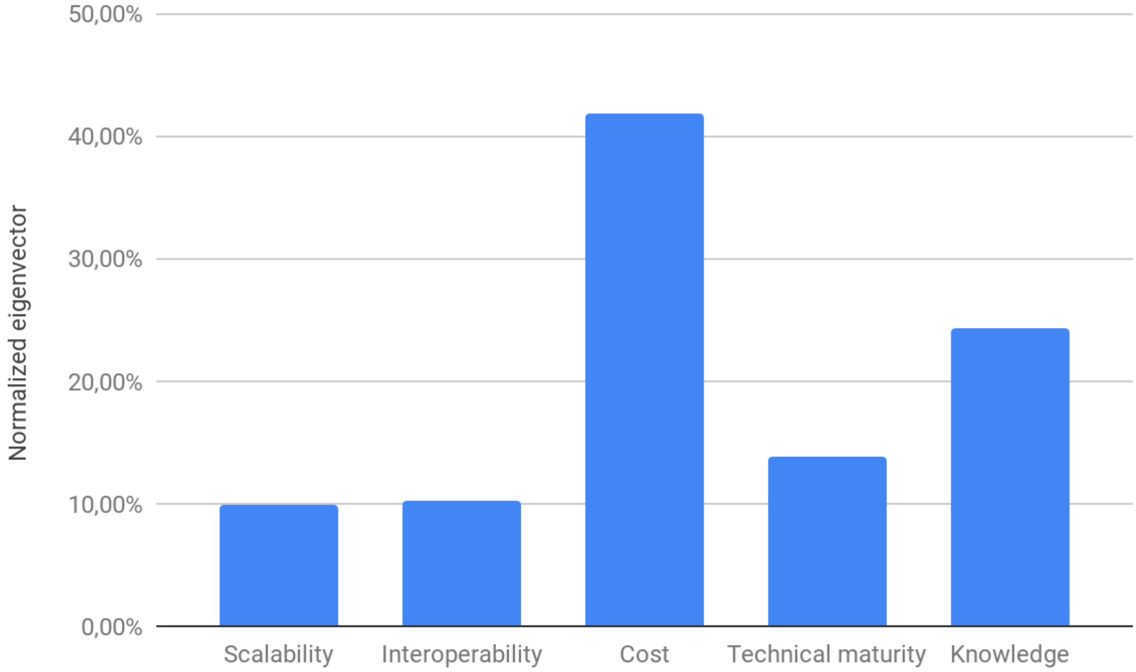

Figure 28: Barriers for cancelled projects

We see a significant difference between the aggregated data on barriers, and the barriers as reported by the respondents with cancelled projects. Cost (41,8%) and knowledge (24,2%) have the highest weight by a large margin, cost being the absolute dominant barrier.

Barrier rankings, normalized and consolidated for cancelled projects
1. Cost 41,8%
2. Knowledge 24,2%
3. Technical maturity 13,8%
4. Interoperability 10,2%
5. Scalability 10,0%

