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Master Thesis

**Aiming for Supply Chain Transparency:  
Exploring the Potential of Blockchains**

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*“Marketing used to be about creating a myth and selling it;  
now it’s about finding a truth and sharing it.”*

Marc Mathieu, Unilever  
(Provenance Team, 2017)

## Abstract

**Purpose:** Supply chains lack transparency due to their complexity and fragmentation. Blockchain technology is increasingly expected to revolutionise businesses and promises to create trustworthy transparency. This study aimed to investigate the potentials of blockchain technology for supply chain transparency beyond the growing glorification.

**Methodology:** The potentials, as well as immaturities and drawbacks of blockchain technology, are reviewed in general and related to supply chain information disclosure, complemented by an investigation of the status quo of blockchain adoption and best practices in the supply chain field. In cooperation with IKEA, a case study was conducted, based on a workshop, document analysis, and interviews. The purpose was to identify specific areas in supply chains that urge transparency, to better understand the reasons for the opacity and to reveal how blockchain can be of help.

**Findings:** Blockchain was found to still face some serious immaturities. Nevertheless, it was acknowledged a promising technology for adoption in fields other than the original industry of application, finance. Some conceptual aspects, particularly regarding the kind of underlying shared ledger, need adjustments, some technological aspects need further development, and the framing conditions in economy and society need to be created.

**Value:** This study provides an overview of an emerging field – supply chain blockchain adoption – in which not much research yet exists, and most publications remain very vague. The next actions that researchers, developers, regulators and businesses interested in blockchain need to take are pointed out and reasoned.

**Key words:** *blockchain, shared ledger, supply chain transparency, supply chain integrity, social sustainability*

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Finally, I want to use this opportunity to express my gratitude to my parents, who supported me throughout the five years of studying by believing in me, leaving me the freedom to go my own way, and last but not least giving me economic support so that I was able to focus on studying and extracurricular engagement.

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Lund, 15 August 2017

*Benedict Lützenburg*

## Table of Contents

<b>Abstract</b>	<b>III</b>
<b>Acknowledgements</b>	<b>IV</b>
<b>Table of Figures</b>	<b>VII</b>
<b>Table of Tables</b>	<b>VII</b>
<b>Table of Abbreviations</b>	<b>VII</b>
<b>1 Introduction</b>	<b>1</b>
1.1 Background	1
1.2 Problem	2
1.3 Research Issue	4
1.4 Aim and Research Questions	5
1.5 Delimitations	6
1.6 Thesis Outline	6
<b>2 Methodology</b>	<b>8</b>
2.1 Literature review	9
2.2 Document Analysis	10
2.3 Single Case Study	11
2.4 Critical Reflection	13
<b>3 Frame of Reference: Blockchain</b>	<b>15</b>
3.1 Status Quo: Centralised Systems and Associated Problems	15
3.2 The Bitcoin Blockchain	16
3.3 Strengths	18
3.4 Challenges for Wide-Scale Adoption	19
3.5 Comparison of Different Ledgers	22
<b>4 Blockchain Adoption</b>	<b>24</b>
4.1 Status Quo Blockchain Adoption in General	24
4.2 Best Practices Related to Supply Chains	26
<b>5 Case Study IKEA</b>	<b>31</b>
5.1 IKEA Supply Chains in Figures	32
5.2 Allegations by Media and Unions	32
5.3 Examination of the IKEA Documents	33
5.3.1 People and Planet Positive	34
5.3.2 IKEA IWAY	35

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5.3.3	IKEA Sustainability Report 2016	37
5.3.4	IWAY Auditing Status Quo	39
<b>6</b>	<b>Analysis</b>	<b>40</b>
6.1	RQ1: How Can Blockchain Technology Enable an Increase of Transparency in Supply Chains, Especially in Transportation?	40
6.2	RQ2: What Adjustments and Improvements Are Needed to Apply Blockchain to Transportation Chains with Their Specific Characteristics?	41
<b>7</b>	<b>Conclusion</b>	<b>46</b>
7.1	Discussion	46
7.2	Contributions of the Study	50
7.3	Critical Reflection of the Research Design	51
	<b>Bibliography</b>	<b>53</b>
	<b>Appendix</b>	<b>62</b>

## Table of Figures

Figure 1: Structure of the thesis .....	7
Figure 2: Videos watched by year of release.....	8
Figure 3: Papers included by year of publication .....	10
Figure 4: The transfer of 1BTC on the Bitcoin blockchain.....	17
Figure 5: Total market capitalisation of cryptocurrencies in the first half year 2017	24

## Table of Tables

Table 1: Workshop and interviews conducted for the study.....	13
Table 2: The four main kinds of ledgers .....	22
Table 3: Some study-relevant goals of People and Planet Positive.....	35
Table 4: Some study-relevant IWAY requirements.....	36
Table 5: Some study-relevant challenges stated in the Sustainability Report .....	38
Table 6: Comparison of the ledgers .....	49

## Table of Abbreviations

BTC	Bitcoin
Dapp	Decentralised Application
GDP	Gross Domestic Product
ICT	Information and Communication Technology
IoT	Internet of Things
IP(V4)	Internet Protocol (Version 4)
ISO	International Organisation for Standardisation
NFC	Near Field Communication
NGO	Non-Governmental Organisation
RFID	Radio Frequency Identification

## 1 Introduction

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*Underlying this entire study, the first chapter introduces the background and the problem – the increasing interest in sustainability in supply chains, and the characteristics that lead to opacity in them. This leads to the challenge for the industry to establish transparency, which is demonstrated by the example of this thesis' partnering organisation IKEA. Blockchain and the expectations of this new technology to be able to support transparency are introduced as the research area, followed by the aim and the research questions of the study. Finally, the delimitations and the thesis outline are presented.*

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### 1.1 Background

Consumers increasingly demand higher levels of **sustainability**. In supply chains and especially transportation – the focus area of this study – consumers are now valuing and demanding sustainability in all three categories of the triple bottom line, economics, the environment, and society: For a long time, the focus was on the economic aspect, aiming to purchase a product or service at the lowest possible costs, until the environmental and later the social aspect became increasingly important (Basu et al., 2015; Bergqvist and Behrens, 2011; Johnstone and Tan, 2015). People want to be enabled to easily obtain reliable information regarding by whom and under which conditions a product was handled throughout the supply chain, from the raw material sourcing and production to the transport segments. Guarantees that certain sustainability and quality standards are applied at all stages are required (Bhaduri and Ha-Brookshire, 2011; Carter and Rogers, 2008; Svensson, 2009). The retailer in their role as connector between the consumer and the supply chain faces the challenge to provide such information and guarantees. Peter Ägnefjäll, President and CEO of the IKEA Group, summarises: “Sustainability is [...] essential for business success” (IKEA Group, 2016b: 6).

A series of projects have analysed the share of logistics and in particular transportation costs in various products' total costs. The analysis of nearly 50 products has shown that transportation usually only accounts for 1-4% of the total costs, and up to 10% for products with an atypical weight/volume-ratio (e.g. Åkesson, 2015; Obada and Maditati, 2015; Petkova, 2015; compare also Lammgård et al., 2012). That is, even if using old trucks and low-wage drivers reduces transportation costs to about one third lower than operating under sustainable conditions, overall additional costs for sustainable transportation account for only 0.5-3% of a product's final retail price, as confirmed by a thesis related to these projects (Esparza Franco, 2016).

This is within the additional 5% which McKinsey found 70% of consumers in Europe and America willing to pay for sustainability (Miremadi et al., 2012). Other surveys and studies came to similar results, for example one conducted by Nestlé with more than 30,000 participants (Gibbs and Hungerford, 2016). Nielsen carries out surveys of similar scope on a yearly basis, finding that the share of people “willing to pay more

for products and services that come from companies who are committed to positive social and environmental impact” is increasing every year due to the fact that especially the younger generations care about those aspects (Nielsen Company, 2015).

Hence, customers of transportation services – shippers – can hardly argue not to strive for sustainability in their supply chains. The characteristics of the road transport industry, however, point in another direction, with negative effects on sustainability: The competition is high, and underpricing and destructive competition are common (Belzer, 2000), leaving little space to improve sustainability. As a consequence, transportation has a particularly bad sustainability balance in supply chains (Weich, 2015).

While the sustainability in stationary production processes can be monitored quite reliably, supply chains’ transportation sequences are widely uncontrolled and often actually impossible to control. This is due to several factors:

Modern transport chains are characterised by a vast **complexity**. There is a high number of actors who fulfil different functions, such as shipper, planner, operator, or fleet-owner, and roles, such as sender, forwarder, and haulier (Nilsson et al., 2017; Sternberg et al., 2013). Products, services, and information have to be processed through all these layers, both downstream and upstream (Manuj and Sahin, 2011; Serdarasan, 2013). Recent research has shown that this complexity is often underestimated, with models simplifying the reality too much (Sternberg et al., 2013).

Furthermore, the complexity is increased by the **fragmentation** of a) the structure of (especially European) transport chains with independent hauliers, route operators, and private fleets, b) the different specialisations, and c) the sizes of the actors from owner-operated businesses to global corporations (Klaas-Wissing and Albers, 2010; Sternberg et al., 2013; Tjokroamidjojo et al., 2006). Particularly in Europe, the freedom of movement for workers in combination with overall deregulation facilitate this fragmentation not only on a national, but on an international level (Andersson and Sternberg, 2016).

## 1.2 Problem

**Managing and monitoring** sustainable operations under the described conditions is a challenge in itself, but becomes even more complicated by an increasingly common practice in Sweden and other Western- and Northern-European countries to outsource: Services are sub-contracted to 2<sup>nd</sup> tier actors, who might in turn sub-contract, in order to reduce costs. Sub-contractors are often unknown to the original initiator of a transport chain, making it impossible to monitor the quality of the services, the labour conditions, et cetera (Svensson, 2009). In fact, a black hole emerges, lacking information and more so reliable information (Sternberg et al., 2013). Even if information is existing, it is easy for companies to either keep it secret to maintain

competitive beneficial knowledge or to manipulate it to obscure deficiencies (Steiner, 2015).

Besides these challenges originating from the market's characteristics, there are other problems harming companies directly, also caused by the opacity of modern supply chains: As products and their identities cannot be monitored and guaranteed through all the layers in many supply chains, **fraud and counterfeit** are facilitated and lead to massive direct financial losses for companies. Furthermore, this lack of supply chain integrity again damages consumers' trust when they find a value proposition unfulfilled. The aftermath of counterfeit products is an increased amount of supply available on the market, which leads to prices decreasing (Mettler, 2016; Steiner, 2015).

The Swedish furniture retailer **IKEA** faces some specific challenges and allegations related to this topic that have recently been discussed in the media. These reports, issued by transport unions as well as mass media outlet such as the BBC, allege IKEA tolerates bad working conditions in the supply chain, specifically for the truck drivers. Even though IKEA has an industry-leading code of conduct for all suppliers – "IWAY" – it struggles to monitor the many layers of the supply chain. In fact, many of the 94 regulations only directly affect the 1<sup>st</sup> tier suppliers. The unions argue that IKEA is the economic initiator of the chain and responsible for all layers. Additionally, although the transportation and other supply chain services IKEA purchases are mostly off the shelf (which means the problems with working conditions are an industry-wide problem), IKEA has an increased responsibility as they are a big enough actor to make a change. IKEA sees and promotes itself as sustainable company. Credibility in this area is vital for the company, but is right now being damaged by the media coverage and protest action. Based on its ambition to be a leader in sustainability, IKEA showed interest in this study and agreed on a collaboration in the form of a case study to better understand where exactly improvements are needed, what creates opacity, and to investigate a new approach to potentially enhance the status quo.

Everything described so far leads to the need for more **transparency** – also defined as disclosure of information in literature – in supply chains and in road transportation in particular. This challenge is not new, but has been a key topic in research since Akerlof (1970) published his fundamental work, explaining information asymmetries between sellers and buyers. Such imbalances have the consequence that consumers cannot differentiate between good and bad products or services, favouring those delivering below-average quality by producing at lower costs, which finally leads to a quality decline (Andersson and Sternberg, 2016). The trend is, as pointed out above, that consumers increasingly care. Creating transparency is thus becoming vital for companies, and needs to be promoted in a trustworthy way (Andersson and Sternberg, 2016; Tapscott and Ticoll, 2003).

### 1.3 Research Issue

The characteristics of today's transport chains, as previously described, correspond with considerable potential for deficiencies firstly to emerge – be it by accident or on purpose – and then not to be discovered at an early stage, or simply at all. As the main cause of this, the complexity and opacity of current transport chains were explained. Serdarasan (2013) differentiates between necessary and unnecessary complexities. In this case, the complexities are accepted to be given by the globalised nature of today's economy. Thus, the goal is not to eliminate them, but to manage them. This highlights the need to increase transparency in supply chains, and to investigate the applicability of new concepts and technologies.

One such technology is **blockchain**. The idea to distribute a ledger and validate transactions via a network of participants, rather than relying on intermediaries had existed for several decades. However, it was only made possible to do this in a trusted, tamperproof and transparent way in 2008, when Nakamoto presented the Bitcoin blockchain protocol (Tapscott and Tapscott, 2017; Tschorsch and Scheuermann, 2016).

Both in research and in practice the interest in blockchain is rapidly increasing (Lemieux, 2016; Tschorsch and Scheuermann, 2016; Yli-Huumo et al., 2016). A large share of the publications read for this study, even those discussing major flaws of the existing blockchain protocol, state that this technology has the potential to revolutionise business (e.g. Baur et al., 2015; Gupta, 2017; Karame, 2016) and to be disruptive to current practices (e.g. Friedlmaier et al., 2016; Mettler, 2016; Yuan and Wang, 2016). Several authors expect blockchain to change the way transactions are made as much as the internet did in the past (e.g. Brennan and Lunn, 2016; Ito et al., 2017; Reyes, 2016).

Within the three years prior to summer 2016, over 2,500 patents were applied for, and over \$1.4 billion was invested into projects within the blockchain field, with the majority of both central banks and commercial banks becoming engaged (McWaters and Bruno, 2016). Already a year ago, PricewaterhouseCoopers (2016: 17) identified 700 companies dealing with blockchain, categorising 150 of them as “worthy to be tracked” and 25 as potential industry leaders. A survey answered by over 800 executives at the 2015 World Economic Forum resulted in more than half the participants expecting 10% of the worldwide GDP to be stored on blockchain before the year 2025. Three quarters of the responders expected taxes to be collected on-chain before 2025 (Global Agenda Council on the Future of Software and Society, 2015).

The advice of publications and conferences is consequently ‘not to miss’ the development of blockchain and the potentials of blockchain adoption (e.g. Friedlmaier et al., 2016; Iansiti and Lakhani, 2017; Ito et al., 2017).

Despite the high attention and expectations, research into blockchain adoption in areas other than cryptocurrencies is still in the early stages. Academic papers, as well as consulting reports and other sources, mention massive potentials, but provide little concrete examples or explanations on how to specifically use blockchain to

overcome, for instance, supply chain opacity. The first area this study contributes to is hence the application of blockchain in supply chains with physical assets and the related specific challenges.

The allegations<sup>1</sup> against IKEA not to sufficiently exclude some widely criticised and transportation-industry typical unsustainable practices from the company's supply chains raise the question of how transparency in transportation and supply chains can be increased to a) improve the compliance level with company-defined or legislative regulations, and b) testify this compliance and thus sustainable practices to consumers and the public. Accordingly, the second area of contribution is information symmetry and transparency in transportation, with relation to sustainability. As Weich (2015) points out, this aspect is extensively analysed in the context of supply chains, but hardly related to freight transportation.

#### 1.4 Aim and Research Questions

Based on the challenge for supply chains to counteract opacity and the areas of contribution, this study aims to investigate and evaluate the potentials of the blockchain technology to facilitate transparency of supply chain's actors and operations with the focus on aspects of social sustainability. It shall be analysed how, and to what extent, the traceability of entities and operations in transport chains, and the overall supply chain transparency, including for example the different actors entering the chain, can be improved. Therefore, the characteristics of blockchain's original area of application – a virtual currency – have to be compared to the transparency-related challenges in supply chains and transportation. The focus lies on the transportation sequences, but these are analysed as part of the overall supply chains.

This analysis will be done by first creating a thorough understanding of the concept and how it can be used, based on both existing research and some existing applications. Secondly, the IKEA case study will be used to examine specific challenges related to transparency in supply chains, which will then facilitate the analysis of which adjustments and developments of blockchain are needed, and which next steps are to be taken. The two research questions this study aims to answer consequently read:

**RQ1:** How can blockchain technology enable an increase of transparency in supply chains, especially in transportation?

**RQ2:** What adjustments and improvements are needed to apply blockchain to transportation chains with their specific characteristics?

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<sup>1</sup> Whilst the difficulty to create the needed levels of transparency is generally recognised, several aspects mentioned here and then in detail in *chapter 5.2* are denied by IKEA. One of IKEA's carriers was convicted for its driver exploiting operations, but appealed the conviction with no final judgement issued yet. The different aspects whose potential to be improvable by increased transparency is subject of the case study are hence referred to as allegations.