Table 14: Barrier rankings for cancelled projects

4.5.4 Demographics consistent

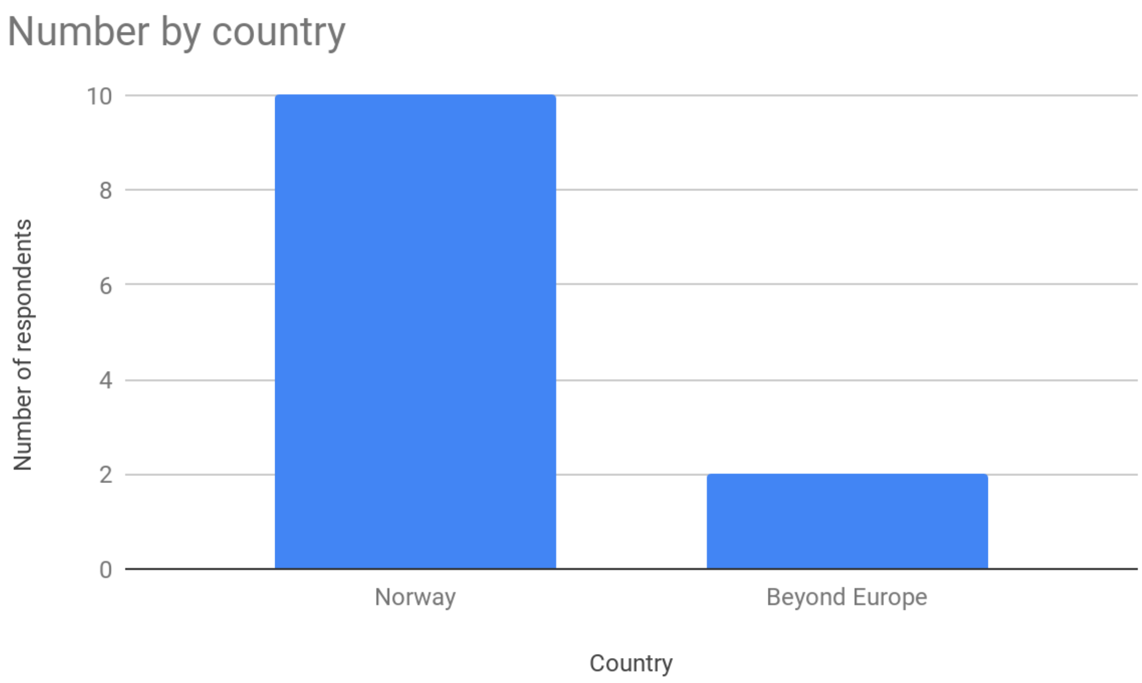

Figure 29: Country distribution consistent

4.5.5 Organization size consistent

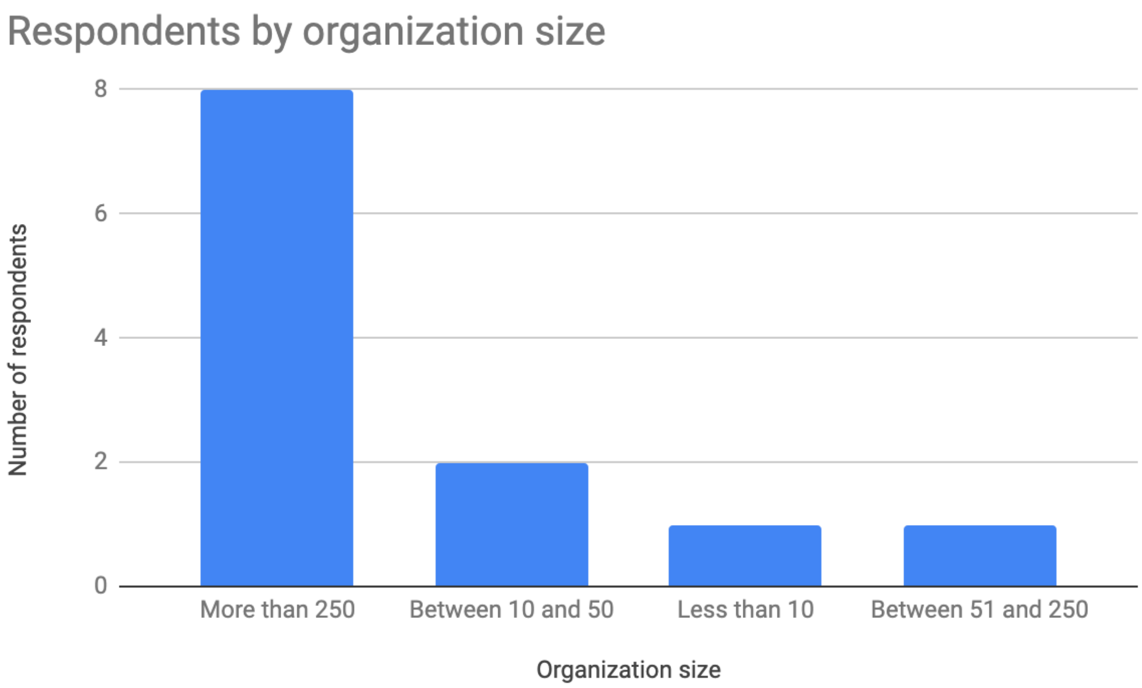

Figure 30: Organization sizes consistent

4.5.6 Aggregated driver and barrier values consistent

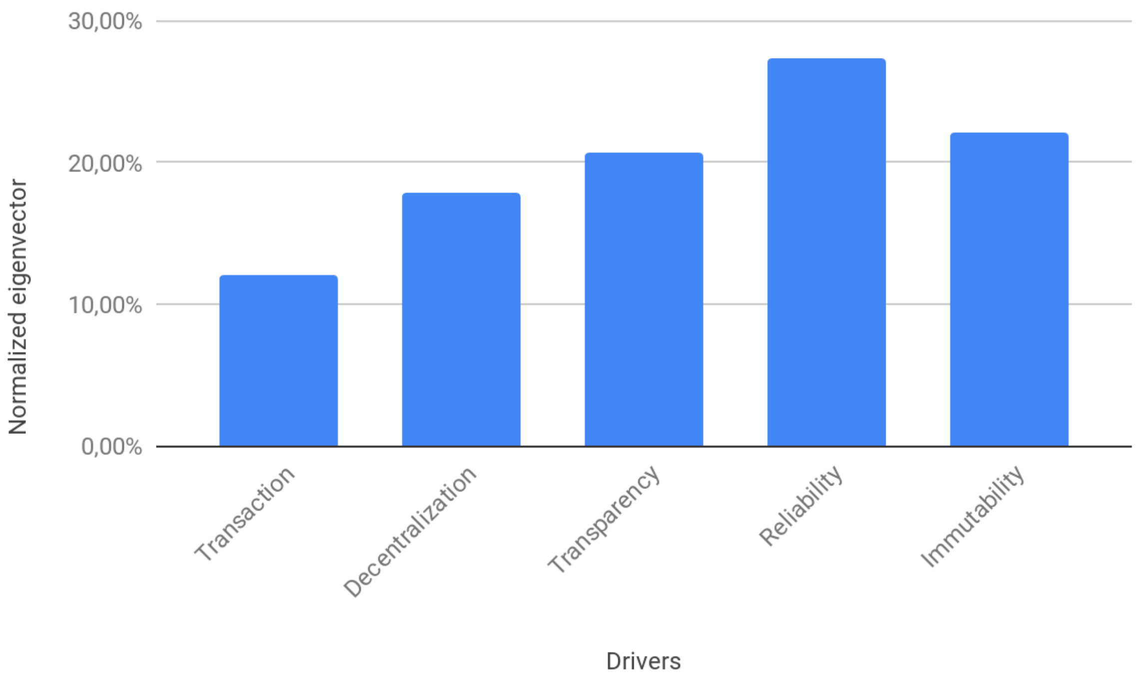

Figure 31: Driver priority rankings consistent

After analyzing the respondents who me the consistency requirements, the ranking of drivers are as follows:

Driver rankings, normalized and consolidated with accepted consistency
1. Reliability 27,4%
2. Immutability 22,1%
3. Transparency 20,6%
4. Decentralization 17,8%
5. Transaction automation 12,0%

Table 15: Driver rankings consistent

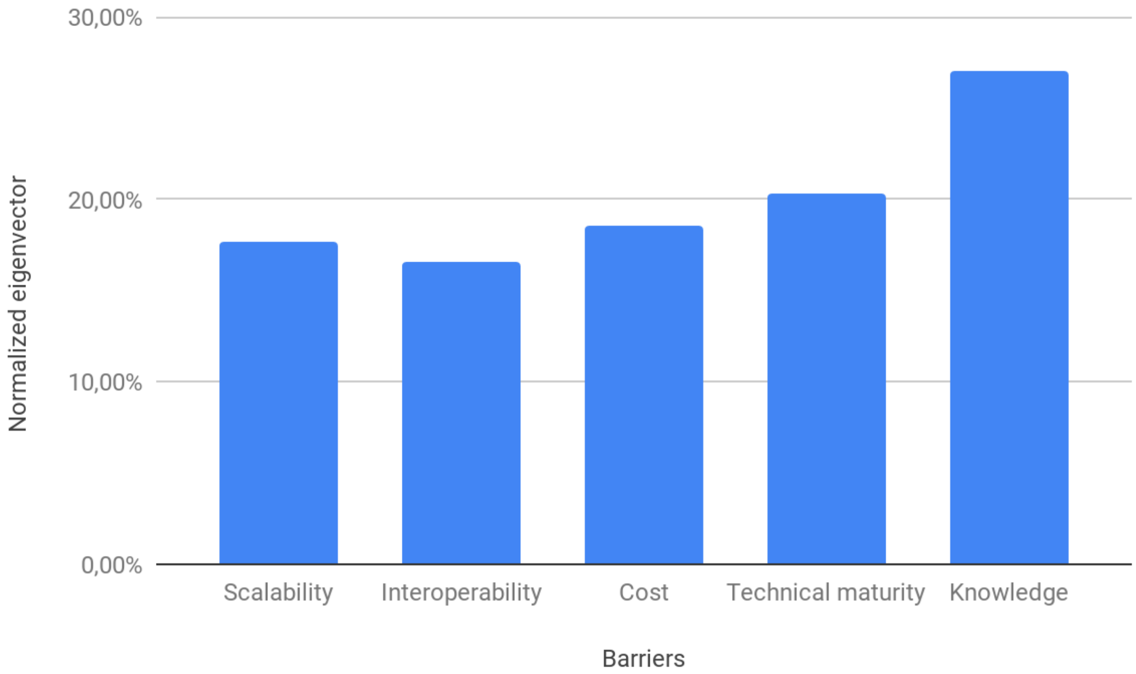

Figure 32: Barrier priority rankings consistent

After analyzing the respondents who me the consistency requirements, the ranking of barriers are as follows:

Barrier rankings, normalized and consolidated with accepted consistency
1. Knowledge 27,0%
2. Technical maturity 20,3%
3. Cost 18,5%
4. Scalability 17,6%
5. Interoperability 16,6%

Table 16: Barrier rankings consistent

4.6 Consistency level comparison

Through filtering the respondents to only the ones who were under the consistency ratio threshold we expectedly see some changes in the criteria weight and rankings. The driver criteria are shown in the matrices below.

Consistent driver ranking	
Reliability	27,40%
Immutability	22,10%
Transparency	20,60%
Decentralization	17,80%
Transaction automation	12%

Table 17: Consistent driver ranking

Unfiltered driver ranking	
Reliability	28%
Immutability	22,70%
Transparency	20,10%
Decentralization	14,40%
Transaction automation	14,90%

Table 18: Unfiltered driver ranking

Drivers through consistency control		
Criteria	**Change**	**Ranking**
Reliability	−0,60%	*Unchanged*
Immutability	−0,60%	*Unchanged*
Transparency	0,50%	*Unchanged*
Decentralization	3,40%	5 --> 4
Transaction Automation	−2,90%	4 --> 5

Table 19: Drivers through consistency control

The changes to the drivers are not significant, and the top three drivers retain their importance ranking with only minor alterations in the weight of no more than +/- 0.60%. The changes to decentralization and transaction automation, while not major, were higher with an increase of 3,40% and decrease of -2,90%, respectively. This caused decentralization to surpass transaction automation in the importance ranking.