## 1.5 Delimitations

This study focuses on using blockchain, and is not a technological paper. To dive deeper into the Bitcoin blockchain's protocol and its technological specifications, Nakamoto (2008) and Tschorsch and Scheuermann (2016) are recommended for reading.

Even though sometimes relating to supply chains as a whole, the attention is on the transportation-legs (not, for example, on sourcing and producing stages), and geographically centered on Europe (since, among other things, the (data) infrastructure and legislation are very different in other parts of the world).

The focus is on the potentials of blockchain and different kinds of shared ledgers to cope with the described problems. The given characteristics of supply chains such as the complexity and fragmentation are accepted as given and not tried to be changed.

The collaboration with IKEA was only for this study. The author is not employed by the company and did not have extensive background knowledge or access to internal data.

All analyses and corresponding results remain theoretical. Some potentials, as well as challenges, would require some test-application to be detected. The time limitation of the study did not allow for this, since both the author and IKEA agreed to first conduct an extensive theoretical analysis, of which the results are believed to be more generalisable. Parallel to the completion of this study, Jeppsson and Olsson (2017) wrote a master thesis originating from the same problems and dealing with the same research issue, but with a different perspective and methodological approach: Collaborating with a 4PL<sup>2</sup> in food logistics, they used a blockchain connected smartphone application for some basic testing. Their approach and findings will be referred to when applicable.

## 1.6 Thesis Outline

The remainder of this thesis consists of six chapters. *Figure 1* illustrates how they are related to each other.

*Chapter 2* explains and critically reflects upon which methods were applied in this study, as well as why and how.

*Chapter 3* provides the frame of reference, the blockchain technology and concept, including an overview of its strengths and weaknesses. Related ledger-approaches are presented, aiming to create an understanding of how blockchain can facilitate trustworthy transparency.

*Chapter 4* summarises the status quo of blockchain adoption – both in its initial field, cryptocurrencies, and in other industries, especially in supply chains and

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<sup>2</sup> *Fourth Party Logistics* service provider, i.e. non-asset based coordinator of logistics activities

transportation. Some examples for blockchain adoption in supply chains are described.

*Chapter 5* includes the IKEA case study: A description of the allegations underline the challenges the transportation industry faces. IKEA's sustainability goals and how these are realised together with its suppliers are analysed, with the goal to understand where and why transparency-deficiencies arise.

*Chapter 6* combines the different findings, and answers the research questions.

*Chapter 7* is of special importance for this study of a very contemporary topic: The implications of which next actions to take to develop, promote, and exploit blockchain are discussed for different groups, including IKEA. The contributions of the study are summarised and finally the research design is critically revised.

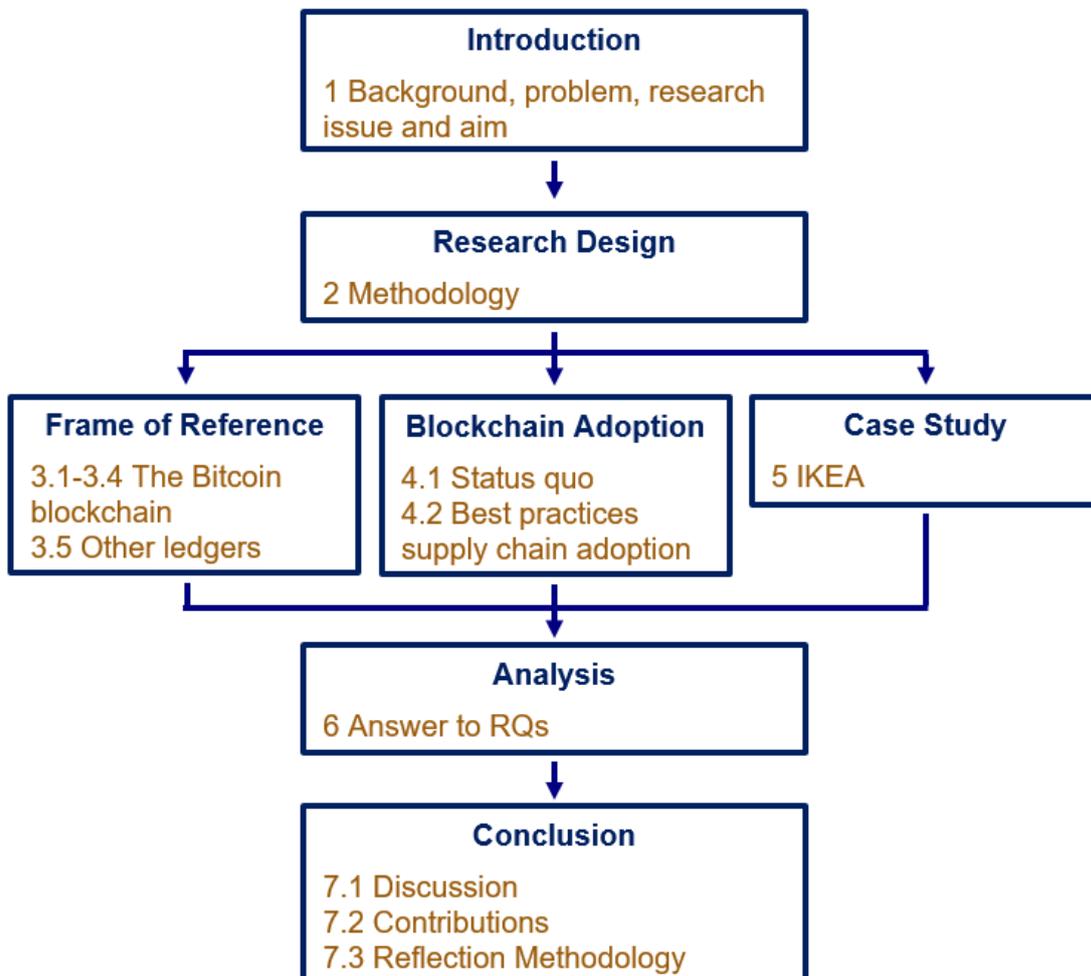


Figure 1: Structure of the thesis

## 2 Methodology

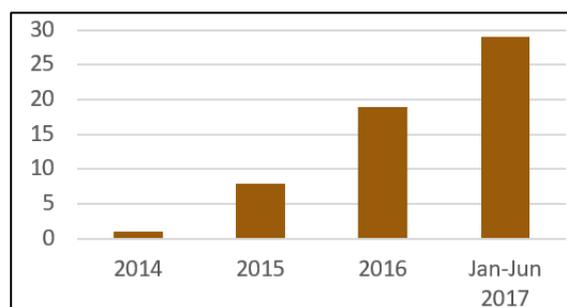
*After introducing the general research approach, this chapter describes the methods applied. The motivation to select each method, the procedure of execution, and the way of documentation is explained for the literature review, the document analysis and the case study, which includes a workshop, document analyses, and interviews. The research design and the aspects of validity, reliability, and objectivity are critically reflected upon.*

On the basis of both the research field of this study, and the research questions, the appropriate research approach and methodology had to be determined.

As Björklund and Paulsson (2014) and Ellram (1996) state, when approaching a field of interest in which very little knowledge is existing, an exploratory study using abductive reasoning is the suitable analytical approach (Bryman, 2004). The decision of which methods to apply is “about using time and other resources in an efficient manner in order to be able to create as much new knowledge as possible [..]” (Björklund and Paulsson, 2014: 50). Furthermore, the researcher “is dependent on how much knowledge exists in the field, on financial funding, time limits, knowledge and attitudes of friends, colleagues, co-authors and supervisors” (Björklund and Paulsson, 2014: 83). The author intended not just to answer very general research questions for which secondary data might have been sufficient, but to develop some specific results and recommendations for further research. The cooperation with IKEA provided a source of primary data required for this.

In the following paragraphs the methods applied are described, including the motivation to choose them and a systematic description of how they were used.

Watching videos on YouTube is not considered a separate method, as it only supported the creation of background understanding, and was not done systematically. Furthermore, the videos’ content is not directly referred to in this study. A list with all videos screened is provided in *appendix 1*. *Figure 2* underlines the growing interest in the field in the last years.



*Figure 2: Videos watched by year of release*

Whenever a systematic search for sources and information was conducted, this was done in English. However, since the author understands both German and Swedish, some sources in these languages were included when found, especially when used for background understanding.

It should be mentioned that the author has an extensive understanding of how road transportation in Europe works, and what challenges it faces, due to his apprenticeship in the area, which facilitated this research.

## 2.1 Literature review

In order to understand the existing body of knowledge within the research area blockchain, a literature review was conducted. The aim was to provide the reader with an overview regarding which characteristics are described, which potentials, challenges, and research gaps are identified, and which research methods are used in this field. The method of reviewing literature was chosen for it offers the possibility to collect much information within time and financial limitations (Björklund and Paulsson, 2014).

In line with the academic requirements, this literature review was meant to focus on academic journal articles. However, the area is characterised by its novelty with continuous new developments. Reviewed academic and journal articles take quite a while to be published. Therefore, many conference papers were also included, but only from the last two years, were included. Books were very rarely included, since they tend to reflect someone's opinion rather than objectivity, and also tend to be outdated by the time they are published in areas developing as rapidly as blockchain.

The database mainly used was Web of Science, for it excludes low-quality articles and papers that are included in many other databases. Google scholar and Lund University's own search system LUBsearch were employed to get an initial overview of the topic and to test the search strings.

Especially due to the limited time available for the study, applying the right search strings from the beginning was very important. In line with the aim of the study, it was first searched for *blockchain* and *distributed ledger*. As suggested by Bryman (2004) and applied by Yli-Huumo et al. (2016), a pilot study with these terms was conducted to create an overview. The search strings were then redefined by help of a Boolean operator:

- Blockchain AND logistics
- Blockchain AND supply chain management
- Blockchain AND transparency
- Blockchain AND integrity

The results of the distributed ledger search were either identical as for blockchain or irrelevant, so this search string was not followed with the same additional search words.

A search diary including the search strings, number of hits, and relevant results was kept. The process of reviewing the hits was systematically documented in tables containing all information relevant for the referencing, keywords, and short summaries of the content. This simplified the aggregating of the findings and writing the review.

The list of hits was narrowed down in a multi-step process in order to filter out those relevant for this study. After excluding some papers just due to the title, the abstracts were read and keyworded. Next, some exclusion criteria were applied: Purely technological or mathematical papers were dropped. Due to the novelty of the topic and the rapid developments of the field, papers published before 2015 were mostly excluded. The remaining papers were read and further keyworded. They were clustered by help of the keywords, and by type of the paper. Finally, they were rated by their relevance to this study. In summary this process led to 23 publications out of 120 initial hits being included in the blockchain literature review, including results up until March 2017.

Furthermore, some publications not from Web of Science were used which came up in the first search via Google or LUB-Search, or which were mentioned in the academic papers. This was necessary as some sources of information, especially regarding the status quo of blockchain adoption could hardly be found in the hits from Web of Science, but rather in reports

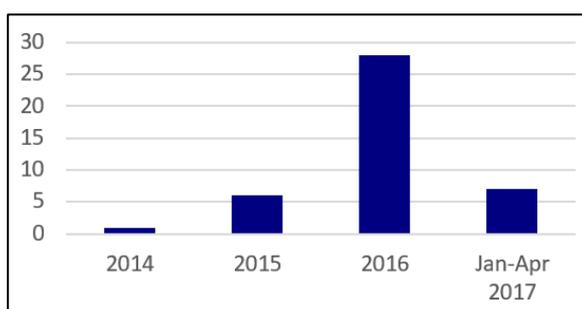


Figure 3: Papers included by year of publication

by big companies, mostly from the finance sector. 19 such publications were used for the literature review on blockchain. Figure 3 illustrates the distribution per year of all blockchain-related papers included in this study.

## 2.2 Document Analysis

Whilst conducting the literature review, the lack of publications covering some critical questions beyond the theoretical potentials of blockchain became apparent and underlined the need for analysing further documents. Moreover, few of the papers included in the literature review linked blockchain to challenges and possible blockchain adoption in supply chains. Consequently, in order to be able to answer the research questions, the goal was to learn about existing applications in supply chain context which would enhance the basis for answering the research questions. In line with Bryman (2004), who points out the flexibility of this method to be applicable to a great variety of documents, different kinds of information sources such as company reports and whitepapers, company websites, and also videos, were analysed in a qualitative way. Often, the projects were mentioned in the academic papers or in the videos that were watched for background understanding, though Google was additionally used to find further projects.

The reading and watching of the sources was systematically documented, similar to the literature review. Attention was always paid to who the issuer was and what its target audience and interests were. Chapter 2.4 will reflect on this further.

### 2.3 Single Case Study

It was already stated, and confirmed by the literature review, that the research field of this study is very contemporary with little research existing, both of academical and practical nature. Pursuing the research questions, this raised the need to better understand the lack of transparency in supply chains – causes and consequences – as well as the potentials and challenges of blockchain adoption to facilitate transparency. Hence, a case study approach was suitable since it allows the study of an actual phenomenon in its physical context on top of the theory, and allows for in-depth understanding of the dynamics and circumstances it (Yin, 2014).

The case study was conducted at IKEA<sup>3</sup> for several reasons: The retailer initiates extensive global supply and transportation chains, and thus faces the above mentioned challenges with their complexity and fragmentation. IKEA was lately alleged to not sufficiently guarantee sustainable operations in its supply chains, and thus has a particular interest in creating transparency to counteract those allegations. Finally, IKEA believes itself to be an innovation leader and perpetuates this image to the public, and as such showed interest in the emerging blockchain technology and concept.

Due to the kind of information needed for this study, no extensive company visits were needed to for example shadow employees. Not all information had to be collected in one go, but the analysed documents were available at any time, and the interview partners could be approached via email or call whenever new questions arose or information was needed.

The case study started with a workshop for which the author travelled to Pratteln, Switzerland to meet a *Global Sustainability Manager* and a *Sustainability Specialist* of IKEA. Based on the literature review which was mostly completed by then, the author introduced the topic of his thesis and the concept of blockchain. IKEA provided background knowledge regarding the structure of its supply chains and information flows, as well as the company's sustainability goals, the related requirements towards the suppliers, and how these are implemented and audited. Then, the scope of the case study and the goals of this project were discussed, and the next steps were agreed on.

Following this, the case study was based on two methods which were applied continuously and complemented each other:

On the one hand, the method of document analysis was used twice more: First, to understand the content of the allegations against IKEA as already briefly summarised in *chapter 1.2*, a Google search was performed to find newspaper and magazine articles, reports, and videos. In combination with several interviews (see below), the aim was to get an impression of in which areas new approaches – possibly blockchain-based – are needed. Then, IKEA's goals regarding social sustainability and transparency in its supply chains, as well as the actions the company takes

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<sup>3</sup> The collaboration was agreed on with *IKEA Purchasing Services (Sweden) AB*

towards its suppliers to improve the same, were analysed by means of document analysis. Several official documents such as the code of conduct and the sustainability report were analysed. The aim was to find out in which specific areas transparency is urged and how the conditions could allow for possible blockchain application.

On the other hand, interviews were used to ask specific questions or talk about certain aspects that emerged conducting the document analysis. In addition to the two contacts in Switzerland, the author was provided a third contact – a *Sustainability Developer* equipped with extensive knowledge regarding the transport planning from positions he had had in the past – in IKEA’s headquarter in Älmhult, Sweden. The interviews were held via phone calls, and additionally the author made a visit to Älmhult.

Furthermore, the author had the opportunity to talk to a journalist working for a logistics magazine that had published critical articles regarding working conditions and transparency in IKEA’s supply chains, and to a representative of the Swedish Transport Workers Union. These interviews aimed to better understand the goals pursued by the media reports and protest actions as well as how these parties think IKEA could improve the situation. They provided the author with input from all involved parties and thus created a broader picture.

All interviews were – typical for qualitative research – held in an unstructured and open way. In fact, in line with Yin (2014: 110), they “resemble[d] guided conversations rather than structured queries.” Usually, the author had a question or just a topic which he asked his contacts to elaborate on. The conversations were then steered by follow-up questions that came up while talking. This flexibility limited the collection of information only to the knowledge of the interviewee or to what they wanted to disclose. Extensive notes were always taken during all interviews. The author was not allowed recording and thus could not write transcripts, but that is not seen as an issue, as the interviews served for clarification and background information only. Additionally, not recording conversations can encourage the involved persons to speak more openly and honestly.

*Table 1* represents the interviews, including the position of the interviewees. The author officially collaborated with IKEA for this study, which included signing a nondisclosure agreement and an agreement that IKEA would get to read the results before publication. The interviewees from a logistics magazine and the Swedish Transport Workers Union asked to remain anonymous.