The barrier criteria are presented in the matrices below.

Consistent barrier ranking	
Knowledge	27%
Technical maturity	20,30%
Cost	18,50%
Scalability	17,60%
Interoperability	16,60%

Table 20: Consistent barrier ranking

Unfiltered barrier ranking	
Knowledge	17,50%
Technical maturity	24,80%
Cost	20,70%
Scalability	18,50%
Interoperability	18,60%

Table 21: Unfiltered barrier ranking

Barriers through consistency control		
Criteria	**Change**	**Ranking**
Knowledge	10%	5 --> 1
Technical maturity	−4,50%	1 --> 2
Cost	−2,20%	*Unchanged*
Scalability	−0,90%	5 --> 4
Interoperability	−2,00%	4 --> 5

Table 22: Barriers through consistency control

Where the alterations were not significant for the drivers, there changes are dramatic for the barriers. The most significant is the 10% weight increase for knowledge, making this criterion go from least important (5) to most important (1), pushing technical maturity down to ranking second.
The large increase in knowledge followingly causes weight distribution to change and all the other criteria drop in importance. Scalability loses over double the amount of interoperability, pushing it down to be the least important factor. Only cost remain unchanged at third place.

5. Discussion and Conclusion

The results that are based on the subset of consistent respondents are the most reliable, so these are discussed in sections 5.1 and 5.2 that follow.

5.1 Drivers

The data analysis brought interesting findings related to which blockchain technology benefits are perceived as more important.

Reliability and immutability are the two most prominent drivers, and by nature they are closely related and can be aggregated, since high reliability and immutability leads to data integrity (Risius & Spohrer, 2017).

They represent the benefits of having a system that is consistently up and running and trusting that it always performs the same actions given the same conditions, with minimal downtime and maximum predictability. And that it represents the benefits of ensuring the ability to verify that data has not been altered. In the literature Beck et al. (2017) states that if blockchain technology delivers the expected potential, we will experience an unmatched level of objectivity and trust, which is in line with the respondent opinions within our findings of this research and is especially related to immutability.

An interesting finding is that transaction automation scored low. We defined this criterion as a "*driver that represents the benefits and potential cost savings of automating transactions either within the organization or between organizations. This would in most scenarios be done using so-called "smart-contracts" (a computer program that directly controls the transfer of digital currencies or assets between parties under certain conditions).*"

This is surprising because as seen in the concept matrix of the literature review (Table 7), automation and efficiency in transactions is one of the most prominent drivers found in the literature.

*"Enterprises of all types are increasingly interested in blockchain technologies because of the promise of significant business value. Blockchain solutions provide the ability to transact directly with trading partners, eliminate the need for reconciliations, track and trace assets instantly, ensure the provenance of data and settle transactions quickly and cheaply" (*Lacity, p. 19, 2018)

When analyzing data especially for continued and successful projects, decentralization and transparency are found to be considered the most prominent drivers. This is contradictory to the related research that has previously not identified decentralization or transparency as prominent when compared to other drivers, while our findings suggest that this was in fact probably the "trigger" in the context explored.

Connecting our findings to the Technology Acceptance Model (TAM), the different drivers we asked the survey respondents to rank, are aspects of the perceived usefulness for Blockchain technology. Our findings are interesting because they show that the technology is valued by professionals with relevant experience for aspects of usefulness that are not always foregrounded in the literature. This suggests that there is still a gap between research and practice in the domain and our study can contribute in bridging the two.

5.2 Barriers

The results for the barriers indicate that knowledge and technical maturity are slightly more prominent than the other barriers. As seen in the concept matrix of the literature review, maturity was one of the most frequently identified barrier in existing research:

"At present, however, there is a huge gap between promised business value and actual business value delivered. Before the full business value of blockchain solutions can be realized, the technology needs to mature to address issues such as scalability, performance and interoperability. Enterprises need to work together to define standards, and regulators need to clarify compliance requirements" (Lacity, p. 19, 2018)

The topic of maturity is interesting, as one may state that barriers such as scalability and interoperability are both aspects of the more general and ambiguous definition for technical maturity: "Barrier that represents the drawbacks of lacking technical properties demanded by users/customers."

Scalability is scoring surprisingly low. It is the second most prominent barrier in related research yet scores low in all analyzed contexts. Both on unfiltered (CR>20%) and on filtered (CR<20%) analysis it ranks second to last in importance. While block times and transaction speed of blockchains are a known challenge (Yli-Huumo, et. al, 2018), this is not supported by the findings of our survey.

When analyzing specific respondents with cancelled projects and/or initiatives on blockchain, we see that the "showstopper" barrier(s) for these respondents are different from the consolidated result. For these respondents, Cost (41,8%) was the absolute main showstopper, followed by knowledge (24,2%).

The context of the respondent in terms of their experience level within in the organization is different, and the results indicate that the difference in context plays a key role. This may also be the case when it is industry specific or geographically based. For instance, industries will have different risks and industry specific risks that cause the barriers for adoption of new technology to differ from others.

An example would be the importance of interoperability for inter-organizational relationships in supply chains and business networks, while interoperability would be less of a challenge for an internal solution. In addition, some industries are risk averse and cost sensitive, while some industries embrace risk taking and invest resources into adopting new technologies and making cutting edge solutions. The perception of "what is a barrier" could generally be widely different depending on the specific context.

When looking at the data it could also indicate that the general knowledge is not at the level where organizations are able to clearly identify the exact reason or reasons why blockchain has not yet been applied. This is reflected in that the most prominent barrier is in fact knowledge. A lack of knowledge and expertise on the technology could present challenges for organizations, for instance in terms of:

1) Identifying use cases
    1. E.g. finding a problem blockchain can solve
2) Finding solutions
    1. Unaware of implementations and solutions for the use case
3) Applying it
    1. Developing a solution/system, implementing it

5.3 Consistent vs unfiltered responses

One of the advantages of using a consistency ratio and filtering out the inconsistent answers is that it increases the validity and reliability of the answers we have, and ensure that the opinions of the results that had a CR below 20% are able to be highlighted as correct and prominent, as described in the method chapter and seen in Apostolou & Hassell (1993).

When analyzing the data and correcting for consistency, the results of the drivers were not changed a lot. Only one position was changed in the hierarchy: the original 4th position (Transaction Automation) from the unfiltered results moved down to position 5 and the original 5th position (Decentralization) moved up to position 4 after filtering for consistency.

These minor changes based on consistent (expert responses) versus the unfiltered responses which even included some with such a high CR that they we're almost considered randomly answered signal that these rankings may not only be perceived by the experts to be the correct rankings but also those of the general population. This would need to be researched further, as our results are not generalizable for the general population, nor were they intended to be as this is foundational research in the domain.

On the barrier side however, we saw major changes when filtering for consistency. The most surprising change was that the original 5th position (knowledge) from the unfiltered results moved all the way up to the 1st position when filtering for consistency.
This seems to indicate that to have a correct understanding of the limitations of the technology, one needs to have expertise within the domain.

5.4 Conclusions and Limitations

This thesis has identified the most prominent drivers and barriers for blockchain adoption in organizations based on expert perceptions. Our findings in some respects support previous research on the topic. Immutability and reliability on the driving side, with knowledge and technical maturity on the barrier side.

However, when looking at more specific data and contexts, more specifically cancelled and completed projects, we see that both drivers and barriers deviate from what has previously been identified. In our research we see that cost (41,8%) has been the clear showstopper for the cancelled projects, while decentralization and transparency have been the main trigger for completing the projects.

Moreover, there were some interesting discoveries that were unexpected based on existing research. On the driver side transaction automation scores significantly lower than expected based on the concept matrix developed from the literature review. Smart contracts and automation of asset or currency transfers is one of the repeated and highlighted drivers in research literature, but this is not well reflected in our data.

One hypothesis is that transaction automation just isn't as important to organizations as blockchain developers, researchers and evangelists claim. Even though it is a clear and well documented value proposition of the technology, it might not be solving the right problems and pain points for businesses.

Another hypothesis is that the factor isn't clearly specified, which leads to it being interpreted differently. The respondents might not be in a position where they know what this factor might include. E.g. thinking of transactions in a narrower way such as financial transactions and transfers, and not in the wider and more comprehensive sense of automatic execution of asset transfers and data distribution, as well as having contracts governing these transfers that automatically are enforced.

Scalability is also scoring surprisingly low. It may be the case that scalability is just not that much of a challenge to organizations yet because the blockchain projects are still at initial stages, or the other possibility is that the respondents are unaware of the documented technical limitations that blockchains currently operate with.

We see context as a strong modifier of results when looking at specific segments or respondents, which is a call for future research to address this topic in a more specific way.

Even though we had enough consistent expert responses within our results, there may be several other factors that influence blockchain adoption and projects that are not covered by to completion by our analysis, e.g. industry specific variables and culture. A reported barrier for the respondents answering the survey was that there was a high threshold for answering, with the potential respondents believing they needed to be experts to respond. AHP worked in this regard as it is meant to be used for analyzing preferences of few experts not for large samples.

The research literature coverage of the topic was shown to be limited. The number of publications directly addressing the topic of drivers and barriers are insufficient, which may cause the findings from literature to be inadequate to conclude that this study is generalizable.

The number of respondents and diversity can be seen as another limitation. Despite distributing the survey through many channels with repeated follow-ups and seeing many respondents entering the survey, only few of them were able or willing to answer all our questions.

As the technology is new, the trends seen in the findings may vary depending on the domain knowledge of the respondents asked as well as their respective industries.

5.5 Further research

There are three main areas we strongly suggest further research within to both solidify our findings but also explain them.

The first is that there is a need for a context specific deep-dive into barriers and drivers of blockchain technology. Considering the fact that the overall consensus of our findings is varying, there is reason to believe that the results could differ if a homogenous group of actors within a specific field or industry was to be examined. We expect this to be possible soon as blockchain technology becomes more widespread. Today, there are still limited experiences with blockchain, resulting to small numbers of domain experts and this prevented us from performing industry-specific analyses.

The second direction for further research would be to perform case studies on specific organizations aborting blockchain adoption projects, their experiences and main reasons for deciding not to move forward. As the cancelled projects we discovered through our analysis were mainly due to cost and knowledge, it would be interesting to see a qualitative study on some of these examples to get a clearer picture of how and why the cost and knowledge became inhibitors for the projects. It could be because of poor planning and budgeting, greater investment needed than originally envisioned or potentially because the general cost of the scarce resource which is competent people within the new field of blockchain became too high for the benefits proposed to come out from the investment.

Additionally, further research could be performed for analyzing the key barriers and drivers and finding ways to overcome barriers and further enhance the drivers. For instance, in our analysis, the drivers *decentralization* and *transparency* were the most prominent from the successfully implemented projects, which to us was somewhat of a surprise when comparing it to existing research. Further investigation on the specific drivers identified as important for successful projects could uncover what aspects of decentralization and transparency was the most important, and why they were so.

Finally, the main barrier for adoption could be that the perceived value proposition is not yet strong enough to justify adopting the technology. It would be interesting for future research to consider looking into this and observing whether organizations at this point are capable of identifying the potential use of blockchain as a solution to their pain points and challenges. A direction for future research here would be to go in depth to find out how the perceived usefulness for organizations can be strengthened.

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Appendix

Attachment 1 - Survey

Landing page

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Motivational factors and inhibitors related to blockchain adoption
The goal of this survey is to investigate the importance of different factors for blockchain adoption.

All factors included in the survey have been reported in related literature.

The survey responses will be analyzed using a method that derives priorities among multiple factors using pair-wise comparisons (Analytic Hierarchy Process – AHP).

You will be asked to fill out two sets of comparisons **one related to barriers** and **one related to drivers.**

The expected time of completion is between 6 and 8 minutes.

If you should have any additional information you would like to share, you can use the free-text input field at the end or email us:

Robin A. R. Moudnib
robin@decentralize.no

Sondre Flovik
sflovik@decentralize.no

Confidentiality: The data from this survey will be treated anonymously and no personal information will be linked to your answers. All gathered data is for research purposes only.

Forrige

Section 1: General information

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Section 1: General information

These questions are mainly to make sure we are not asking people who have neither heard of or considered using the technology.

What kind of industry is your organization operating within?
- ○ Finance/Trade
- ○ Logistics
- ○ Industrial production / Energy
- ○ Blockchain service provider (Consultants, developers)
- ○ Other

Do you know what blockchain technology is?
- ○ Yes
- ○ No

What is your organizations' experience with blockchain technology?
- ○ My organization has never considered using blockchain
- ○ My organization has considered blockchain, but did not move forward
- ○ My organization has considered blockchain, but is undecided about going forward
- ○ My organization has considered blockchain and moved forward
- ○ Other

What is your position within your organization?
- ○ Top management (CXO, Board, Director, e.g.)
- ○ Middle management (Department manager, Project manager, e.g.)
- ○ Service provider (Consultant, advisor, developer, e.g.)
- ○ Other

In what country do you mainly work?
- ○ Norway
- ○ Other country within Scandinavia
- ○ Other European country beyond Scandinavia
- ○ Beyond Europe

What is the size of your organization?
- ○ Less than 10 employees
- ○ Between 10 and 50 employees
- ○ Between 51 and 250 employees
- ○ More than 250 employees
- ○ Would rather not answer this

Forrige

Section 2: Driver rating

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Section 2: Factor rating survey - drivers
In this section, we first define the drivers investigated and then, provide comparisons forms.

Definitions:

Transaction Automation
This driver represents the benefits and potential cost savings of automating transactions either within the organization or between organizations. This would in most scenarios be done by the use of so-called "smart-contracts" (a computer program that directly controls the transfer of digital currencies or assets between parties under certain conditions).

Decentralization
This driver represents the benefits of decentralizing and ensuring distributed control among actors. For instance, in a supply chain, the different actors can share ownership and responsibility of updating and verifying records.

Transparency
This driver represents the benefits of enabling transparent actions, transfers and transactions internally or between organizations that will be auditable by the parties involved.

Reliability
This driver represents the benefits of having a system that is consistently up and running and trusting that it always performs the same actions given the same conditions. Minimal downtime and maximum predictability are key here.

Immutability
This driver represents the benefits of ensuring the ability to verify that data has not been altered. Trust can be increased with this feature.

The intensity of importance scale in this survey range from 1 to 9 and have the following definitions:

The intensity of importance scale in this survey range from 1 to 9 and have the following definitions:

1 - **Equal importance**
3 - **Moderate importance of one over the other**
5 - **Essential or strong importance over the other**
7 - **Very strong importance over the other**
9 - **Extreme importance over the other**

2,4,6,8 - Are intermediate values between the judgements, when compromise is needed

Based on your knowledge and experience within your organization, choose for each pair of drivers the one that is more important for driving a blockchain project, and note how much more important on a scale from 1 to 9.