	Company	Position	Duration
<b>Workshop</b>			
23.03.2017	IKEA	Global Sustainability Manager & Sustainability Specialist	7 hours
<b>Interviews</b>			
11.04.2017	IKEA	Global Sustainability Manager & Sustainability Specialist	1 hour

11.04.2017	Logistics magazine	Journalist involved in the recent IKEA-reports	1 hour
21.04.2017	Transport Workers Union Sweden	Representative	1 hour
10.05.2017	IKEA	Sustainability Developer	2 hours
26.05.2017	IKEA	Global Sustainability Manager & Sustainability Specialist	½ hour
14.06.2017	IKEA	Sustainability Developer	1 hour
29.06.2017	IKEA	Sustainability Developer	½ hour

Table 1: Workshop and interviews conducted for the study

## 2.4 Critical Reflection

### a) Alternative methods

Supporting transparency in the choice of methods, it is briefly explained why three other common methods were not applied:

In line with Björklund and Paulsson (2014), a **survey** was not applicable for this study's area of research. Surveys address bigger groups of people and are typically a method in quantitative research, whilst for this study experts were needed for more in-depth questioning (interviews) than a survey can provide.

There are no real applications of blockchain in supply chains where their utilisation could have been investigated by help of **observation**. To gather insights regarding the existing problems and the status quo of auditing the selected methods offered more accurate information with less effort.

The possibility to perform an **experiment**, more precisely some testing to understand the application challenges better, was considered, but together with IKEA this approach was decided against. Testing would have had to simplify a lot, and it is questionable to what extent the results would have been meaningful and generalisable. Furthermore, an experiment would have been very resource-consuming as the entire setup would have had to be built from scratch. The previously mentioned thesis project by Jeppsson and Olsson (2017) confirmed this, applying a smartphone application, but limiting the testing to a short sequence of the supply chain. Their results nevertheless complement the results of this study and will be referred to in the discussion in *chapter 7.1*.

### b) Validity

"Validity is concerned with the integrity of the conclusions that are generated from a piece of research" (Bryman, 2004: 47). It is thus an aspect of quality that the author kept in mind throughout the study. The collection of all data, primary and secondary, was excessively and systematically documented. Information was doublechecked

with different sources and it was assured that sources with different perspectives – in the literature review as well as in the case study – were included. Interview partners were informed about the scope of the study. As mentioned, it was difficult to apply the same academic standards to the literature review and selecting the included sources, as would have been possible for a more established topic. This is inevitable and accepted for topics of such novelty and fast development (Bryman, 2004). It was hence even more important to be critical towards the resources and to question the authors' and the papers' backgrounds and motivations (Björklund and Paulsson, 2014). Conference papers older than two years were excluded, assuming that in this elapsed time a good conference paper would be published as a peer-reviewed paper.

Besides the general term of validity, relevant literature specifies external and internal validity: "External validity is concerned with the question of whether the results of a study can be generalised beyond the specific research context" (Bryman, 2004: 47). In this study, the analysis of potentials to increase supply chain transparency will be related to IKEA within the case study, but since the challenges IKEA faces are very common for the transportation industry, the results have the potential to be generalised. *Chapter 7.3* critically discusses the generalisability of the results. "Internal validity relates mainly to the issue of causality" (Bryman, 2004: 47), but is not applicable for exploratory studies according to Yin (2014).

### **c) Reliability**

For the sake of reliability, that is the extent to which repeating the data collection processes in another study lead to the same results (Yin, 2014), the author always provided very detailed and systematic descriptions of how the methods were applied.

Nevertheless, due to the novelty of the topic and the fast developments, the results would surely not be the same when conducting the same study again in a year or more. Even within the half year of working on this project, figures and contents had to be updated several times.

### **d) Objectivity**

Finally, objectivity, "the extent to which values affect the study" (Björklund and Paulsson, 2014: 66), was maximised by keeping it in mind both when choosing the methods as well as when applying them. In this chapter, it was always explained why certain methods were chosen and also why others were not applied. In the following chapter of the thesis, impartial descriptions of the existing body of knowledge and best practices are clearly separated from those parts in which the author takes a stand, evaluates certain potentials, and formulates recommendations. In the case study, the application of different perspectives – official IKEA documents and interviews with IKEA employees, juxtaposed with the union's and media reports – supports objectivity.

### 3 Frame of Reference: Blockchain

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*This chapter provides the theoretical knowledge needed for the following parts of the study. First, the existing centralised systems supporting opacity are explained, to then be contrasted by the Bitcoin blockchain. The latter's strengths and weaknesses are reviewed, followed by a comparison of shared ledger approaches different to the one underlying the Bitcoin network.*

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In line with the introductory chapter, the frame of reference for this study is blockchain. Even though this study is not of a technological nature and the Bitcoin blockchain is not of the core interest, it is still important to know about the origins of blockchain and the best implemented product, Bitcoin. Only based on that, the potentials as well as limitations of blockchain can be understood and suggestions how to adjust it for supply chain adoption can be developed. This chapter consequently reaches back to the status quo of centralised systems, in order to then explain the strengths and weaknesses of the Bitcoin blockchain in comparison. Based on that, other forms of shared ledgers are described.

#### 3.1 Status Quo: Centralised Systems and Associated Problems

Historically, businesses were rather small and worked in isolation. The possibilities to collect and store as much information as they do today, as well as to share it and the strong vertical and horizontal integration of businesses along supply chains were only enabled by ICT-development in the last few decades. The two main reasons for sticking to siloed, intra-corporation information systems are the high switching costs and to keep competitively advantageous data locked. Furthermore, people and organisations both tend to trust central authorities more than strangers they would interact with in peer-to-peer networks. For instance, a logistics service provider purchasing a transport on the spot market tends to use a trusted freight exchange with certified hauliers. Including one or several of such intermediaries generates considerable transaction costs.

Today, transactions along a product's supply chain are processed through several of these systems, hosted more or less in isolation on each organisation's servers and responding to internal requests only. Each of the centralised intermediaries has control over the data on the respective stage of the supply chain. These structures lead to a variety of potential problems in which the central authorities become central failure points (e.g. Tapscott and Tapscott, 2017; Walport, 2016; Yuan and Wang, 2016) which can be summarised as following:

In combination with the complexity and fragmentation of supply chains, centralised structures facilitate **information gaps**. Data can often not be synchronised properly between the different databases and are thus out of date or inaccurate. Actors on different stages or layers of a system who do not directly interact with each other have

to trust the intermediaries between them. Information is not exchanged peer-to-peer, but usually takes a detour via the central authority, which creates increased potential for data loss, and additionally causes transaction costs and lead times, i.e. those systems restrict transparency (Iansiti and Lakhani, 2017; Tian, 2016; Walport, 2016).

Even if the data is transferred correctly, **errors** can occur. This can be by accident, for example when a system breaks down or has not enough capacity or due to human error. Alternatively, errors can be created deliberately by censoring or alterations to cover fraud or generally enforce self-interests that are contrary to the system's interests (Friedlmaier et al., 2016; Tapscott and Tapscott, 2017; Yuan and Wang, 2016). Already in the 1980s, Lampport et al. (1982: 382) described the ability to handle "malfunctioning components that give conflicting information to different parts of the system" as a main task for any computer system. Within the last months, several extensive, global hacker-attacks have shocked businesses and private persons all over the world<sup>4</sup>. While the goals of the hackers were different, all those attacks demonstrated the vulnerability of centralised systems. Once an invader has access, the damage is severe. Another problem supply chains face in this context are counterfeit products, harming the businesses selling the original products as well as the consumers and the tax receiver (Mettler, 2016; Steiner, 2015).

**Competition is limited** because only those actors invited to participate in a network by the central authority can compete. Even though today's tender-regulations aim to spur competition, it is in many cases up to a service's purchaser who gets an assignment (Tapscott and Tapscott, 2017).

### 3.2 The Bitcoin Blockchain

The alternative is a decentralised system in which participants interact peer-to-peer. This would potentially eliminate the central point of failure, increase flexibility, reduce hierarchies, fasten decision making, shorten lead times, and minimise transaction costs. Such a scenario was not feasible for a long time because there was no technological solution able to replace the central authorities' verification function and to manage both active (writing) and passive (reading) rights of the data (Berke, 2017; Tapscott and Tapscott, 2017; Tschorsch and Scheuermann, 2016).

In 2008, Satoshi Nakamoto introduced the digital cryptocurrency Bitcoin and the blockchain as the underlying protocol. Using a consensus mechanism called proof-of-work, it was the first technological solution that made a decentralised consensus possible (Nakamoto, 2008; Tschorsch and Scheuermann, 2016).

Despite the fact that this study does not aim to in-depth explain in-depth the technological functioning of the blockchain, briefly describing the main characteristics is vital to understand the strengths and weaknesses in general, and how the specific problem of this study can be alleviated. For further understanding, the three papers

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<sup>4</sup> For example Sony Pictures in November 2015, "WannaCry" in May 2017, Maersk and others in June 2017

that this part is based on – Lemieux (2016), Nakamoto (2008) and Tschorsch and Scheuermann (2016) – are suggested for reading.

First and foremost, the Bitcoin blockchain is a database in form of a distributed ledger. Instead of having a bank that stores and updates a database with information about transactions, every participant in the Bitcoin network – called nodes – stores a copy of the blockchain that is constantly updated. This ledger is public and unpermissioned, enabling everybody to access the information as well as to add transactions to the blockchain. Participation and operation in the Bitcoin network is regulated by help of public and private keys, which can be compared to a wallet’s address respectively the owner’s signature. This technology is of great importance for the security of the ledger and the anonymity of the nodes in the network, but a more detailed technological explanation is outside the scope of this paper.

Figure 4 describes how a Bitcoin (1 BTC) is transferred between two members of the Bitcoin network (sender A to recipient B) and how this is logged on the blockchain. The transfer does not include any middlemen such as a bank, but is instead conducted peer-to-peer.

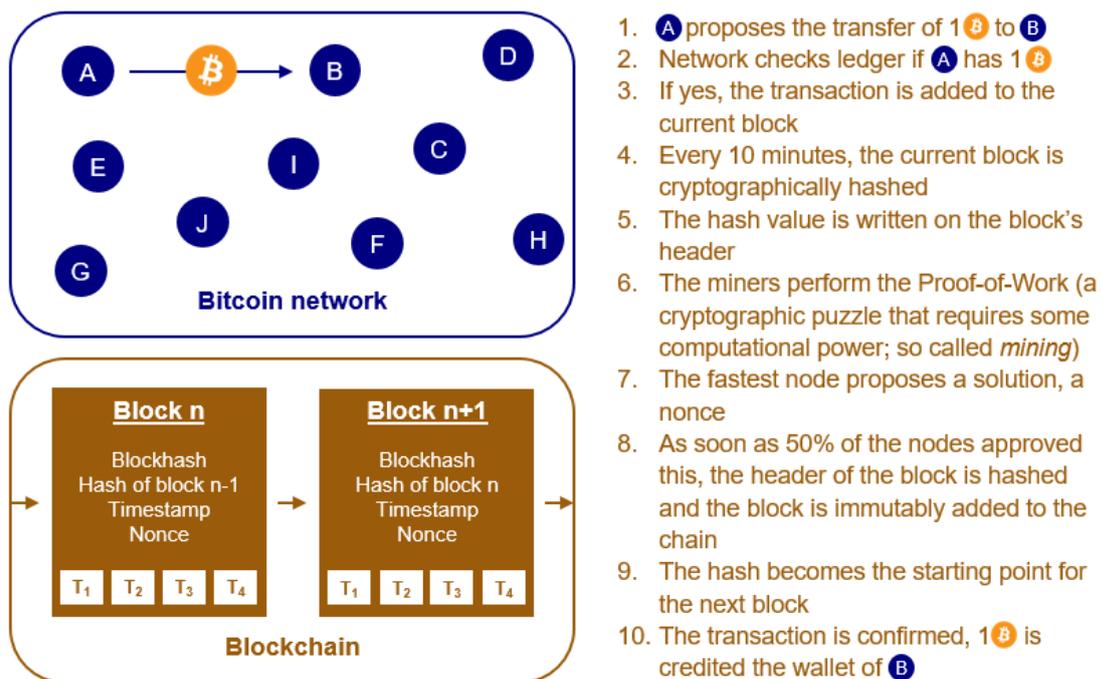


Figure 4: The transfer of 1BTC on the Bitcoin blockchain (own figure, based on Brennan and Lunn (2016), Lemieux (2016) and Tschorsch and Scheuermann (2016))

In the case of the Bitcoin and other digital cryptocurrencies, the blockchain is acknowledged to transfer value, not only information, as the internet does (Brennan and Lunn, 2016; Raval, 2016; Tapscott and Tapscott, 2017). For that purpose, blockchain does not replace but “sits on top of the internet” (Iansiti and Lakhani, 2017: 121).

### 3.3 Strengths

Related to the problems discussed in the beginning of this chapter, the Bitcoin blockchain provides several improvements:

By being **distributed** to many nodes, the potentials for accidental or malicious errors at the central failure point is eliminated (Iansiti and Lakhani, 2017; Tapscott and Tapscott, 2017). To alter the ledger, one would need to control the majority of the nodes, which is virtually impossible without cheating due to the number of nodes on the Bitcoin network. In fact, Sybil attacks, which mean that one entity acts with more than one identity, are a common problem of peer-to-peer-networks. The computational power required to perform the proof-of-work prevent these attacks (Dennis and Owenson, 2016; Tschorsch and Scheuermann, 2016). Using encryption supports the blockchain's security and resilience and the ledger is tamper-proof due to the hashing and the chaining, i.e. establishing chronology, of the blocks. All Bitcoin transactions ever made are stored on one single blockchain. Hence, there is a single source of truth, originating on the genesis block (Iansiti and Lakhani, 2017; Tapscott and Tapscott, 2017; Underwood, 2016). Furthermore, the distribution and replication of the ledger minimises the risk of a system breakdown. If some of the many nodes drop out for whatever reason, the network's functionality is not affected (Lemieux, 2016; Tschorsch and Scheuermann, 2016).

By being publicly accessible, the Bitcoin blockchain is **transparent** (Tapscott and Tapscott, 2017; Underwood, 2016) and the time stamp "enables the traceability and precise positioning of blockchain data" (Yuan and Wang, 2016: 2665). Assets become traceable all the way back to their provenance (Catalini, 2017; Steiner, 2015; Walport, 2016).

Despite the transparency, Nakamoto (2008) claims that **privacy** is given by using anonymous public keys. This is controversially discussed. Godsiff (2015) argues that there is no real anonymity but rather pseudonymity and that based on the public visible transaction flows, patterns can be detected that lead to the identities behind the pseudonyms. This is supported by Hurlburt (2016), who furthermore suggests that there are ways to link user pseudonyms to IP addresses.

Tapscott and Tapscott (2017: 11), in accordance with Iansiti and Lakhani (2017) and Lemieux (2016) believe that blockchain "allows companies to **eliminate transaction costs** and use resources on the outside as easily as resources on the inside". This can facilitate bigger networks with lower entry barriers and higher competition (e.g. Catalini, 2017; Gupta, 2017; Nguyen, 2016).

Different to the high variations in the response **time** when requests have to proceed through several systems, every transaction in the Bitcoin network appears on the blockchain after a maximum of ten minutes. This enables not just fast money transfer, but also nearly real-time monitoring (Tapscott and Tapscott, 2017; Tian, 2016).

All these strengths result in **integrity and credibility**. Many publications included in this literature review stress that the blockchain technology creates trust (e.g. Lehmacher and McWaters, 2017; Tian, 2016; Weber et al., 2016). Yuan and Wang

(2016: 2666) specify that “trust is guaranteed by code, mathematics and verification from the majority, and thus can be considered as ‘software-defined” and Walport (2016) further explains that trust in cyberspace is based on authentication and authorisation (which is not the same as identification).

**Smart contracts** are not part of the blockchain protocol itself, but a feature executed on it, which is considered a core strength: They are “contracts that are translated into computer programs and, as such, have the ability to be self-executing and self-maintaining” (PricewaterhouseCoopers, 2016: 17). Hence, “both express[...] the contents of a contractual agreement and operate [...] the implementation of that content, on the basis of triggers provided by the users or extracted from the environment” (Idelberger et al., 2016: 168). Several papers found within the above explained literature search explicitly deal with the usage and potentials of smart contracts (Banasik et al., 2016; Luu et al., 2016; Swan, 2016; Yasin and Liu, 2016), mainly focusing on mechanisms and languages to translate human-readable contracts into smart contracts (Bhargavan et al., 2016; Frantz and Nowostawski, 2016; Idelberger et al., 2016). Overall, smart contracts are believed to be one of the biggest strengths of blockchain networks (e.g. Brennan and Lunn, 2016; Frantz and Nowostawski, 2016; Iansiti and Lakhani, 2017) due to large potentials for automatisisation and speeding up processes (PricewaterhouseCoopers, 2016), and at the same time creating transparency regarding what “the respective parties have signed up to and whether those things are actually getting done” (Tapscott and Tapscott, 2017: 5).

### 3.4 Challenges for Wide-Scale Adoption

With increasingly usage, several immaturities of the Bitcoin blockchain protocol which hinder wide-scale implementation have become apparent. In the following sections, these are summarised in the categories of capacity, security, resources, and standards and regulations.

#### a) Capacity

The **throughput** is limited to 7 transactions per second (in comparison, Visa processes roughly 2000 with a peak capacity 20 times higher). That is not sufficient if further growth is striven for (Dennis and Owenson, 2016; Swan, 2015; Yli-Huumo et al., 2016).

At the same time, the **size** of the bitcoin blockchain had already grown too big to be manageable by ‘normal’ nodes – the size exceeded 100GB in the beginning of 2017 – and would increase rapidly with higher throughput. This leads to a centralisation of the system in which only a few big miners, which are the nodes that perform the Proof-of-Work (compare *figure 4*), can handle the amount of data (e.g. Dennis and Owenson, 2016; Tschorsch and Scheuermann, 2016; Yli-Huumo et al., 2016).

Resulting from these problematic characteristics, the **scalability** of blockchain was found to be the most discussed problem in recent publications and a major reason for blockchain not to diffuse faster (Dennis and Owenson, 2016; Karama, 2016; Yli-Huumo et al., 2016).

Some papers suggest ways to securely reduce the size of the blockchain, i.e. the amount of data that has to be processed by each node for every verification process. However, none of these approaches is more than conceptual so far and they all come with major drawbacks regarding the integrity of the system. For example, the ideas of side-chains, versioning, or hard forks are discussed, but found to be difficult to realise, as there would not be one single truth anymore and the potential for attacks would be increased (Hurlburt, 2016; Swan, 2015; Yli-Huumo et al., 2016).

## b) Security

It was found – and this is backed by Yli-Huumo et al. (2016) – that a large number of publications in the field of blockchain focus on security issues.

**Attacks** cannot be 100% eliminated, but can be made too expensive for the culprits and thus deprived of incentives (Dennis and Owenson, 2016). The most discussed is the so called 51% attack. In the Bitcoin blockchain with nearly 40,000 nodes, controlling the majority and hence being able to manipulate the chain is virtually impossible. For smaller blockchains, for example other cryptocurrencies or newly setup blockchains in supply chains, this is a threat requiring further technological improvements (Dennis and Owenson, 2016; Yli-Huumo et al., 2016).

In the Bitcoin blockchain, processing and adding a block to the chain takes about 10 minutes. This **latency** allows for double spending and other attacks (e.g. Swan, 2015; Tschorsch and Scheuermann, 2016; Yli-Huumo, 2016).

The combination of the capacity and security problems leads to a dilemma: On the one hand, security increases with rising network-size and the entire system is based on the idea to have only one chain with one single truth. On the other hand, the Bitcoin blockchain is already reaching a point where the expansion entails several drawbacks, even though the number of transactions is still very low compared to networks with mass-adoption.

Applying the public-private-key infrastructure comes along with the drawback that if the private key is lost or is subject to theft, then the content of the wallet is lost – just like cash in a physical wallet. The value of Bitcoins already lost in this way is estimated to be around \$1 billion (Berke, 2017).

However, it has to be stated that the blockchain protocol itself has proven secure. So far, attacks have only been successful because users did not protect their systems sufficiently or because applications running blockchain-based platforms had vulnerable codes. The most prominent example is the DAO attack, a project that was running on the public blockchain platform Ethereum (Berke, 2017; Underwood, 2016; Walport, 2016).

### c) Resources

The computational processes of problem solving to create security – called mining in the Bitcoin context – require huge amounts of **energy**. According to Walport (2016: 5) “it has been estimated that [already a year ago] the energy requirements to run Bitcoin are in excess of 1GW”, which is similar to the energy consumption of Ireland. Additionally, the **hardware** needed is expensive. Both energy and hardware requirements increase even more with higher throughput or block size. This ultimately leads to centralisation with private nodes being excluded and a few professional mining farms running the blockchain (e.g. Dennis and Owenson, 2016; Hurlburt, 2016; Yli-Huumo et al., 2016).

### d) Standards and regulations

As many rapidly emerging and developing ICTs, blockchain technology faces a **law leg**, i.e. regulations are not yet adjusted with sufficient consideration of all new aspects of shared ledgers; nor are they harmonised, leaving actors adopting the technology facing uncertainties about future legal limitations, as well as the governance of the regulations. This affects every possible developer, as well as user of blockchain technology, increases the risk of investments, and thus the attractiveness of the technology (e.g. Godsiff, 2015; McWaters and Bruno, 2016; Reyes, 2016).

Furthermore, a **lack of technology standards** was pointed out. In the current situation, with a variety of competing concepts and developments continuously being added to the different protocols, there is no body of established technology one can rely on. In order to create trustworthiness and reliability in a technical code, legislative framework and rules determining the technological functions are equally important (Friedlmaier et al., 2016; Walport, 2016).

**In summary**, seeing these immaturities in the light of the excitement of many scholars as well as managers and investors as described in *chapter 1.3*, a gap appears. Several papers such as Dennis and Owenson (2016), Iansiti and Lakhani (2017), and Ito et al. (2017) point out this gap, with the latter stating that “the exuberance of fintech investors is way ahead of the development of the technology”. It is explained by comparing the developments of blockchain and the internet: “In contrast to the internet, which took two decades to develop and yet another decade to become commercial, the blockchain ecosystem is developing more rapidly as an economic platform” (Tapscott and Tapscott, 2017: 13), and more so, “the early internet was noncommercial [...] It wasn’t designed to make money, but rather to develop the most robust and effective way to build a network” (Ito et al., 2017). Blockchain, on the contrary, was developed for Bitcoin.

### 3.5 Comparison of Different Ledgers

The analyses of the status quo – centralised and siloed systems – and the Bitcoin blockchain – distributed, public, and unpermissioned – as contrasting extremes have shown major challenges and flaws. Accordingly, this section will investigate mixed approaches, that are non-centralised but at the same time not completely unpermissioned, public ledgers.

Reviewing both academic journals as well as company reports and other publications, it became apparent that in many cases the first blockchain, the one Nakamoto designed for the Bitcoin, was described as *the* blockchain. In reality, there are several other shared ledgers that blockchain technology can use.

Table 2 provides an overview about the three main kinds of shared ledgers, regarding their level and the number of copies, as well as readers and writers, and compares them to the traditional, centralised single-copy ledger. The main advantage of permissioned ledgers compared to the Bitcoin ledger is the possibility to set up rules regarding who has and who has not got access to the information on the ledger (Walport, 2016).

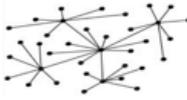
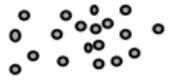
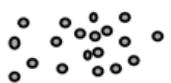
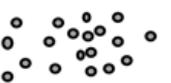
	traditional	permissioned private	permissioned public	unpermissioned public
Level	 centralised	 decentralised	 decentralised	 distributed
Copies	 one	 multiple	 multiple	 unlimited
Readers	 one	 multiple	 unlimited	 unlimited
Writers	 one	 multiple	 multiple	 unlimited

Table 2: The four main kinds of ledgers (own table, adopted from Brennan and Lunn (2016))

Decision-making regarding which kind of shared ledger should be used for a specific problem, and under certain conditions, requires an in-depth understanding of the advantages and disadvantages of each type of ledger. In the following, permissioned ledgers are compared to the characteristics of unpermissioned ledgers. This comparison is based on Berke (2017), Brennan and Lunn (2016), Provenance (2016), and Walport (2016).

### **a) Advantages**

Permissioned ledgers are based on a smaller network of (contributing) nodes, which reduces the complexity and makes the usage cheaper and easier. Especially when it comes to the validation of information on the ledger, the scalability issue of the Bitcoin blockchain is non-existent: If the network consists of selected and trusted nodes only, no proof-of-work or similar method is needed.

The initiator or issuer of a ledger in many cases does not want to give away all control. Permissioned ledgers allows for selection of who has the right to contribute to the ledger, or to even access the information on it.

As mentioned before, the blockchain protocol does not create real anonymity but rather pseudonymity. If that is a problem, a private permissioned ledger is beneficial.

Due to the mining process, transactions on the Bitcoin blockchain have a certain latency. This potential weakness can be reduced using different ways to validate data, which is particularly possible for permissioned ledgers with selected nodes.

### **b) Disadvantages**

Using a permissioned ledger, the number of those entitled to add information is limited. That is, the distance between the contributor and the product on its journey through the supply chain is potentially bigger. The information quality, however, is usually best when the tracking happens in connection to the product as directly as possible in every step along the supply chain. This is closely related to the ability to cover the entire supply chain: Only when actors on every stage of the supply chain are entitled to write on the ledger is the information-chain really completely first hand.

For big networks of nodes using an unpermissioned ledger, it is no problem if some nodes exit or new nodes join. In permissioned networks, consensus mechanisms might have to be adjusted and high fluctuations decrease the stability and trustworthiness.

Transparency is strongly limited in private ledgers because not everybody is entitled to access the information on the ledger.

The information on a permissioned ledger is controlled by fewer nodes, and the owner of the ledger can even select the nodes, so there is a much higher risk of censorship. The overall robustness of the ledger, and the information stored and shared on it, is the highest for unpermissioned, distributed ledgers.

## 4 Blockchain Adoption

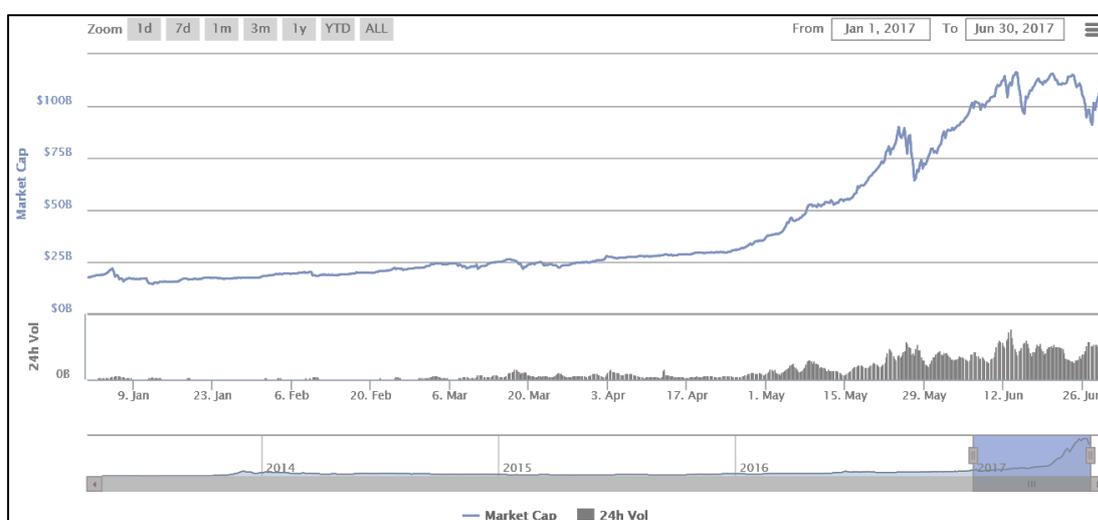
*First, the level of blockchain penetration in finance is described, followed by an overview in of the other industries where blockchain is already used. Then, development platforms and cases of best practice are presented, linking blockchain to supply chain transparency and pointing out supply chain specific adjustments.*

Considering the novelty of the topic of blockchain, which is subject to constant change and new developments, it is not only important to review the literature, but also the state of implementation and the necessary adoptions in fields other than cryptocurrencies. This chapter will thus first generally describe blockchain adoption in finance and other areas, and then introduce some specific cases of implementation that are related to the problem this study deals with, i.e. the need to create transparency in supply chains and transportation. This will contribute to the analysis and the concrete recommendations of this study.

The author does not have the background, nor is it the aim to understand the details of the protocols and how they differ. In line with this study's focus on the usability of blockchain, this chapter is about understanding the possible ways blockchain can establish transparency in supply chains, not how to programme a specific application.

### 4.1 Status Quo Blockchain Adoption in General

The main area of application of blockchain is digital **cryptocurrencies**, with the Bitcoin being by far the biggest 'product'. Every paper and publication about blockchain either focuses on or derives from Bitcoin, and the usage of blockchain in the finance sector. By the end of June, 2017, CoinMarketCap (2017) tracked 928 cryptocurrencies with a total market value of around \$100 billion (Bitcoin accounting for nearly \$40 billion and Ethereum for another \$30 billion). As *figure 5* shows, the



*Figure 5: Total market capitalisation of cryptocurrencies in the first half year 2017 (source: CoinMarketCap (2017))*

market capitalisation has increased massively since the beginning of 2017. In this time period it can be observed that even though Bitcoin nearly tripled its volume, it has lost market shares, suggesting it has lost its advantage of being the first and most mature product using blockchain.

Friedlmaier et al. (2016), in June 2016, analysed 1,140 start-ups having implemented blockchain in their business model. They found that over 40% can be located in the finance and insurance sector, and another 37% in the information and communication industry. Some other industries in which Friedlmaier did not identify, but in which many start-ups have appeared, are intensively discussed in the publications reviewed for this study:

A strong interest lies on the **healthcare** industry, in which counterfeit products can cause particularly severe damage, and also where the handling of patient data is eminently sensitive. Blockchain technology is believed to help by creating one single record for each patient instead of different, possibly outdated ones. With the help of the public-private-key technology, the patient, being the owner of the record, could grant reading and writing rights (e.g. Liu, 2016; Mettler, 2016; Yue et al., 2016). The most advanced project in this area can be found in Estonia, where a governmental authority in cooperation with *Guardtime* manages the health records of over a million Estonians based on blockchain (Guardtime, 2017; Walport, 2016).

For the use of **intellectual property**, hope exists that blockchain could help overcome the massive problems existing with copyrights of digital content. Owners could profit from improved access rights management and consumers could have better options to select what they really want (e.g. Hurlburt, 2016; Nguyen, 2016; Walport, 2016).

In **elections**, problems like double voting or invalid votes could be eliminated with blockchain technology. The voting process itself could be done from home, facilitated by the public-private-key infrastructure, which would make voting more convenient and is assumed to increase voter participation (Foroglou and Tsilidou, 2015).

Other potential areas for future adoption discussed are for example the energy sector (Friedlmaier et al., 2016) and gambling (Foroglou and Tsilidou, 2015).

A few papers mention the potential of applying blockchain technology in **supply chains**, but mostly only vague ideas without specific suggestion of how to use it (Friedlmaier et al., 2016; Underwood, 2016). Tian (2016) suggests a traceability system for agri-food supply chains in China based on RFID and blockchain. Walport (2016) sees potentials for tracking and verifying the documents that are passed through supply chains with their respective products. Lehmacher and McWaters (2017) believe blockchain to be able to record and show all kinds in “information about ownership, provenance, authenticity and price” of a product’s supply chain “from the source of the raw material to where and how the products were manufactured, to their distribution, maintenance, repair, recall and recycling histories”.

**Summarising**, the status quo of blockchain adoption can be described by two characteristics: First, cryptocurrencies are the number one topic both in blockchain research and literature, as well as in implementation, with interest growing exponentially, especially in the last two years. Since the beginning of 2017, the market capitalisation is exploding. Second, the research in most other areas of adoption is far behind. Many papers only point out the prospect of benefits achievable by help of blockchain, but do not describe specific concepts or projects.

## 4.2 Best Practices Related to Supply Chains

Hence, the focus was switched from academic papers and research reports to whitepapers, websites, and videos that describe the first blockchain projects in supply chains which have actually been rolled out, at least in test-environments.

17 projects that the author came across reading the papers and watching the videos were reviewed in detail. Additionally, a Google search was performed for further supply chain blockchain adoption projects. The goal was to find approaches that could be used or adapted to contribute to this study's aim.

The overall results were quite disappointing: There are numerous projects mentioned and websites launched, but very few projects are actually live. Hardly any website, report, or whitepaper describes how blockchain is actually adopted to increase supply chain transparency. Some projects have been rolled out in a test-environment or on a very small scale, but they seem far from wide-scale adoption.

In the following sections, some of the most advanced and relevant projects that are either directly from the supply chain field, or that use approaches related to transparency, are presented, along with the development platforms that many of them are based on:

### a) Ethereum

Out of the projects discussed, Ethereum (Ethereum Foundation, 2017) is the next biggest after Bitcoin, one of the fastest growing, and is mentioned in many blockchain-related articles. Ethereum is a decentralised platform for apps which operate through smart contracts, based on a blockchain. It is designed with great universality to allow for easy implementation of decentralised applications (dapps), providing its own currency called Ether and support for the development and management of blockchain projects. By the end of June 2017, 544 apps were listed on the related website EtherCasts (2017), out of which 140 were live. Within the first half of 2017, the market capitalisation of Ethereum grew from \$722 million to a \$36,762 million peak and the market share grew from 4% to over 30%. Thus, even though Ethereum is not a project building any own blockchain app, it is worth keeping an eye on its development and on the dapps launched on it.

The 544 dapps were searched for 'supply chain', 'transport', 'logistics', 'transparency', 'traceability', and 'provenance'. The only result found relevant was **Provenance**:

This Ethereum-based project with the status 'concept' operates in the area of food supply chains. Provenance states its main goals as lifecycle transparency, real-time tracking, and empowering consumers with trusted information (Project Provenance Ltd., 2017; Steiner, 2015). First small scale tests have been carried out.

During a six-month-long pilot (Provenance, 2016), fish were tracked through the supply chain, aiming to verify social sustainability claims. Storing the data on a public blockchain, the data collection was conducted by help of simple and existing hardware and systems, for example SMS from the fishermen, to demonstrate that a blockchain solution can be built on top of existing systems, instead of replacing them. The report states the need to include trusted organisations in the sourcing to initially certify product characteristics. After that, the blockchain did the rest, even throughout transformation processes. The pilot provided insights on how to best present the newly available information to consumers, for instance by screens telling the stories of scanned products in the supermarket.