Transaction Automation — Decentralization

9 7 5 3 1 3 5 7 9

Transaction Automation — Transparency

9 7 5 3 1 3 5 7 9

Transaction Automation — Reliability

9 7 5 3 1 3 5 7 9

Transaction Automation | Immutability

9 7 5 3 1 3 5 7 9

Decentralization | Transparency

9 7 5 3 1 3 5 7 9

Decentralization | Reliability

9 7 5 3 1 3 5 7 9

Decentralization | Immutability

9 7 5 3 1 3 5 7 9

Transparency | Reliability

9 7 5 3 1 3 5 7 9

Transparency | Immutability

9 7 5 3 1 3 5 7 9

Reliability | Immutability

9 7 5 3 1 3 5 7 9

Is there any additional driver of great importance you would like us to be aware of?

Forrige Neste

Section 3: Barrier rating

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Section 3: Factor rating survey - barriers
In this section, we first define the barriers investigated and then, provide comparisons forms.

Definitions:

Scalability
This barrier represents the drawbacks of not being able to handle additional traffic in a seamless manner.

Interoperability
This barrier represents the drawbacks of not having interoperability with various systems, either internally or externally.

Cost
This barrier represents the drawbacks of the cost of implementation and the financial risk involved in implementing the technology.

Technical maturity
This barrier represents the drawbacks of lacking technical properties demanded by users/customers.

Knowledge
This barrier represents the drawbacks of lacking knowledge about the technology, its applicability, potential benefits and disadvantages.

The intensity of importance scale in this survey range from 1 to 9 and have the following definitions:

1 - Equal importance
3 - Moderate importance of one over the other
5 - Essential or strong importance over the other
7 - Very strong importance over the other
9 - Extreme importance over the other

2,4,6,8 - Are intermediate values between the judgements, when compromise is needed

Based on your knowledge and experience within your organization, choose for each pair of barriers the one that is more important for putting a halt on a blockchain project, and note how much more important on a scale from 1 to 9.

Scalability — Interoperability
9 7 5 3 1 3 5 7 9

Scalability — Cost
9 7 5 3 1 3 5 7 9

Scalability — Technical Maturity
9 7 5 3 1 3 5 7 9

Scalability — Knowledge
9 7 5 3 1 3 5 7 9

Interoperability								Cost
9	7	5	3	1	3	5	7	9

Interoperability								Technical Maturity
9	7	5	3	1	3	5	7	9

Interoperability								Knowledge
9	7	5	3	1	3	5	7	9

Cost								Technical Maturity
9	7	5	3	1	3	5	7	9

Cost								Knowledge
9	7	5	3	1	3	5	7	9

Technical Maturity								Knowledge
9	7	5	3	1	3	5	7	9

Is there any additional barrier of great importance you would like us to be aware of?

Forrige

Neste

Section 4 - Wrapping up

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Section 4: Wrapping up

In this section, we are finishing the survey by providing the possibility of answering in free-text if you have any suggestions.

Please send us an email if you would be willing to participate in an in-depth interview at a later stage to delve deeper into the possible explanations for your inclination regarding adopting blockchain-technology.

If you participate, your organization will be anonymized and only referred to as an organization within the industry you operate within.

Robin A. R. Moudnib
robin@decentralize.no

Sondre Flovik
sflovik@decentralize.no

Do you have any further input or comments?

Forrige Neste

Section 5 - Exit page

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Thank you for answering!

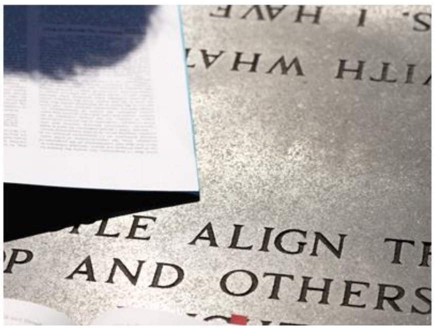
We will make sure to distribute the results as best possible.

If you have any questions, feel free to contact us at:

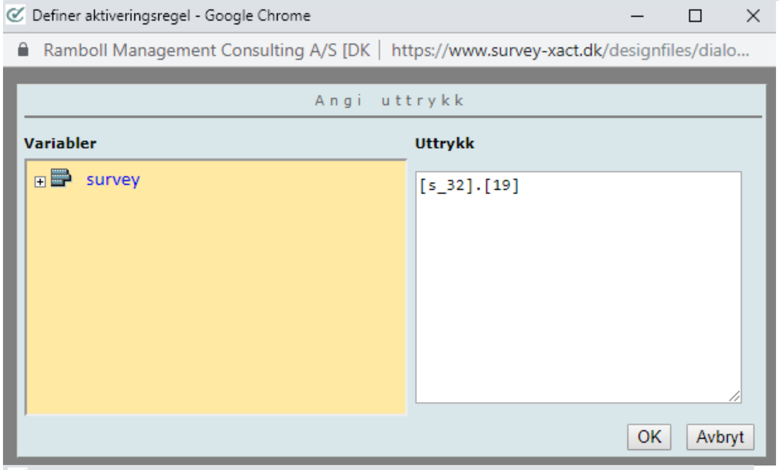
Robin A. R. Moudnib
robin@decentralize.no

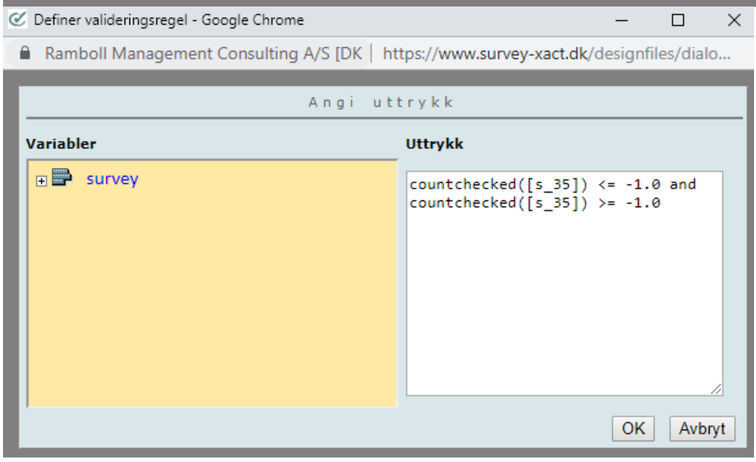
Sondre Flovik
sflovik@decentralize.no

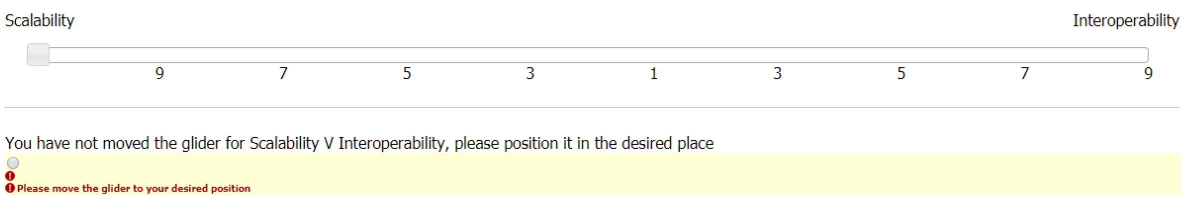
Best regards
Robin Amir Rondestvedt Moudnib & Sondre Flovik



Attachment 2 - Survey input validation







Attachment 3 - Survey pilot test

Sector: Energy
Country: Norway
Position: Product owner / engineer
Background: Renewable energy engineering, industrial economy and technology management
Start time: 19:19

Observation of respondent:
(Upon entering the first page with pairwise comparison sliders)
"Do I need to read all these definitions? There seems to be so many questions, eeeh. Ok, I'm done with this page…"
(Upon entering the following page for barriers)
"The new page is the exact same as I just answered?"
I clarified: It's very similar, except here we measure negative factors, the barriers.
Observation of respondent:
"aaaha, okay, alright. I feel the terminology and descriptions are helpful and okay, they don't stop me from answering. It's understandable."
"Okay, I'm done, I'll exit the survey now"

Time: 19:27

After the pilot, we asked some questions and let the respondent talk freely about the experience, summarized below.
Comments from the respondent:
"I felt the survey was okay when I got to part two (e.g. sliders for barriers)*, because then I knew what you were looking for and how to answer. Part 1 of the sliders took longer because I was not completely confident. "*

Question: How was the definition of the variables?
"The definitions were concise and clear, I was able to understand what each variable represented from a technical standpoint."

"It was a bit confusing that the slider midpoint had the value 1 and not 0. You could highlight better how the scale works, I didn't read thoroughly, and it didn't make that much sense at first."
Question: If you were sent this survey, what would the biggest barrier be to prevent you from answering?
"Generally, if a survey is too long, but I didn't feel this one was. Or if it keeps asking for the same things in different ways, this frustrates me and makes me close the survey. Especially I don't like it if a survey asks for mandatory free text answers, this takes time and I just quit. You could introduce the survey by stating the expected length to make sure that they know the entry barrier is low."

Question: Any concluding comments?
"Like I mentioned, start by introducing the length so that I know how much time is going to be required and how much I need to fill. Apart from that I don't have much. I feel it was okay to answer and didn't take too much effort on my behalf."

Attachment 4 - Spreadsheet from AHP analysis

Example respondent from spreadsheet, participant 1

n	Criteria	Comment	RGMM	+/-
1	Transaction Automation		3,9%	1,8%
2	Decentralization		7,5%	3,6%
3	Transparency		18,8%	8,2%
4	Reliability		26,7%	10,6%
5	Immutability		43,0%	17,3%
6				
7				
8				
9		for 9&10 unprotect the input sheets and expand the		
10		question section ("+" in row 66)		

Name	Weight	Date	α:	CR:
Participant 1			0,1	9 %
				Consistency Ratio

i	j	Criteria A	Criteria B	more important? A or B	Scale (1-9)
1	2	Transaction Automation	Decentralization	B	4
1	3		Transparency	B	6
1	4		Reliability	B	4
1	5		Immutability	B	8
1	6				
1	7				
1	8				
2	3	Decentralization	Transparency	B	5
2	4		Reliability	B	3
2	5		Immutability	B	8
2	6				
2	7				
2	8				
3	4	Transparency	Reliability	B	2
3	5		Immutability	B	4
3	6				
3	7				
3	8				
4	5	Reliability	Immutability	A	1
4	6				

participant 1 matrix:

1	Participant 1					0		00.01.1900	
	1	2	3	4	5	6	7	8	9	10
1	1	1/4	1/6	1/4	1/8	0	0	0	0	0
2	4	1	1/5	1/3	1/8	0	0	0	0	0
3	6	5	1	1/2	1/4	0	0	0	0	0
4	4	3	2	1	1	0	0	0	0	0
5	8	8	4	1	1	0	0	0	0	0
6	0	0	0	0	0	1	0	0	0	0
7	0	0	0	0	0	0	1	0	0	0
8	0	0	0	0	0	0	0	1	0	0
9	0	0	0	0	0	0	0	0	1	0
10	0	0	0	0	0	0	0	0	0	1

Attachment 5 - Master excel data file

The following attachment shows the remaining data used in the thesis.
All respondents

Complete respond	Timestamp	Respondent ID	Industry	Blockchain status	Role	Country	Size
Respondent 1	03.04.2019 19:17	MM6R-HFNF-7ZKT	Industrial production / energy	Undecided	Service provider	Norway	More than 250
Respondent 2	30.04.2019 13:03	59K3-GMQX-8DKS	Finance & trade	Considered but not forward	Service provider	Norway	More than 250
Respondent 3	06.04.2019 08:35	76V6-79JK-QDKT	Industrial production / energy	Considered but not forward	Middle management	Norway	More than 250
Respondent 4	22.04.2019 22:44	JHH8-XLFF-MHT9	Logistics	Considered but not forward	Top management	Norway	Less than 10
Respondent 5	30.04.2019 15:37	CLNZ-2ZDW-8HMW	Blockchain service provider	Considered and moved forward	Top management	Beyond Europe	Between 10 and 50
Respondent 6	26.04.2019 13:45	H4WT-89C2-HYT9	Blockchain service provider	Considered and moved forward	Top management	Norway	Between 10 and 50
Respondent 7	16.04.2019 23:26	CF7W-L3XM-AVVS	Other (Government)	Consider and undecided	Other (Architect)	Norway	More than 250
Respondent 8	25.04.2019 11:48	QNVU-65NU-VGMA	Blockchain service provider	Other (Planning on running nodes)	Top management	Norway	Less than 10
Respondent 9	29.04.2019 02:03	KUDX-SRQ2-HCK9	Other (Research professor)	Considered and moved forward	Top management	Beyond Europe	Between 51 and 250
Respondent 10	22.04.2019 23:40	MSKA-9D6E-VYTX	Blockchain service provider	Never considered	Top management	Norway	More than 250
Respondent 11	27.04.2019 09:54	XQMT-X7S6-6ZMS	Other (Education)	Other (Not sure)	Service provider	Norway	More than 250
Respondent 12	04.05.2019 17:01	J84C-FX6C-FVKE	Other (Media)	Considered and moved forward	Top management	Norway	Less than 10
Respondent 13	06.05.2019 19:17	HTNC-NSKU-PDTT	Industrial production / energy	Other (Don't know)	Service provider	Norway	More than 250
Respondent 14	05.05.2019 15:38	P85D-3NXK-XVTS	Logistics	Never considered	Middle management	Norway	More than 250
Respondent 15	05.05.2019 18:04	RYGF-YZ79-ZUVE	Finance & trade	Considered and moved forward	Service provider	Norway	More than 250
Respondent 16	07.05.2019 01:30	HUUE-7M8D-PCTF	Blockchain service provider	Considered and moved forward	Top management	Norway	More than 250
Respondent 17	05.05.2019 16:54	ZXSS-HU3E-PVM9	Industrial production / energy	Considered and undecided	Middle management	Norway	Between 51 and 250
Respondent 18	04.05.2019 17:12	T2MN-RFHG-6ZK9	Industrial production / energy	Considered and moved forward	Top management	European beyond scandinavia	Between 10 and 50
Respondent 19	07.05.2019 17:25	RG81-7ZWJ-3K6W	Blockchain service provider	Considered and moved forward	Top management	Beyond Europe	Less than 10
Respondent 20	07.05.2019 14:27	2Y9P-19G5-128T	Blockchain service provider	Consider and undecided	Service provider	Norway	More than 250
Respondent 21	11.05.2019 10:15	65P4-2EZU-CJHA	Other: Academic	Never considered	Other: Academic	Norway	More than 250
Respondent 22	13.05.2019 12:55	T1E4-RMYT-716T	Other: IT	Never considered	Service provider	Norway	Less than 10
Respondent 23	13.05.2019 15:09	NUXE-59MA-52H9	Blockchain service provider	Considered and moved forward	Top management	European beyond scandinavia	Less than 10
Respondent 24	13.05.2019 15:36	UXKH-KXMT-7J6S	Other (IT Consulting)	Never considered	Service provider	Norway	Between 51 and 250
Respondent 25	14.05.2019 07:06	L5GK-DV6E-G6F9	Blockchain service provider	Considered and moved forward	Service provider	Norway	More than 250
Respondent 26	21.05.2019 10:34	NYLV-DD26-628W	Blockchain service provider	Considered and moved forward	Top management	Beyond Europe	Between 10 and 50
Respondent 27	22.05.2019 14:17	LC9W-ELCL-8J8E	Other (Impact)	Considered and moved forward	Top management	Norway	Between 10 and 50
Respondent 28	22.05.2019 17:28	2T34-5958-FKHS	Other (Education)	Never considered	Other (Professor)	Beyond Europe	More than 250
Respondent 29	22.05.2019 18:16	URQG-WFGQ-618E	Blockchain service provider	Considered and moved forward	Service provider	European beyond scandinavia	More than 250
Respondent 30	23.05.2019 09:54	FTFJ-PCUV-FNFE	Blockchain service provider	Considered and moved forward	Top management	European beyond scandinavia	Between 10 and 50
Respondent 31	23.05.2019 12:01	Q8ZZ-TK4U-82HT	Other (IT Consulting)	Considered but not forward	Service provider	Norway	Between 51 and 250
Respondent 32	4/28/19 14:45	XZFR-1GGN-6CKW	Blockchain service provider	Considered and moved forward	Top management	Norway	Between 10 and 50
Respondent 33	5/24/19 0:16	UPGW-PT91-RPFX	Blockchain service provider	Considered and moved forward	Middle management	European beyond scandinavia	More than 250
Respondent 34	5/24/19 16:23	TQGA-Z9UA-ZJF9	Other (Consultant)	Considered but not forward	Service provider	Norway	Between 10 and 50
Respondent 35	5/24/19 16:53	AK4D-9RJF-ZK89	Finance & trade	Considered and undecided	Service provider	Norway	More than 250