Furthermore, the Provenance publications discuss differences between public and private blockchains. The project states it works with a public blockchain, even though that is more difficult, in order to achieve more of the blockchain benefits.

Provenance carried out more projects of similar scope. Jessi Baker, the founder, appears in many videos, praising the great potentials of blockchain to track products through supply chains and back to their provenance. Regardless, some questions regarding how it is actually done, how events stored on the blockchain are validated, or how to apply it on a wider scale are not answered properly. On its website, Provenance encourages visitors to get in contact and try its blockchain solution for free. However, when the author did so, he was told they did not currently have the resources, and furthermore they would not answer some specific questions on how they collect and validate data with their blockchain.

## b) Hyperledger

Hyperledger is an open source collaboration that was created to advance cross-industry blockchain technology development. Started in December 2015 by The Linux Foundation, the project is already being supported by more than 120 contributors. The aim is to bring together a number of independent efforts to develop open protocols and standards. Based on permissioned blockchains, several platforms and frameworks are provided to support different components for various uses. The platform offers participants the possibility to initiate their own blockchains with customised settings regarding for example achieving consensus, creating anonymity or visible identities, or managing access rights (Linux Foundation, 2017).

Being one of the biggest contributors, **IBM Blockchain** uses the platform Hyperledger Fabric, which offers various blockchain solutions for companies to try and use. IBM

blockchain furthermore runs an extensive information campaign with comprehensive information on its websites, in YouTube videos, and with free accessible online courses, which enable individuals, as well as companies, to learn about blockchain (IBM, 2017).

One project based on IBM blockchain, which is already live and can be now considered more than a pilot, is **Everledger**. The start-up has the main goals of securing identity and legitimacy, and lifecycle tracking. Besides other valuable assets, the focus is on diamonds with more than one million registered in a hybrid blockchain model: a public blockchain supports a high level of security, complemented by private blockchains that allow for permissioned control. Hence, trusted but only selected information regarding provenance, ownership et cetera is provided to a number of stakeholders such as potential buyers, insurance companies, or financial authorities (Everledger Ltd., 2017). This hybrid ledger solution, as well as the electronic record that is created for every diamond and to which sourcing and transaction data and certificates are added, make Everledger interesting to this study.

### c) Factom

Factom is another open source platform, on which apps can be built using the Bitcoin blockchain protocol, aiming for data security and immutability (Factom, 2017). The 2014 whitepaper (Snow et al., 2014) describes how Factom aims to overcome what they identified as the core constraints of the Bitcoin blockchain, namely speed, volatile transaction costs, size, and throughput, by adjusting the protocol. The Factom protocol has been in use since September 2015, with over 100 million records by now. Various ideas are being developed and presented on their website or in YouTube videos, but their status often remains unclear. For example, Factom SmartID aims to validate identities in a network while simultaneously keeping them anonymous to the nodes of the network. With Factom Harmony, the organisation pursues the goal to eliminate physical document flows, including risks like losses, and the associated processing times and costs. Two Factom-projects shall be introduced briefly:

The U.S. Department of **Homeland Security** funded Factom within the project 'Blockchain Software to Prove Integrity of Captured Data from Border Devices', which aims to secure the digital identities of Internet of Things (IoT) devices. Based on blockchain technology, Factom is developing "an identity log that captures the identification of a device, who manufactured it, lists of available updates, known security issues and granted authorities while adding the dimension of time" to make the records tamperproof (Kastelein, 2016b).

Partnering with the government of **Honduras**, Factom started a project to secure land title records with its blockchains in 2015. Whilst the project garnered much attention and high expectations in the beginning, and is mentioned in some papers included in the literature review such as Lemieux (2016) and Underwood (2016), it was never actually realised because it was too complex to make it politically possible. This

demonstrates one of the challenges for blockchain adoption in areas other than cryptocurrencies.

#### d) Other projects

Three more projects which are not directly connected to one of these platforms shall be introduced briefly, for they serve as exemplary cases for many more projects in this field. They have three things in common: They tackle real world problems for which no other solutions have yet been found, and they promise a lot, but they do not provide much information regarding how they want to realise their visions nor what their status of development or implementation is.

**Wave** is an Israeli start-up that aims to reduce the use of paper-based documents in supply chains and to speed up the information and document flow, whilst increasing security, integrity, and visibility. Using the blockchain technology to manage the ownership of documents and goods, Wave experiments with different public and private ledgers (Rizzo, 2015; Wave, 2015). The project received media attention in September 2016 when British bank Barclays and Wave claimed to have been the first organisations worldwide to execute a global trade transaction on the blockchain by transferring a letter of credit. (Barclays, 2016). Wave's invitation to get in touch was followed in mid-May, but not answered within two months' time.

**Gatechain**, from Switzerland, wants to use smart contracts to automate finance and other flows in supply chains: By help of these self-executing contracts, payments or documents shall be released when certain conditions are met, for example once a shipment has been delivered. With the transactions recorded on a blockchain, the goal is to eliminate intermediaries, and cut costs and time (Gatechain GmbH, 2017).

**La'Zooz**, another Israeli start-up, is building an open-source ride-sharing platform based on blockchain. Calling themselves the "blockchain version of Uber", the developers promise a network that is actually shared, in contrast to Uber, Lyft and other apps that are controlled by companies which require payment for the use or their surface. In real-time, free capacities and people looking for a ride shall be connected. The entire project is distributed and owned by all users, with not even the developers owning any special stake. La'Zooz now faces the problem that a ride sharing platform only works if enough people in one region use the app at the same time. Once this critical mass is reached, and rides are actually being shared – so far only network participants are recruited – a blockchain shall be used to secure identities and ride-related information, while protecting the participants' identities and information (La'Zooz, 2017). The future will prove if this approach will work and its potential to eventually be applicable to freight transportation.

#### e) Collaborations

Besides organisations providing platforms for open source developments and start-ups running specific projects on these platforms, or based on their own protocols,

there are collaborations, initiated and funded either by governments or companies, that aim to develop blockchain technology for various applications. These are often cross-industry and include universities or other research entities. For example, a Dutch consortium, including the TU Delft, the Port of Rotterdam, and more than a dozen other partners, united for a blockchain project in logistics. Funded with €2.2 million, the project is developing and testing three applications that use blockchain in a logistics context (Kastelein, 2016a). It is complementary to the *Dutch Blockchain Coalition*, a public-private initiative for a national blockchain research institute (dutch digital delta, 2017). Similar projects and initiatives can be found in many industries, underlining the high interest in the technology and the expectations regarding potentials in other areas aside from cryptocurrencies and finance.

## 5 Case Study IKEA

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*This chapter, after introducing the case study company, starts by reviewing the allegations against IKEA. This is followed by a document analysis of several IKEA documents, regarding the company's goals related to sustainability, how these are tried to be met with the suppliers, and what the challenges are. Finally, the status quo of the supplier auditing process is explained. All of this aims to develop an understanding of why, where, and what kind of transparency is needed, what the challenges are to establish it, and what existing structures can be built on.*

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IKEA has the aspiration to be recognised as a leading company regarding sustainability. In its sustainability report, it is stressed that this includes all kinds of sustainability: “We set minimum requirements on environment, social and working conditions throughout our supply chain [...]. We pay particular attention to vulnerable groups in our supply chain [...]” (IKEA Group, 2016b: 10).

IKEA furthermore acknowledges its size as a source of power and leadership: “We want to use our influence, as a global company, to contribute to tackling [social and environmental challenges]” (IKEA Group, 2016b: 4).

Focusing on the social conditions for the workers in the supply chains, IKEA claims: “Our co-workers and our suppliers' co-workers should earn enough to meet their basic needs and those of their family. That includes access to education, food, healthcare, housing and transport. They also have the right to reasonable working hours, benefits and good working conditions” (IKEA Group, 2016b: 69).

Despite IKEA's high ambitions, and their many actions taken to realise their sustainability goals, the concern faces protests and negative media reports, especially related to the aspect of social sustainability in the transportation legs of its supply chains. IKEA denies most of the allegations, but struggles to provide the public with information proving them wrong. This is, to put it simply, due to the lack of transparency in IKEA's supply chains, a problem affecting most companies.

In this case study, after providing a very brief overview of IKEA's supply chains in figures, the allegations are analysed in order to find out what they specifically include, and what the accusers want to be changed. Then, IKEA's sustainability strategy, the code of conduct for its suppliers, and last year's sustainability report are analysed with the purpose of understanding what IKEA's goals are in relation to the criticised topics, what actions have been taken when a problem is admitted, and how the company evaluates its success in doing so. Based on the meetings with IKEA employees and the aforementioned documents, the status quo of the auditing is described. All this is aimed at both identifying very specific aspects that lack transparency, and also at evaluating to which extent applying blockchain could be beneficial.

It has to be mentioned that while the problem description below is based on IKEA as an example, but these are problems the entire industry faces. In fact, IKEA is acknowledged to work hard to improve all aspects of sustainability in their supply

chains and to have very strong CSR policies, even by the union representative who was interviewed.

## 5.1 IKEA Supply Chains in Figures

The following figures for the financial year 2016 are from IKEA's sustainability report (IKEA Group, 2016b) and the yearly summary (IKEA Group, 2016c), and provide an overall understanding of the scale of IKEA's supply chains:

In the financial year 2016, IKEA generated some € 34.2 billion total sales by help of nearly 190,000 co-workers. These employees operate 38 Distribution Centres, 22 Pick-up and Order Points, 41 Shopping Centres, and 340 stores in 28 countries. To have all materials, intermediate and finished products available at the right place, around 2.5 million shipments per year accumulate.

There are 3,592 tier one suppliers within the scope of IWAY. In home furnishing, 1,028 tier two suppliers are supplied by nearly 20,000 tier 2 suppliers. 10% of these sub-suppliers are identified as 'sub-suppliers of critical materials and processes', that is compliance with IWAY Must Requirements (MR) is checked by IKEA (compare *chapter 5.3.4*).

## 5.2 Allegations by Media and Unions

This part summarises both the allegations by the unions and the negative media reports regarding social sustainability and problems with the working conditions in IKEA's supply chains, in order to understand their view of the problem. It is based on the document analyses of newspaper and magazine articles, videos, and the two interviews with a journalist and a representative of the Swedish Road Workers Union. For a list of the documents analysed please refer to *appendix II*.

The main allegation is that IKEA tolerates social dumping and exploitation, as well as breaches of several regulations in its supply chains: Drivers employed by Eastern-European hauliers are driving in Western- and Northern-European countries, such as Sweden, Germany or the Netherlands, for weeks or even months without returning home. Furthermore, being contracted in Eastern-Europe, they are paid Eastern-European wages, which makes most of them stay in their truck cabs rather than in a hotel during their weekly rest periods in Western- and Northern-Europe. This is already against the law in for example Germany and France (DSL, 2017), with a draft for an EU-wide ban existing, but not being adopted yet (European Commission, 2017). The infrastructure at the highway parking zones, for example sanitary facilities, is often not even sufficient for the regular rest-periods. Spending the weekly rest breaks there is even worse and additionally increases the capacity problems. Closely connected to this are allegations that drivers breach rest-time regulations: They are said to be encouraged, or at least allowed, by their employers to drive over-time hours in order to fulfil more deliveries and maximise the utilisation of the trucks. This would

not only be against the law, but cause considerable security issues when drivers are too tired. Earlier this year, media outlets reported on the *Brinkman Trans* case: A Dutch court found the IKEA road freight supplier guilty of breaching rest time regulations, not respecting labour laws, and exploiting drivers. The author was explained the case very differently by IKEA and it is in the process of appealing, but the public and IKEA's customers only get to read those allegations without access to further information.

In 2015, a different case was reported. A Macedonian driver transporting IKEA goods to a destination in Sweden was checked by the police, who found he was using fake Bulgarian personal documents.<sup>5</sup> Similar incidents have been reported intermittently in the European transportation industry and are thus – along with the other problems – not IKEA-specific. Though they do raise the question of how such document fraud can be prevented and how suppliers can guarantee that to their customers.

Some reports furthermore state – and this was underlined in the two open interviews – that IKEA does not take full responsibility for its supply chains, even though it is the economical owner. Despite IKEA stating it feels responsible, it is criticised that this is not reflected in its actions. For instance, the code of conduct (IKEA IWAY, see *chapter 5.3.2*) is only applied to 1<sup>st</sup> tier, and in a few cases 2<sup>nd</sup> tier suppliers, meaning their responsibility for the labour conditions is not extended to the entire supply chain. The author is not to take sides here; the next parts of the case study explore what means IKEA uses to prevent such fraud.

Finally, one aspect which arose in both the documents and the talks is the potential collaboration of IKEA and the unions in this matter: The unions believe that they could improve IKEA's auditing, and in turn compliance with the law and supply chain sustainability goals. IKEA states: "We continue to engage in dialogue with the transport unions so that together we can find ways to contribute to the positive development of the transport industry" (IKEA Group, 2016b: 66). On the other hand, IKEA – like other similar companies – is not willing to give union representatives extensive access to its data and processes, presumably because the company is worried about losing some control.

In summary, the allegations show a strong need for means to create supply chain transparency – regardless of the actual truth of the allegations. If they are not true, transparency can prove the reports wrong and support trust in IKEA's image as leader in sustainability. If they are true, transparency, in combination with other measures, can help to eliminate the 'bad' actors in the supply chain.

### 5.3 Examination of the IKEA Documents

In the next step, several official IKEA documents were reviewed with the aim to identify goals that are related to the problems described above. To understand where

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<sup>5</sup> As a Bulgarian citizen the driver would be entitled to work in the EU, different to Macedonians since this country is not a member state of the EU.

to begin when trying to create transparency, it had to be known what goals IKEA has, and how they can be measured and audited. It was also of interest to determine how IKEA evaluates its suppliers' performance against the IKEA requirements and where the company sees difficulties in ensuring compliance.

### 5.3.1 People and Planet Positive

First, IKEA's publication *People and Planet Positive* (IKEA Group, 2014), which contains the sustainability strategies outlines up to the year 2020, was analysed. The goal was a) to identify goals that are related to the allegations described above and the need for supply chain transparency and b) with the possible introduction of blockchain technology in mind, to understand IKEA's attitude towards new approaches and technologies. *Table 3* includes the statements that were found interesting for the further analyses of this study:

	Goal	Page
A	"We need to transform our businesses [...] It's no longer possible to use 20 <sup>th</sup> century approaches to meet 21 <sup>st</sup> century demands."	4
B	Ensure that "chain-of-custody of all critical materials and processes is established."	6
C	One of three change drivers stated: "create a better life for the people and communities" by extending IWAY throughout the value chain.	7
D	"Integrate sustainability in all IKEA communications channels. This includes strengthening information at point of sale (in store and online) to provide ideas, inspiration, knowledge, and smart solutions."	8
E	"Actively promote more sustainable products and solutions by increasing transparency on how they were produced and their customer benefits. Communication tools that are the most credible and relevant for our customers will be used; including third party certification."	8
F	"Perform regular, transparent and systematic reporting on progress to steer our business and increase transparency and trust. This includes independent auditing and verification of relevant tools and reports."	8
G	"Adopt innovative new technologies, solutions and thinking around clean energy, water, resources and transport of people and goods across our operations and supply chain to transform our business."	8
H	"Invest in innovative technologies and companies that can deliver positive sustainability and commercial benefits through various IKEA investment initiatives."	8
I	"Ensure full supply chain control (chain-of-custody) for all critical materials and processes by August 2016."	13
J	"Take a lead in the responsible sourcing of [many] key raw materials", including requiring certificates for some of them.	13

K	“By August 2017, go further into our supply chain by securing compliance to IWAY Musts at all sub suppliers of critical material and processes”	16
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Table 3: Some study-relevant goals of *People and Planet Positive*

In summary, the analysis revealed three interesting aspects:

The document acknowledges the **need for transparency** throughout the supply chain and at the point of sale, both for internal and external use (C, D and E).

It is a goal to **take responsibility for increased parts of the supply chain** (B, C, I and K). The question of how IKEA wants to achieve this is kept in mind when analysing the next documents and when talking to the employees. The goals related to this topic seem a bit inconsistent: On the one hand, the code of conduct shall be extended “throughout the value chain” (C), on the other hand the scope is limited to the “chain-of-custody of all critical materials and processes” (B, similarly I and K). The next steps of the analysis reveal what scope the specific actions aim for.

IKEA is open for investigating **new approaches and technologies** that might have transformative impact on the business (A, E, F, G, and H). Considering the predictions that blockchain will be ‘disruptive’ or even ‘revolutionise businesses’ (compare *chapter 1.3*), this eager attitude is required.

Furthermore, with the analysis of blockchain potentials and challenges for supply chain adoption, and the allegations against IKEA in mind, excerpt J raises the question of how these certificates are made visible for customers and how they are validated and connected to the goods; the willingness to involve third party certifiers (E) is noticed.

### 5.3.2 IKEA IWAY

Next, the *IWAY Standard* (IKEA Group, 2016a) and the *IWAY Transport Section* (IKEA Group, 2013) publications were analysed. These documents translate the overall goals of *People and Planet Positive* into actions and supplier requirements.

IWAY is short for *IKEA Way on Purchasing Products, Materials and Services*. It is the IKEA Code of Conduct, which was launched in 2000. It contains the *Minimum Requirements for Environment and Social & Working Conditions when Purchasing Products, Materials and Services*, stated in 94 requirements, out of which eight are so-called Must Requirements (further explained in *chapter 5.3.4*). It was later complemented by a *Transport Section (TS)*, containing some additional requirements and specifying some more for suppliers of transport services. According to the IKEA employees, the IWAY is one of the industry’s most extensive and sustainable code of conducts. This was confirmed by the union representative, stating that “this is a fight against the business model of international transport in Europe. IKEA is not the target. They are all the same. [...] IKEA’s CSR policy is one the best in the business”.

Table 4 shows some requirements that are relevant to the challenges described above, as well as the three areas of goals identified in the sustainability strategy. These requirements are relatively easy to measure, and their evaluation of being met or not does not require much subjective evaluation.

	<b>Requirement</b>	<b>Section</b>
L	“proof of age documentation for all workers [of the supplier] is in place”	1.1 (MR)
M	“Trust and transparency related to the IKEA business are ensured at all times. [...] official documents required by law are not manipulated.”	1.3 (MR)
N	“a transparent and reliable system for records of working hours and wages for all workers is maintained by the IKEA supplier.”	1.6 (MR)
O	“The supplier provides accident insurance to all workers [...]”	1.8 (MR)
P	“The IWAY requirements [...] are communicated by the supplier to all its 1 <sup>st</sup> tier sub-suppliers [...]”	2.3
	“[...] all 1 <sup>st</sup> tier sub-suppliers [...] are registered by the supplier.”	2.4
Q	[Supplier-] “Internal audits: Transparent and reliable routines to ensure, verify and report IWAY compliance [...] are implemented”	2.6
R	Maximum age of trucks / fulfilling certain national engine emissions standards	4.9 (TS)
S	“Contractors for [handling] of waste are licensed [...]”	6.6
T	Worker qualifications for chemicals, waste, emergencies, health & safety	5, 6, 7 and 8

Table 4: Some study-relevant IWAY requirements

With emphasis on the three topics of interest described in the previous part, the analysis of the IWAY revealed the following:

The need for transparency, which was acknowledged in the *People and Planet Positive*, can also be found in the IWAY requirements and is actually named twice in the eight most important requirements (M and N). However, it became apparent that the transparency IKEA is calling for is limited: Many required documents, for instance recording workers’ age (L), working hours (N), or lists of sub-suppliers (P) and trucks (R), only need to exist on the supplier site. That is, IKEA can only check their existence and content during the on-site audits. For other requirements like various worker qualifications (T) it is not even specified how they should be documented. That results in limited access to information and thus limited transparency. It raises the question why more extensive transparency is not sought after. At this stage it is assumed that IKEA – similar to its competitors – simply does not have the means to close the physical gap to the suppliers and hauliers on the different levels, which would facilitate increased transparency. In the next section, the sustainability report was checked for explanations and it was brought up in the talks with the IKEA employees.

IKEA's claim to take responsibility for its supply chains can only partly be found in IWAY, even though the first sentence of its introductory *Guiding Principles* reads: "We recognise that our business has an impact on people and the planet, on particular people's working conditions". The scope of IWAY is mostly limited to IKEA's direct suppliers, with a few basic requirements also applying to so-called 'critical' sub-suppliers. It can be assumed that the main reason for this limitation is the lack of transparency in the multi-layer supply chains. Again, the next section is referred to for further information regarding this aspect.

The attitude towards new approaches and technologies to improve processes and for example supply chain transparency is nothing directly connected to the supplier requirements. Especially since IWAY does not include specific technological descriptions on how the auditing should be performed it was not expected to find anything related here.

In general, it was found that, besides the requirements included in *table 4*, many have limits of measurability and are hence subject to human evaluation, which is in line with Bueno et al. (2015), describe the problem of defining quantifiable parameters. This limits the potentials for automatised auditing and, for example, the application of smart contracts.

### 5.3.3 IKEA Sustainability Report 2016

As the final document, the official sustainability report of the financial year 2016<sup>6</sup> (IKEA Group, 2016b) was analysed in order to find out about the status quo of the realisation of the *People and Planet Positive* goals. Furthermore, it was aimed to see which challenges IKEA names in the implementation and auditing of IWAY.

The document devotes one subchapter to social sustainability in IKEA's supply chains (4.2: *Better lives for workers in our supply chain*, pages 60-67).

*Table 5* contains some of the challenges the sustainability report states that are related to the previous analyses:

	<b>Challenges</b>	<b>Page</b>
U	Increase the traceability of the raw materials back to their source to demonstrate that they are increasingly sustainably sourced – documented by certificates.	24 ff.
V	"Our vision is to create a better everyday life for the many people. This includes the lives of people working in our supply chain. Whether they work for our direct suppliers (tier 1), or their suppliers (our sub-suppliers), it is our responsibility to work together to support and enhance their rights."	60

<sup>6</sup> 1 September 2015 – 31 August 2016

W	Working with sub-suppliers: IKEA's suppliers are responsible to "communicate" certain IWAY requirements to their suppliers because these are "a step removed from day-to-day contact [with IKEA] and are not in a contractual relationship with IKEA".	62
X	"We are working to extend our sub-supplier monitoring and development [...]."	62
Y	"Audits provide a window on a single moment of time. They are an important indication of overall supplier performance, but they do not account for fluctuations in compliance with IWAY requirements in between auditor visits. We are therefore shifting our focus towards working with suppliers on continuous compliance [...]." "This requires [among others] developing the capability to collect high-quality data from suppliers so that we can measure and track compliance rates"	63 64
Z	Challenges in SE-Asia with "ensuring transparent and reliable systems for records of working hours and wages – most of the [breaches] were due to manipulation of data or lack of transparency."	65

Table 5: Some study-relevant challenges stated in the *Sustainability Report*

As in the sustainability strategy and IWAY, the need for transparency is mentioned several times. Excerpt W furthermore stresses the challenge coming from IKEA not being in direct contact with any other but their direct suppliers. Y mentions a new aspect – the goal to establish "continuous compliance". This requires a whole new level of transparency which is believed to hardly be achievable with today's means of auditing and data transfer – the next section investigates this further. Besides the need for access to data, Z again points out the demand for data security.

Regarding the extent of responsibility for the supply chain, the statements in this document are a little inconsistent: On the one hand, IKEA aims to be able to trace goods throughout the supply chain (U) and states the vision to improve the lives of all people working along the chain (V), for which the goal to extend the sub-supplier monitoring is defined (X). On the other hand, responsibility to "communicate" some of the IWAY requirements is delegated to the suppliers; IKEA does not take direct responsibility for sub-suppliers that are not immediate contract partners (W).

The document contains a paragraph taking a stand on the allegations and protests, and acknowledging IKEA's responsibility. At the same time, there is no information regarding how IKEA aims to solve the acknowledged problems, except for the introduction of spot checks, which will be analysed in the next section of this case study: "Recently, there has been increasing awareness and concern about social conditions in the trucking industry, particularly within the European Union (EU). Free movement of transport and workers in the EU offers opportunities for workers and employers, but also presents the risk of exploitation. For example some companies will pay drivers the minimum wage of their country of origin, but predominantly offer them work in countries with higher local wages. This makes it difficult for drivers to maintain a good standard of living while they work. We recognise our responsibility to

work with suppliers to ensure every truck driver can expect decent work for fair pay” (IKEA Group, 2016b: 66).

Since 2013, IKEA has partnered with the Fair Wage Network to assess wage practices within IKEA and similarly at its suppliers. Some pilots conducted with the NGO are still being analysed and there is no information given if transportation practices in Europe, including subcontractors, are part of these pilots.

#### 5.3.4 IWAY Auditing Status Quo

The *sustainability report* provides some information regarding the status quo of the auditing (pages 62 and 64). Together with information from the meetings with IKEA employees, which allowed the author to delve further into specific aspects, the IWAY auditing can be summarised as following, with figures from the financial year 2016:

IKEA employed 98 ‘Sustainability Compliance Auditors’. Together with third-party auditors, they conducted 1,757 audits across the 3,589 suppliers of all categories, out of which 724 were unannounced. Thereof, 177 were done by third-party auditors.

In the beginning of a business relationship, a new supplier is checked with an initial assessment to see if the IWAY Must Requirements are in place. Within a year, the supplier has to establish full compliance with all IWAY requirements. From then on, standard audits are executed every 24 months. Such an audit takes one to two days, consisting of on-site tours, interviews with employees, and the verification of the required documentation. In case of non-compliance, business consequences up to supplier phase-outs can be and are being enforced.

In the two supplier categories connected to transport services – land transports to stores and distribution centres (250 suppliers) and customer delivery (94) – the audits have shown IWAY approval rates of 90% and 86% respectively.

As mentioned in the previous part, IKEA just introduced spot checks as an answer to the transparency-issues in transportation: “In FY16, we introduced a process and guidelines for *IWAY Spot Checks* of truck drivers [...]. [We] carry out voluntary, confidential interviews with truck drivers to verify their working conditions and provide input to IWAY audits. Since January 2016, we have carried out 37 spot checks in 5 countries” (IKEA Group, 2016b: 66). These first spot checks were carried out mostly in Europe. In 2017, spot checks were introduced globally and in a much higher number. IKEA widely uses pick-and-drop practices, that is trailers are loaded and sealed, or unloaded, and then left for a haulier to pick up, who in turn leaves another trailer, without any direct interaction. This system reduces the contact between IKEA staff and drivers, which increases the need for spot checks to get their input.

In summary, it can be seen that the auditing is very resource-intensive. Aiming for continuous compliance, new ways to check some of the easily measurable requirements and the documentation are needed. Ensuring sustainable conditions and operations at sub-suppliers is hardly possible with their current procedures.

## 6 Analysis

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*The analysis chapter combines the findings from the previous chapters and the knowledge gathered throughout this study and answers the research questions.*

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Transparency is required on different levels by various stakeholders: As the economic employer of a supply chain, the shipper is responsible for the different aspects of sustainability throughout the chain and thus has an interest in monitoring all actors and operations. Consumers increasingly expect transparent conditions throughout the entire supply chain, whether it be sourcing, production, or transportation. They want to feel qualified to make a buying decision based not only on the price and the promised quality, but also on the level of social and environmental sustainability. Other stakeholders such as unions call for transparency to be able to monitor their own or their principals' interests, that is to be enabled to understand and to doublecheck companies' audit practices and results. However, the aim is not to create full transparency for everyone, possibly by simply granting everyone access to a company's databases, but the level of transparency rather has to be controllable since companies do not want all their data to be publicly visible.

The description of the background of this study and the associated case study have highlighted characteristics of supply chains and particularly the transport legs which hinder transparency: Today's global supply chains have a high level of complexity and fragmentation. This leads to physical distance between different actors, for example between a shipper such as IKEA, and its suppliers, sub-suppliers, hauliers, sub-contracted hauliers and so on, with no adequate ICT-means to sufficiently bridge these gaps in the information flow. The missing contact points, sometimes increased by practices such as pick-and-drop, lead to opacity of such an extent that often certain actors such as hauliers are not even known to the shipper. Just as in the case of IKEA, shippers can enforce highly sustainable standards in the operations of their direct contract partners, but further down the supply chain layers this is impossible and can only be delegated from tier to tier. Furthermore, supply chains are very diverse from region to region and from product to product, which makes standardising processes and information flows even more difficult.

### **6.1 RQ1: How Can Blockchain Technology Enable an Increase of Transparency in Supply Chains, Especially in Transportation?**

Recording transaction data on a blockchain, i.e. information regarding a transaction itself plus the items and entities involved, creates a digital image of the physical flow of goods. Accepting the complexity and fragmentation of supply chains and thus of the physical flows as given, the parallel digital ledger can counteract the physical gaps and the problems with lacking contact points. The idea that all actors of a supply chain contribute to one database is not new, but has so far not succeeded as a sufficient solution without blockchain technology, because organisations were not able to

protect identities and data privacy where needed, nor to prevent data tampering. For Bitcoin, the blockchain protocol has already proven to be capable of solving these problems.

As explained above, information disclosure is only of value if the information made transparent is trusted. By immutably locking data on the chain and by eliminating central authorities, i.e. potential weak points, this trust can be established. As a side effect, excluding intermediaries cuts costs and speeds up transactions.

Whilst on the Bitcoin blockchain only transaction data is recorded, this study has emphasised that in supply chain adoption of blockchain additional information need to be recorded and validated.

With regards to a shipper's monitoring of other actors in its supply chains, blockchain can reduce the need for on-site checking of certain key performance indicators or sustainability requirements. Instead, certain information can be requested from blockchain, which reduces the amount of labour and consequently costs.

By help of smart contracts, certain events or statuses can be detected and even be followed by predefined action automatically. For instance, breaches in drivers' working hours can be easily detected and pursued, or new versions of documents that are about to expire can be requested. In case of failure to meet a contract's requirements an actor can automatically be blocked from being assigned orders. This again reduces labour and costs.

With all these potentials, applying blockchain technology in supply chains can be beneficial both internally to support audits and managing the chains, as well as externally as a marketing tool, creating a competitive market advantage in times where consumers demand increasing levels of sustainability.

The above mentioned requirement to control transparency levels is a problem for the Bitcoin blockchain which is based on a completely public and unpermissioned ledger. The adjustments to meet this and other supply chain specific requirements are a subject of the second research question.

## **6.2 RQ2: What Adjustments and Improvements Are Needed to Apply Blockchain to Transportation Chains with Their Specific Characteristics?**

The review of the strengths and weaknesses of the Bitcoin blockchain and examples of blockchain supply chain adoption, along with the IKEA case study, which pointed at some typical challenges in supply chain management and the transportation industry, have revealed a number of areas in which the original blockchain, i.e. the blockchain used for Bitcoin, needs adjustment to serve supply chain transparency. In the following sections, these areas are summarised, analysing the contrary specifications and requirements.

Besides these supply chain specific adjustments, the previous chapters also highlighted the general need for improvements to overcome the immaturity of the

blockchain technology, no matter in which field it is applied. The necessary steps to do so are discussed in *chapter 7.1*.

### **a) Anonymity vs. Identity**

One of the strengths of the Bitcoin blockchain as designed by Nakamoto (2008) is its anonymity, or at least pseudonymity, which allows actors to conduct transactions in a publicly accessible system without revealing their identity. For supply chain adoption, this feature is only partly a benefit, but at the same time a problem: On the one hand, for some stakeholders like consumers, the identities are not necessarily important, since they rather want to be provided with a trusted attestation that a product was handled under sustainable conditions. On the other hand, to create the kind of transparency and visibility the shipper, as well as for example the unions, want to have, this demands identification of all the actors involved in a supply chain, and certain identity related attributes such as – in the case of drivers – age, country of origin, driver license, insurance certificates, et cetera. At the same time, the identities should not always be revealed to everyone in order to protect competitive interests. Dennis and Owenson (2016) suggest a reputation system where a digital identity is linked to the real one. This is checked by help of the user's IPV4 address. Another idea of the same authors was to build "identity-based encryption systems with the ability to generate a public key based on an email address". In several papers the idea of personal black boxes is discussed. Such a virtual profile could be created and equipped with the initial information by the owner. Certain critical information could then be added or confirmed by trusted 3<sup>rd</sup> parties, for instance ISO certifiers, banks or insurance companies. Reading and writing rights could be managed by help of the public and private key infrastructure (Tapscott and Tapscott, 2017; Weber et al., 2016; Zyskind et al., 2015). Having such a trusted virtual identity could be set as a requirement to be contracted to carry out a transport or to render any service.

### **b) Transparency vs. Privacy**

At a first glance, creating transparency is easiest achieved by using a fully public and unpermissioned distributed ledger. Consumers for instance could just scan a code on a product or shelf with their smartphones and receive all information regarding the provenance and the journey through the supply chain.

However, as mentioned, actors in many cases do not want all their transaction data to be publicly visible due to competitive reasons. Thus, a system that enables someone, likely the economic initiator of a supply chain such as a retailer, to determine who has access to which piece of information by defining reading rights is required. As described in *chapter 3.5*, the blockchain technology cannot only be based on public and unpermissioned ledgers, but also on permissioned ones, which is done by most of the projects reviewed for *chapter 4.2*. Unfortunately, it has become apparent that such a ledger would limit the transparency and trustworthiness compared to a public, unpermissioned distributed ledger. With some kind of regulating

central authority, certain information could be hidden or even altered. This aspect requires further technological development to enable creating different levels of transparency for different stakeholders without risking manipulation.