Drivers	Transaction automation	Decentralizatio	Transparency	Reliability	Immutability	CR% drivers	Barriers	Scalability	Interoperability	Cost	Technical maturity	Knowledge	CR% barriers
	3,90%	7,50%	18,80%	26,70%	43%	9%		4,90%	13,10%	7,80%	31,80%	42,40%	12%
	29%	14,20%	7,70%	43,20%	5,80%	10%		13,10%	6,10%	21,20%	5,20%	54,40%	19%
	3,90%	7,70%	20,60%	29,90%	37,80%	4%		4,90%	11%	53,50%	23,60%	7%	11%
	16,50%	3,10%	7,70%	40,70%	32,00%	11%		12,40%	46,90%	20%	16,50%	4,20%	43%
	20%	20%	20%	20%	20%	0%		26,90%	17,80%	6,20%	29%	20,20%	12%
	12,80%	59,60%	3,40%	3%	21,20%	35%		14,40%	6,30%	56,90%	20,40%	2%	41%
	21,70%	5,60%	18,70%	32,80%	21,20%	34%		11,70%	20,20%	3,70%	34,40%	30%	16%
	26,60%	7,30%	11,20%	17,40%	37,50%	19%		5%	14,10%	2,20%	20,40%	58,40%	33%
	4,70%	2%	48,80%	31,60%	13,10%	35%		26,70%	12,30%	40,20%	12,60%	8,20%	73%
	35,70%	14,90%	12,40%	8,60%	28,40%	59%		10,80%	29,60%	27,20%	16,50%	15,90%	33%
	19,80%	2,50%	10,90%	46,90%	19,80%	23%		4,30%	5,90%	55%	17,40%	17,40%	13%
	3,40%	6,90%	11,80%	43%	34,90%	32%		56,70%	6,80%	15,80%	14,60%	6%	15%
	9,10%	12,30%	17,20%	45,10%	16,30%	15%		35,80%	21,10%	6,80%	19,80%	16,60%	9%
	33,10%	30,70%	3,80%	11,30%	21,10%	37%		19,30%	6,50%	44%	8,70%	21,50%	26%
	29,90%	3,90%	20,70%	42,20%	3,30%	23%		4,50%	28,40%	7,60%	17,40%	42%	17%
	21,60%	16,40%	25,50%	18,20%	18,20%	9%		20%	20%	20%	20%	20%	0%
	45,30%	6,90%	27,30%	17,20%	3,30%	27%		61,50%	12,20%	11,70%	12,20%	2,40%	17%
	30,30%	6,60%	9,10%	21%	33%	121%		33,60%	18,20%	29,10%	12,90%	6,30%	63%
	4,20%	57%	9%	15,30%	14,50%	10%		20%	20%	20%	20%	20%	0%
	5,80%	7,90%	22,50%	48,10%	15,70%	8%		6,90%	3,60%	28%	13,90%	47,60%	14%
	11,30%	15%	18,70%	28,20%	26,80%	8%		8,20%	9,80%	32,40%	7,20%	42,50%	13%
	9,90%	14,90%	41%	15,10%	19,10%	43%		5,90%	25,20%	25,10%	34,90%	8,90%	142%
	6,40%	7,40%	7,20%	53,60%	25,50%	28%		44,60%	12%	11,80%	24,20%	7,30%	66%
	3,80%	7,70%	3,80%	42,40%	42,40%	4%		8,70%	5,60%	3,80%	43,60%	38,30%	6%
	35,40%	14,60%	7,80%	35,40%	6,70%	1%		48,10%	15,10%	3%	27,20%	6,60%	27%
	2,70%	19,60%	23%	16,80%	37,90%	33%		8,90%	40,60%	5,70%	27,20%	17,60%	13%
	5,20%	13,50%	55,60%	6,90%	18,80%	11%		34,50%	10,20%	43,60%	9%	2,60%	13%
	2,20%	14,10%	34,70%	19,80%	29,20%	68%		3,50%	14,10%	25%	50,10%	7,30%	10%
	12,80%	21,70%	34,70%	12,40%	18,40%	65%		13,80%	29,20%	20,90%	11,20%	24,90%	69%
	2,20%	16,20%	25%	33,10%	23,50%	27%		16,70%	38,30%	16,10%	27%	1,90%	48%
	38,40%	5,60%	7,20%	16,40%	32,40%	27%		15,60%	12,10%	14,80%	35,60%	21,80%	20%
	5,20%	43,80%	35,10%	12,10%	3,70%	19%		41,90%	12,40%	16,20%	14,80%	14,70%	49%
	12,00%	13,70%	33,10%	37,90%	3,30%	39%		8,70%	46,20%	3,30%	19,30%	22,50%	19%
	11,10%	4,80%	9,90%	23,40%	50,70%	12%		62,40%	22,30%	2,30%	4,50%	8,50%	32%
	54,40%	24,30%	15,60%	2,80%	2,80%	17%		16,80%	61,60%	2,80%	5,30%	13,50%	16%
	0,1139219227	0,1102206813	0,1539231892	0,2150567873	0,1737725792			0,1405711381	0,1415273167	0,1579178771	0,1886767138	0,1329191718	
Aggregate values	Transaction Automation	Decentralizatio	Transparency	Reliability	Immutability			Scalability	Interoperability	Cost	Technical maturity	Knowledge	
	15%	14%	20%	28%	23%			18%	19%	21%	25%	17%	

Consistency filtered respondents:

Complete respondents	Timestamp	Respondent ID	Industry	Blockchain status	Role	Country	Size
Respondent 1	03.04.2019 19:17	MM6R-HFNF-7ZKT	Industrial production / energy	Considered and undecided	Service provider	Norway	More than 250
Respondent 2	30.04.2019 13:03	59K3-GMQX-8DKS	Finance & trade	Considered but not forward	Service provider	Norway	More than 250
Respondent 3	06.04.2019 08:35	76V6-79JK-QDKT	Industrial production / energy	Considered but not forward	Middle management	Norway	More than 250
Respondent 5	30.04.2019 15:37	CLNZ-2ZDW-8HMW	Blockchain service provider	Considered and moved forward	Top management	Beyond Europe	Between 10 and 50
Respondent 13	06.05.2019 19:17	HTNC-NSKU-PDTT	Industrial production / energy	Other (Don't know)	Service provider	Norway	More than 250
Respondent 16	07.05.2019 01:30	HUUE-7M8D-PCTF	Blockchain service provider	Considered and moved forward	Top management	Norway	More than 250
Respondent 19	07.05.2019 17:25	RG81-7ZWJ-3K6W	Blockchain service provider	Considered and moved forward	Top management	Beyond Europe	Less than 10
Respondent 20	07.05.2019 14:27	2Y9P-19G5-128T	Blockchain service provider	Considered and undecided	Service provider	Norway	More than 250
Respondent 21	11.05.2019 10:15	65P4-2EZU-CJHA	Other: Academic	Never considered	Other: Academic	Norway	More than 250
Respondent 24	13.05.2019 15:36	UXKH-KXMT-7J6S	Other (IT Consulting)	Never considered	Service provider	Norway	Between 51 and 250
Respondent 27	22.05.2019 14:17	LC9W-ELCL-8J8E	Other (Impact)	Considered and moved forward	Top management	Norway	Between 10 and 50
Respondent 35	24.05.2019 kl. 16.53	AK4D-9RJF-ZK89	Finance & trade	Considered and undecided	Service provider	Norway	More than 250

Complete respondents	Drivers	Transaction automation	Decentralization	Transparency	Reliability	Immutability	CR% drivers	Barriers	Scalability	Interoperability	Cost	Technical maturity	Knowledge	CR% barriers
Respondent 1		3,90%	7,50%	18,80%	26,70%	43%	9%		4,90%	13,10%	7,80%	31,80%	42,40%	12%
Respondent 2		29%	14,20%	7,70%	43,20%	5,80%	10%		13,10%	6,10%	21,20%	5,20%	54,40%	19%
Respondent 3		3,90%	7,70%	20,60%	29,90%	37,80%	4%		4,90%	11%	53,50%	23,60%	7%	11%
Respondent 5		20%	20%	20%	20%	20%	0%		26,90%	17,80%	6,20%	29%	20,20%	12%
Respondent 13		9,10%	12,30%	17,20%	45,10%	16,30%	15%		35,80%	21,10%	6,80%	19,80%	16,60%	9%
Respondent 16		21,60%	16,40%	25,50%	18,20%	18,20%	9%		20%	20%	20%	20%	20%	0%
Respondent 19		4,20%	57%	9%	15,30%	14,50%	10%		20%	20%	20%	20%	20%	0%
Respondent 20		5,80%	7,90%	22,50%	48,10%	15,70%	8%		6,90%	3,60%	28%	13,90%	47,60%	14%
Respondent 21		11,30%	15%	18,70%	28,20%	26,80%	8%		8,20%	9,80%	32,40%	7,20%	42,50%	13%
Respondent 24		3,80%	7,70%	3,80%	42,40%	42,40%	4%		8,70%	5,60%	3,80%	43,60%	38,30%	6%
Respondent 27		5,20%	13,50%	55,60%	6,90%	18,80%	11%		34,50%	10,20%	43,60%	9%	2,60%	13%
Respondent 35		54,40%	24,30%	15,60%	2,80%	2,80%	17%		16,80%	61,60%	2,80%	5,30%	13,50%	16%
		0,094591	0,139949	0,161990	0,214758	0,173839			0,134345	0,126247	0,141196	0,154609	0,206145	
	Aggregate values	Transaction automation	Decentralization	Transparency	Reliability	Immutability			Scalability	Interoperability	Cost	Technical maturity	Knowledge	
		12,05%	17,83%	20,63%	27,35%	22,14%			17,62%	16,56%	18,52%	20,28%	27,03%	

Trigger drivers for those who did go forward				
Transaction automation	Decentralization	Transparency	Reliability	Immutability
20%	20%	20%	20%	20%
21,60%	16,40%	25,50%	18,20%	18,20%
4,20%	57%	9%	15,30%	14,50%
5,20%	13,50%	55,60%	6,90%	18,80%
0,09855623291	0,2241406448	0,2247614728	0,140010458	0,1774830195
Transaction automation	Decentralization	Transparency	Reliability	Immutability
11,39%	25,91%	25,99%	16,19%	20,52%

Showstopper barriers for those who did not go forward				
Scalability	Interoperability	Cost	Technical maturity	Knowledge
13,10%	6,10%	21,20%	5,20%	54,40%
4,90%	11%	53,50%	23,60%	7%
0,080118662	0,08191458967	0,3367788592	0,1107790594	0,1951409747
Scalability	Interoperability	Cost	Technical maturity	Knowledge
9,96%	10,18%	41,85%	13,77%	24,25%

Respondent metadata:

All 35 respondents		
Industry	**Blockchain status**	**Role/Position**
Industrial production / energy	Considered and undecided	Service provider
Finance & trade	Considered but not forward	Service provider
Industrial production / energy	Considered but not forward	Middle management
Logistics	Considered but not forward	Top management
Blockchain service provider	Considered and moved forward	Top management
Blockchain service provider	Considered and moved forward	Top management
Other	Considered and undecided	Other
Blockchain service provider	Other	Top management
Other	Considered and moved forward	Top management
Blockchain service provider	Never considered	Top management
Other	Other	Service provider
Other	Considered and moved forward	Top management
Industrial production / energy	Other	Service provider
Logistics	Never considered	Middle management
Finance & trade	Considered and moved forward	Service provider
Blockchain service provider	Considered and moved forward	Top management
Industrial production / energy	Considered and undecided	Middle management
Industrial production / energy	Considered and moved forward	Top management
Blockchain service provider	Considered and moved forward	Top management
Blockchain service provider	Considered and undecided	Service provider
Other	Never considered	Other
Other	Never considered	Service provider
Blockchain service provider	Considered and moved forward	Top management
Other	Never considered	Service provider
Blockchain service provider	Considered and moved forward	Service provider
Blockchain service provider	Considered and moved forward	Top management
Other	Considered and moved forward	Top management
Other	Never considered	Other
Blockchain service provider	Considered and moved forward	Service provider
Blockchain service provider	Considered and moved forward	Top management
Other	Considered but not forward	Service provider
Blockchain service provider	Considered and moved forward	Top management
Blockchain service provider	Considered and moved forward	Middle management
Other	Considered but not forward	Service provider
Finance & trade	Considered and undecided	Service provider

Only consistant				
Industry	**Blockchain status**	**Role/Position**	**Country**	**Organization size**
Industrial production / energy	Other	Service provider	Norway	More than 250
Finance & trade	Considered but not forward	Service provider	Norway	More than 250
Industrial production / energy	Considered but not forward	Middle management	Norway	More than 250
Blockchain service provider	Considered and moved forward	Top management	Beyond Europe	Between 10 and 50
Industrial production / energy	Other	Service provider	Norway	More than 250
Blockchain service provider	Considered and moved forward	Top management	Norway	More than 250
Blockchain service provider	Considered and moved forward	Top management	Beyond Europe	Less than 10
Blockchain service provider	Consider and undecided	Service provider	Norway	More than 250
Other	Never considered	Other	Norway	More than 250
Other	Never considered	Service provider	Norway	Between 51 and 250
Other	Considered and moved forward	Top management	Norway	Between 10 and 50
Finance & trade	Considered and undecided	Service provider	Norway	More than 250