### **c) Single Virtual Asset of Trade vs. Various Physical Assets to Be Defined**

Another conceptual challenge comes with the fact that the blockchain protocol was written for a cryptocurrency, i.e. a single, intangible asset. Adopting this to supply chains, that is recording transactions not only of money or information flows, but also of tangible assets of all kinds, requires creating a secure connection between the physical asset and its digital record. Provenance (2016) discusses pros and cons of both low- and high-tech solutions to do so: Low-tech such as barcodes or QR codes are on the one hand easy to produce and use, but on the other hand easily reproduced and thus – assumed there is an incentive to substitute products – a risk for the validity of the information on the ledger. High-tech like RFID or NFC tags is more expensive, but at the same time considered more secure. Tian (2016) describes a blockchain-based traceability system for agri-food supply chains using RFID, but without actually testing or implementing it. There is a lot of research going on in this field with both increasingly advanced and at cheaper tags. The selection of the most appropriate technology from existing options has to be made on an individual level, depending on the assets that are to be identified and the existing systems. In a supply chain like IKEA's, with goods of relatively low value, the focus is rather on implementing a solution that comes along with low initial costs, i.e. that can make use of existing hard- and software, and low operating costs.

While the Bitcoin is the only asset traded in the original blockchain, using this protocol in supply chains implies that external assets with varying characteristics enter the system. Both the relevant properties as well as their values are very different. As Catalini (2017) states, the key for the quality of all information stored on a blockchain is that the original information is correct. Since the network of actors cannot provide a verification of for instance asset characteristics or actor identities, trusted third parties are needed to perform this service. Those actors – for example NGOs or public authorities – need to be trusted by everyone using the information from the ledger. This is a limitation to the Bitcoin blockchain of fully eliminating potential central failure points. However, confirmed by the review of best practices, it seems unavoidable at the current state of research. Provenance's tuna tracking test, for instance, included those third parties to identify the fisherman and to confirm the origin of the tuna at the beginning of its journey through the supply chain.

As a third challenge which arises with these differences between the clearly defined Bitcoin and various assets in supply chains, the system integration has to be handled: To facilitate the proper retrieval and processing of information, the number of blockchains needs to be minimised, i.e. where possible, the entirety of a supply chain's data base has to be recorded on one ledger. This requires standardisation of the input-data and integration of various input-sources.

#### **d) Validation: Different Requirements**

The validity of a Bitcoin transaction is only dependent on whether the sender owns the right amount of Bitcoin, which can be ascertained by anyone looking at the history of transactions on the blockchain. In a similar way, it could be checked if the sender of a good possesses the good at that time, but this is not sufficient: More information, either asset attributes or at least a seal that allows to pass on the description from the last transaction, needs to be verified. This can only be done by actors directly involved in the transaction, not by random nodes in the network. Additionally, these need to include some human evaluation of for instance the intactness of packaging that is redundant for Bitcoin transfers. It becomes even more complex when a commodity passes through several transformation processes on its way to the finished product and thus its properties change. If the blockchain technology is used to secure the integrity of a document such as an insurance certificate, there is not even a transaction and consequently no receiver to confirm anything.

This once again emphasises the need for trusted third parties, which is counteractive then the goal is to fully eliminate potential central failure points. It furthermore favours permissioned ledgers, for which those participants with reading rights – actors directly involved in transactions or third parties to validate certain information – can be preselected.

On the other hand, assuming all transactions of an entire system are recorded on the ledger, if for instance a truck driver and a warehouse worker both validate a delivery, it can be trusted because each actor can only do one thing at once. In the end, to create a level of transparency that convinces the consumer that a product was produced and handled under sustainable conditions, he or she does not exactly need to know who carried the product, because 'bad' actors are eliminated from the network anyways. Furthermore, in the context of transparency in transportation as described in this study, the main issue is not a lack of trust in the validity of data, but rather that information is not even available at the point of sale. In contrast, for Everledger, tracking diamonds, the aspects of validating identities is the core task (compare *chapter 4.2*). The requirements in validation are thus not only different between cryptocurrencies and supply chain blockchain adoption, but vary from application to application.

#### **e) Problem: Amount of Data**

The blockchain is, as explained above, not suitable to store large amounts of data: Even though the stored information per Bitcoin transaction is very limited (sender, recipient, timestamp), the Bitcoin blockchain already faces massive scalability issues. To track a physical good through the supply chain, much more information needs to be stored in every transaction, such as attributes that describe the good. Furthermore, transformation processes from raw materials to intermediate products to finished products have to be documented and be replicable. Additionally, information that is of interest needs to be available for a long time if much time passes between raw

material sourcing and selling a good to the consumer. Hence, besides the need for further development of solutions in which not every node has to re-download the entire ledger after the addition of a new block, permissioned ledgers seem more suitable for supply chain adoption, given the actual state of technological development: If the ability to write on a ledger is limited to only trusted actors, then there is no need to constantly download and re-check the entire ledger. Some nodes that are only demanding information without themselves adding information could receive them on request without downloading the entire ledger. Another interesting approach, followed by Factom (compare *chapter 4.2* and the Factom videos in *appendix II*), is to separate transaction data and data defining assets or actors in different databases, but link them securely.

#### **f) Problem: Need for corrections**

Accidental human errors present an additional problem: Whereas a wrong amount in a Bitcoin transaction can easily be corrected by a second transaction, this is not possible for supply chains. For example, if a driver realises at an unloading point that he confirmed the receipt of 40 pallets at the last loading stop, but in fact he only received 30, he cannot just ask that loading stop to confirm the reverse transaction of 10 pallets as this would require an additional trip. Changing the number of pallets in the initial transaction would not be possible anymore as the same is already locked in a block. Just enabling some special kind of corrective transaction would totally undermine the immutability of the data. A solution for this is yet to be found.

**Overall**, it became apparent that a single solution such as the Bitcoin blockchain is not sufficient for the various challenges surrounding supply chain and especially transportation transparency entails. Instead, some hybrid solution is needed. To manage the different information and its visibility, and at the same time using the benefits of a distributed ledger as much as possible, information needs to be connected to both the products and the actors in a supply chain. Each service has to be assigned a service provider.

## 7 Conclusion

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*This concluding chapter discusses the implications of the findings from the previous chapters and their analysis. As the field of blockchain supply chain adoption is very new, the recommendations of what actions are to be taken next by the various actors either involved in the development or interested in exploiting the technology is of special importance. The study's contributions are pointed out and the research design is critically revised.*

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The analysis contained in this study have revealed blockchain's great potentials to improve the way transactions are conducted and to create transparency. They also pointed out in which areas adjustments are needed when aiming to use blockchain to generate transparency in transportation and supply chains.

### 7.1 Discussion

Studying the new and emerging blockchain technology has revealed various challenges for different stakeholders to exploit its potentials. This chapter discusses which next steps are important to take for three groups – developers and programmers, promoters of blockchain, and IKEA and other shippers in similar positions. In the course of this, the consumers' increasing demand for sustainability is referred to and, associated with that, the need for trustworthy information confirming sustainability key performance indicators.

**Developers and programmers** need to increase their efforts to solve the main challenges blockchain technology faces at the moment, especially related to capacity, throughput, and scalability. In line with Brennan and Lunn (2016) and other authors, the review of blockchain applications in supply chains underlined that in several cases researchers are taking blockchain as a solution and are then looking for a problem. Contrary to that, it is important to base research and development on existing problems, for which it helps to take the consumer perspective, as they are the driving force behind organisations' decisions to, for example, establish sustainability. Originating from their demands and according to the specifications of the markets in which blockchain is implemented, blockchain solutions can be developed. Connected to this need for a more practical view is the willingness to recognise cases in which blockchain is not the solution, as well as extended testing to understand the true potentials and challenges of the technology from first hand insights. Furthermore, blockchain has to be developed together with other technologies and approaches, not in isolation. This opinion is shared by several papers which particularly mention the internet of things and machine-to-machine economy, and smart contracts to be linked to the developments of blockchain (Lehmacher and McWaters, 2017; Lemieux, 2016; Provenance, 2016; Yuan and Wang, 2016). Further development of open-source platforms such as the described Ethereum, Hyperledger and Factom is needed, bringing together knowledge from different disciplines, to integrate actors and to

maximise speed. This can mitigate blockchain's problem that the technology was from the very beginning used to make money – contrary to the internet which was initially developed open source and not for generating profits.

Examining the different perspectives on blockchain – research and scholars, consultancy reports, start-ups and platforms, and IKEA as a shipper – highlighted that the **promoters of blockchain** need to improve the communication and enlightenment of both professionals and consumers. The status quo as observed during this study is that in the business context, blockchain gets a lot of attention and is expected to become of increasing importance. At the same time, terms like Bitcoin, blockchain, and distributed ledger are often mixed up. As also perceived by some of the publications included in the literature review, the massively increasing interest in blockchain makes it tempting to – as Ito et al. (2017) put it – “jump on the buzzword bandwagon”. To consumers, blockchain remains widely unknown. Some have heard of Bitcoin, but do not understand associated terms such as blockchain or distributed ledger nor their usage. As is normal for developments with the potential to become disruptive to existing processes, general scepticism exists. It is thus vital to find ways to communicate what blockchain actually is and what it can possibly be used for in the future, in a way that people who are not technically adept can understand. This is especially important since consumers do not only need to accept the technology, but trust the provision of information it facilitates. Furthermore, those responsible for regulations – political and legislative – need to be encouraged to create the framework conditions. For example, the elimination of intermediaries such as banks raises completely new questions regarding taxation and supervision.

For **IKEA**, getting involved or initiating some project dealing with blockchain adoption in supply chains is the recommended next step to take. This will help to create in-depth understanding of the potentials of blockchain to increase transparency and to facilitate monitoring in the company's supply chains, but also of the challenges entailed. So far, most publications only talk about the great potentials of blockchain and *that* it will revolutionise businesses, but too few explain *how*. Such a project can make use of existing platforms and initiatives, but by IKEA getting involved itself and not just observing others, the company can shape products and implementations in a personalised way and create IKEA-specific in-house knowledge. At the same time, contributing to an inter-organisational research collaboration with partners from different backgrounds will enhance the results. It is very important to get IKEA's partners such as suppliers, producers and hauliers on board at an early stage, not just to develop customised solutions together, but also to ensure their understanding and acceptance: Besides the need to explain blockchain to decision-makers in businesses and to educate consumers for the above mentioned reasons, possible future users of a blockchain application – for example drivers or warehouse workers – need to be convinced of the advantages. Their motivation to use and support it is vital for its success; it was even identified as one of the three main challenges to implement and use blockchain technology by Jeppsson and Olsson (2017), together

with the need for cooperation between all parties involved in a supply chain, and the integration of IT-systems.

The review of theory as well as best practices has shown that, for many functions, blockchain can make use of existing systems, which lowers the implementation barriers. Nevertheless, the case study has highlighted one aspect that has to accompany the development, testing, and implementation of blockchain at IKEA or any company in a similar position: Whilst a human can include some subjective consideration in a decision, a computer needs clear right or wrong criteria. That is, the more decisions are made by machines, for example by smart contracts, the higher the need for black/white-scenarios. In some grey areas such as ethical considerations in trucking routines this is hardly realistic, but for instance when it comes to checking a driver's working hours, standardisation and quantification can be increased and additionally make results more trusted and easier for external actors to understand.

To IKEA's consumers, the provision of additional information and transparency is a value proposition. Thus, besides the above mentioned fact that they need to understand where this information comes from and why it is trustworthy, it is vital to provide it in an easily accessible way that does not require much effort from the consumer, but encourages them to make use of it and thereby co-create value. Not all consumers value the different aspects of sustainability equally. For example, a consumer who mainly cares about purchasing a product at the lowest possible price will only pay attention, and maybe consider, blockchain-based and -verified information attesting high compliance with social sustainability goals when these are provided in an easily accessible and appealing way. To distinguish from other products in a way that consumers can directly see the differences and make a qualified buying-decision, concrete key performance indicators need to be defined and communicated, which are easy to understand for customers without extensive knowledge of economics and supply chains. One could for example be that all actors involved in a product's supply chain earn a certain minimum hourly wage. This again underlines the need to adopt the perspective of the consumer when developing blockchain to establish supply chain transparency.

With both innovation and sustainability rooted in the company's values, IKEA should not wait for *the perfect solution* to be available from the shelf but take this study as a starting point for its own blockchain journey.

With the study focusing on social sustainability, some implications of blockchain-based supply chain transparency on the other two parts of the triple bottom line can be expected: The intended identification and visibility of supply chain actors and their operations would put pressure on them to improve in all areas. For example, hauliers employing old, environmentally unfriendly trucks, or actors not handling hazardous goods carefully enough and thus risking environmental damage, have to change for the better, or fear not to be contracted any further. Information and guarantees regarding certain key performance indicators of environmental sustainability can be provided to the consumers in a similar way as those discussed focusing on social aspects, and thus further qualify the consumers in their buying decisions. Finally, by

increasing supply chain transparency, the initiator of a supply chain can learn about it and find potentials for improvement of processes and efficiency and thus economic figures.

Even though the reality of wide-scale blockchain adoption and extensive transparency is far from existing, the possible implications should already be considered in order for people and businesses to prepare for potentially enormous disruption. To only briefly get into one possible scenario: If IKEA could directly 'see' hauliers that are today anonymously driving the company's goods from A to B, would there still be a need for intermediaries that sub-contract hauliers? Or would IKEA give its orders to the hauliers directly, trusting their blockchain-secured virtual identities and thus eliminate intermediaries and minimise transaction costs? This would lift competition to a whole new level, with potential to lower costs for IKEA and its consumers, and simultaneously result in better wages for the hauliers. Cooperation would become more short-term, services would to a greater extent be purchased on the spot market. This would in turn raise questions regarding the effects of demand-fluctuations and so on.

Table 6 summarises the findings of *chapter 3* regarding the **different ledgers**, complemented by the knowledge gathered throughout this study. The right column represents the papers discussing these aspects: [1]: Berke (2017), [2]: Brennan and

	traditional	permissioned private	permissioned public	unpermissioned public	Source
<b>Costs</b>					[2,3,4]
<b>Scalability</b>					[3]
<b>Ownership</b>	one or multiple	one or multiple	one or multiple	noone / everybody	[2,4]
<b>Control</b>	everyone entitled by owner	everyone entitled by owner	everyone entitled by owner	noone / everybody	[2]
<b>Centralisation</b>	centralised	mix	mix	decentralised	[2]
<b>Distance ledger to asset</b>					[3]
<b>Ability to cover entire SC</b>					[3]
<b>Network flexibility</b>					[3]
<b>Privacy</b>					[3,5]
<b>Transparency</b>					[1]
<b>Censorship resistance</b>					[1,2,3]
<b>Robustness</b>					[1,3,4]
<b>Latency</b>					[1,4]

Table 6: Comparison of the ledgers (own table)

Lunn (2016), [3]: Provenance (2016), [4]: Walport (2016), and [5]: Weber et al. (2016). It can help to get an overview of the strengths of weaknesses of the different ledgers in comparison to each other. In the end, for every case of application, an individual solution has to be found with the best mix of anonymity, transparency, validation method, irreversibility, and other unique criteria for the given task and conditions.

**Finally**, not related to blockchain but as a side-finding of this study, focusing on sustainability in European road transportation and dealing with the topic of cabotage, the lack of drivers in the EU15 countries appeared a massive problem: Besides the incentive for companies to tolerate sub-contracting routines in their supply chains that result in Eastern-European hauliers operating in Northern and Western Europe under bad conditions and breaching both cabotage regulations and sustainability requirements, this driver shortage in many cases serves as an excuse. Tackling this problem is a challenge that the industry and politics have to take on together. The same applies to the urgent need to improve the infrastructure. The shortage of parking lots next to highways and hotels with truck parking for drivers to spend their short, daily, and weekend rest periods makes operating in compliance with the regulations very difficult and generally threatens the well-being of drivers.

## 7.2 Contributions of the Study

The literature review enables readers who are so far unfamiliar with blockchain to get an overview of how the technology can be used, but also how it cannot properly be used (yet) and what general alternatives exist to the Bitcoin blockchain.

Blockchain as a research field is still fairly new and its adoption in other industries apart from finance is scarcely researched with very few applications live so far. This study provides an overview of the status quo of publications suggesting how to use blockchain for tasks other than transferring cryptocurrencies, as well as of projects that develop the first applications in this field. Thereby, and by help of the case study, some specific challenges – conceptual and technological – were detected and explained, including suggestions on how to approach them. The case study particularly followed the call to base the development of blockchain and cases of adoption on actual problems, taking the circumstances into consideration.

The study furthermore demonstrated and explained why efforts to increase transparency are vital to be able to operate with desired sustainability, and to testify this to different interest groups. Blockchain is not the only means to possibly decrease opacity, but since other attempts that have existed for a longer time and have been developed and researched much more extensively have so far failed to create transparency on the scale needed, blockchain should be developed and investigated further.

For IKEA, the contribution of this study is twofold. By pursuing the first research question, it was shown how blockchain can be of value for the company: Internally, the value of blockchain as a possible means to increase the level of IWAY compliance

was demonstrated. Additionally, the increased transparency would enable IKEA to learn more about its supply chains and to discover potential for improvements in all aspects of the triple bottom line. Externally, the value of blockchain to answer the consumers' demand for increased transparency by providing trustworthy information about products' lifecycle journeys including working conditions of people involved in the value creation was explained. The results of the second research question can guide IKEA in the first steps to get involved in blockchain development and adoption. The study encourages being critical towards blockchain, unlike many projects and publications that are promoting and glorifying blockchain.

Since many companies that operate as shippers face similar challenges as IKEA, these contributions are not only of value for IKEA.

Besides being convinced that blockchain has considerable potentials, it is hoped that this study prevents the reader from blindly glorifying blockchain as some papers, projects and videos do: The confusion about different terms that are mixed up and the danger to fall for the buzzword was pointed out. No company should approach blockchain from a 'how can we make use of it?' perspective, instead any evaluation of the benefits of blockchain has to originate from an existing problem.

The aforementioned other thesis project (Jeppsson and Olsson, 2017) spent most resources on developing and testing a blockchain application. The findings from a 4PL-perspective generally support the findings of this study; the studies complement each other.

### **7.3 Critical Reflection of the Research Design**

Regarding the findings, the chosen mix of methods allowed for an investigation of the topic from various perspectives and cross-validation of the results. Since existing publications about blockchain mainly focus on the finance sector, it was important to include the review of cases of blockchain adoption in the supply chain field to get a better picture of the status quo. In line with the need for blockchain research to be grounded on an existing problem, the case study – as intended when choosing this method – was able to provide more extensive insights into the industry's challenges and into the conditions under which blockchain would have to be implemented, including the required adjustments.

Testing would have been beneficial to gain additional and more direct insights regarding the actual challenges of using blockchain technology in supply chains. However, basic research had to be conducted first and then testing it would have been difficult within the time-frame of this study. Tests would only have been possible on a very small scale and within a simplified scenario, as done by Jeppsson and Olsson (2017), and could hence complement but not replace the methods applied in this study.

The level of generalisation – the external validity – is high for the described challenges with transparency not being IKEA-specific. Findings and recommendations for further research can be generalised to other shippers' supply chains.

Reliability was already described as a difficult aspect for this study to achieve in *chapter 2.4* and this assumption was confirmed: Despite providing detailed descriptions of how the research was conducted, the results would be different when repeating the study simply due to the speed of development in the field. The study reflects the status quo of research in spring 2017.

Reflecting on the objectivity of the research, the triangulation of methods, the extensive explanations of the research design and the motivation for it, and always being critical towards sources led to a good level of objectivity. It has to be recognised that interviews with IKEA employees from other areas than sustainability would have been able to increase objectivity, as the view on the sustainability-supporting measures of those who are responsible is naturally biased. Equally, the official documents published by IKEA are inherently biased, as is media coverage and especially union reports and interviews. This was always kept in mind and the different perspectives counterbalanced each other.

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## Appendix

### I. Videos watched

Pub-lished	Publisher	Title	URL
04.06.2014	Ethereum	What is Ethereum?	<a href="https://www.youtube.com/watch?v=Clw-qf1sUZg">https://www.youtube.com/watch?v=Clw-qf1sUZg</a>
29.03.2015	Satoshi Pollen	Blockchain Technology Affords Tracking Supply-chains Anonymously	<a href="https://www.youtube.com/watch?v=SqlUBn80pg4">https://www.youtube.com/watch?v=SqlUBn80pg4</a>
01.06.2015	La'Zooz	La`Zooz – Social Ridesharing	<a href="https://www.youtube.com/watch?v=0BttJsLLOHo">https://www.youtube.com/watch?v=0BttJsLLOHo</a>
30.07.2015	Ethereum	Ethereum: the World Computer	<a href="https://www.youtube.com/watch?v=j23HnORQXvs">https://www.youtube.com/watch?v=j23HnORQXvs</a>
06.12.2015	Chainthat	Simple introduction to smart contracts on a blockchain	<a href="https://www.youtube.com/watch?v=FkeLDPZ-v8g">https://www.youtube.com/watch?v=FkeLDPZ-v8g</a>
07.12.2015	WIRED UK	Jessi Baker: Blockchain Could Track your Fish Supper   WIRED Retail   WIRED	<a href="https://www.youtube.com/watch?v=NCDhPfhWSig">https://www.youtube.com/watch?v=NCDhPfhWSig</a>
11.12.2015	Ethereum	DEVCON1: Ethereum for Dummies – Dr. Gavin Wood	<a href="https://www.youtube.com/watch?v=U_LK0t_qaPo">https://www.youtube.com/watch?v=U_LK0t_qaPo</a>
16.12.2015	Open Data Institute	Opening supply chain data on the blockchain: Jessi Baker – ODI Summit 2015	<a href="https://www.youtube.com/watch?v=IWP8Y6NQRk&amp;t=2s">https://www.youtube.com/watch?v=IWP8Y6NQRk&amp;t=2s</a>
30.12.2015	Wave	Introducing Wave	<a href="https://www.youtube.com/watch?v=lpmRQjM4Ey0">https://www.youtube.com/watch?v=lpmRQjM4Ey0</a>
01.03.2016	Developer Works TV	IBM Blockchain Car Lease Demo	<a href="https://www.youtube.com/watch?v=lgNfoQQ5Reg">https://www.youtube.com/watch?v=lgNfoQQ5Reg</a>
18.05.2016	Ewald Fuchs	Wie funktioniert die Blockchain und wie kann man finanziell von ihr profitieren	<a href="https://www.youtube.com/watch?v=IAOQH1Ysht8">https://www.youtube.com/watch?v=IAOQH1Ysht8</a>
24.05.2016	Factom	Factom Harmony	<a href="https://www.factom.com/products/harmony/video">https://www.factom.com/products/harmony/video</a>
24.05.2016	Factom	Factom Use Case: Protecting Sony Pictures with Blockchain Technology	<a href="https://www.youtube.com/watch?v=M8dey4Uo5eY">https://www.youtube.com/watch?v=M8dey4Uo5eY</a>

24.05.2016	Factom	Factom Use Case: Saving BoA \$17 Billion	<a href="https://www.youtube.com/watch?v=2Dj3qZeSLdY">https://www.youtube.com/watch?v=2Dj3qZeSLdY</a>
05.07.2016	Factom	Factom SmartID	<a href="https://vimeo.com/173526159?from=outro-embed">https://vimeo.com/173526159?from=outro-embed</a>
11.07.2016	Talks at Google	Blockchain Revolution – Talks at Google	<a href="https://www.youtube.com/watch?v=3PdO7zVqOwc&amp;t=56s">https://www.youtube.com/watch?v=3PdO7zVqOwc&amp;t=56s</a>
03.08.2016	TheOnDemandDemoGuy	Business Networks and Transactions	<a href="https://www.youtube.com/watch?v=obA0InYr0VA">https://www.youtube.com/watch?v=obA0InYr0VA</a>
22.08.2016	TheOnDemandDemoGuy	Course 1: Blockchain Asset Transfer	<a href="https://www.youtube.com/watch?v=vDE0RT98-BU">https://www.youtube.com/watch?v=vDE0RT98-BU</a>
29.08.2016	TheOnDemandDemoGuy	IntroducingBlockchainV2	<a href="https://www.youtube.com/watch?v=ZVIKAY2jtL4">https://www.youtube.com/watch?v=ZVIKAY2jtL4</a>
30.08.2016	TheOnDemandDemoGuy	Course 1: Example Use Cases	<a href="https://www.youtube.com/watch?v=9wpusrXnFUy">https://www.youtube.com/watch?v=9wpusrXnFUy</a>
23.09.2016	IBM Think Academy	IBM Think Academy: Blockchain, How it works	<a href="https://www.youtube.com/watch?v=ID9KAnkZUjU">https://www.youtube.com/watch?v=ID9KAnkZUjU</a>
26.09.2016	Developer Works TV	Building a blockchain for business with the Hyperledger Project	<a href="https://www.youtube.com/watch?v=EKa5Gh9whgU">https://www.youtube.com/watch?v=EKa5Gh9whgU</a>
03.10.2016	Capgemini Group	Blockchain: Real-World Use Cases	<a href="https://www.youtube.com/watch?v=cHe_ow9v094">https://www.youtube.com/watch?v=cHe_ow9v094</a>
28.10.2016	IBM Internet of Things	IBM Watson IoT Platform and Blockchain: a supply chain use case	<a href="https://www.youtube.com/watch?v=PluemoDf--s">https://www.youtube.com/watch?v=PluemoDf--s</a>
02.11.2016	IBM Internet of Things	Blockchain and the Internet of Things explained	<a href="https://www.youtube.com/watch?v=ZKscEx2IO-4">https://www.youtube.com/watch?v=ZKscEx2IO-4</a>
05.11.2016	Anders Brownworth	Blockchain 101 – A Visual Demo	<a href="https://www.youtube.com/watch?v=_160oMzblY8">https://www.youtube.com/watch?v=_160oMzblY8</a>
07.12.2016	IBM Blockchain	Why Hyperledger	<a href="https://www.youtube.com/watch?v=dimE7DI6VLI&amp;spfreload=1">https://www.youtube.com/watch?v=dimE7DI6VLI&amp;spfreload=1</a>
09.12.2016	Henrik Sternberg	Transparenta transporter: Så här förbättrar vi transportbranschen	<a href="https://www.youtube.com/watch?v=6VcdlluCe1Y">https://www.youtube.com/watch?v=6VcdlluCe1Y</a>
17.01.2017	next47	Quick guide to Blockchain: All you need to know – expert interview with Alex Tapscott	<a href="https://www.youtube.com/watch?v=CsR2livCdAw">https://www.youtube.com/watch?v=CsR2livCdAw</a>
18.01.2017	IBM Blockchain	Applying blockchain to customs declarations	<a href="https://www.youtube.com/watch?v=LeKapqAQimk">https://www.youtube.com/watch?v=LeKapqAQimk</a>
18.01.2017	IBM Blockchain	Applying blockchain to Asset Management	<a href="https://www.youtube.com/watch?v=UZgNLIwdILA">https://www.youtube.com/watch?v=UZgNLIwdILA</a>

26.01.2017	Microsoft in Business	NRF Partner showcase: Blockchain Technology and the Supply Chain with Mojix	<a href="https://www.youtube.com/watch?v=V-CuC76zm5A">https://www.youtube.com/watch?v=V-CuC76zm5A</a>
06.02.2017	Fintech Week	Blockchain Use Cases Blockchain & Logistics	<a href="https://www.youtube.com/watch?v=CRe3ALH181E">https://www.youtube.com/watch?v=CRe3ALH181E</a>
16.02.2017	Simardeep Kochar	Blockchain for Supply Chain Transparency & Traceability	<a href="https://www.youtube.com/watch?v=FtK65VH5OBo">https://www.youtube.com/watch?v=FtK65VH5OBo</a>
18.02.2017	FinTech	Blockchain in the Supply Chain	<a href="https://www.youtube.com/watch?v=hHzmNFL39ds">https://www.youtube.com/watch?v=hHzmNFL39ds</a>
15.03.2017	IBM Blockchain	IBM and Maersk Demo: Cross-Border Supply Chain Solution on Blockchain	<a href="https://www.youtube.com/watch?v=tdhpYQCWnCw">https://www.youtube.com/watch?v=tdhpYQCWnCw</a>
17.03.2017	IBM Blockchain	Sneak preview: Blockchain hot topics at IBM InterConnect 2017	<a href="https://www.youtube.com/watch?v=SLvydsllnn0">https://www.youtube.com/watch?v=SLvydsllnn0</a>
17.03.2017	Bosch Software Innovations	Tech deep dive on fog computing, cloud, IoT networks, AI and blockchain	<a href="https://www.youtube.com/watch?v=KeXPnIrrqu5k#t=4m1s">https://www.youtube.com/watch?v=KeXPnIrrqu5k#t=4m1s</a>
04.04.2017	IBM Blockchain	Blockchain: How it works	<a href="https://www.youtube.com/watch?v=UnJ5bCAdzeQ">https://www.youtube.com/watch?v=UnJ5bCAdzeQ</a>
04.04.2017	Manuel Stagars	The Blockchain and Us (2017)	<a href="https://www.youtube.com/watch?v=2iF73cybTBs">https://www.youtube.com/watch?v=2iF73cybTBs</a>
17.04.2017	IBM Blockchain	How Blockchain Reduces Crime and Fraud in the Diamond Trade	<a href="https://www.youtube.com/watch?v=pQoPRAajHT8">https://www.youtube.com/watch?v=pQoPRAajHT8</a>
17.04.2017	IBM Blockchain	IBM InterConnect 2017: Blockchain Technology for the Diamond Industry	<a href="https://www.youtube.com/watch?v=-zYnYXpmtoc">https://www.youtube.com/watch?v=-zYnYXpmtoc</a>
10.05.2017	IBM Blockchain	Securing the Diamond Trade with Blockchain	<a href="https://www.youtube.com/watch?v=hHkc-DH0ep4">https://www.youtube.com/watch?v=hHkc-DH0ep4</a>
11.05.2017	FIA London	Changing the Future of Fashion with Blockchain Technology	<a href="https://www.youtube.com/watch?v=2mkxiZ1Q9t4&amp;feature=youtu.be">https://www.youtube.com/watch?v=2mkxiZ1Q9t4&amp;feature=youtu.be</a>
12.05.2017	Ameer Rosic	What is a Smart Contract? A Beginner's Guide	<a href="https://www.youtube.com/watch?v=qdoUpGg_DpQ">https://www.youtube.com/watch?v=qdoUpGg_DpQ</a>
16.05.2017	Galileo	Bitcoin-Mine: Hier werden Millionen verdient   Galileo   ProSieben	<a href="https://www.youtube.com/watch?v=4pyRW8YpQM">https://www.youtube.com/watch?v=4pyRW8YpQM</a>

06.06.2017	IBM Blockchain	An introduction to Hyperledger Fabric and IBM Blockchain	<a href="https://www.youtube.com/watch?v=JuXH9OYXcQQ">https://www.youtube.com/watch?v=JuXH9OYXcQQ</a>
09.06.2017	IBM Blockchain	Why is Blockchain Relevant for Business -- Blockchain for Business.mp4	<a href="https://www.youtube.com/watch?v=U5_Se1JltxU">https://www.youtube.com/watch?v=U5_Se1JltxU</a>
09.06.2017	IBM Blockchain	Requirements Deep Dive - - Blockchain for Business	<a href="https://www.youtube.com/watch?v=Wf_pYYPQoyss">https://www.youtube.com/watch?v=Wf_pYYPQoyss</a>
09.06.2017	IBM Blockchain	The Problem Area -- Blockchain for Business	<a href="https://www.youtube.com/watch?v=IUWlOLbcuOc">https://www.youtube.com/watch?v=IUWlOLbcuOc</a>
09.06.2017	IBM Blockchain	Requirements Overview -- Blockchain for Business	<a href="https://www.youtube.com/watch?v=hUjKp5be_Cg">https://www.youtube.com/watch?v=hUjKp5be_Cg</a>
09.06.2017	IBM Blockchain	Relation to Bitcoin -- Blockchain for Business	<a href="https://www.youtube.com/watch?v=ycZPhLTxqyY">https://www.youtube.com/watch?v=ycZPhLTxqyY</a>
09.06.2017	IBM Blockchain	The Business Backdrop -- Blockchain for Business	<a href="https://www.youtube.com/watch?v=DmsJlcUtSvk">https://www.youtube.com/watch?v=DmsJlcUtSvk</a>
12.06.2017	IBM Blockchain	Car Leasing Demo -- Blockchain for Business	<a href="https://www.youtube.com/watch?v=LUZp4SsExXU">https://www.youtube.com/watch?v=LUZp4SsExXU</a>
12.06.2017	IBM Blockchain	Public References -- Blockchain for Business	<a href="https://www.youtube.com/watch?v=f5SEKAwuCA0">https://www.youtube.com/watch?v=f5SEKAwuCA0</a>
14.06.2017	IBM Blockchain	Trading Coffee with IBM Blockchain	<a href="https://www.youtube.com/watch?v=suE5KHkESF4">https://www.youtube.com/watch?v=suE5KHkESF4</a>
15.06.2017	Future Thinkers	19 Industries The Blockchain Will Disrupt	<a href="https://www.youtube.com/watch?v=G3psxs3gyf8">https://www.youtube.com/watch?v=G3psxs3gyf8</a>

## II. Media reports analysed (for chapter 5.2)

Date	Issuer	Name	URL
11.11.2015	SVT	Olaglig Ikea-transport stoppad	<a href="http://www.svt.se/nyheter/lokalt/vas-ternorrland/olaglig-ikea-transport-stoppad">http://www.svt.se/nyheter/lokalt/vas-ternorrland/olaglig-ikea-transport-stoppad</a>
13.11.2015	SVT	Ikea får kritik efter olaglig transport	<a href="http://www.svt.se/nyheter/lokalt/vas-ternorrland/ikea-bakom-olaglig-transport">http://www.svt.se/nyheter/lokalt/vas-ternorrland/ikea-bakom-olaglig-transport</a>
19.12.2016	Teamster	Teamsters Stand in Solidarity with European Truck Drivers	<a href="https://teamster.org/node/104650">https://teamster.org/node/104650</a>
20.12.2016	ITF	ITF unions highlight problems in IKEA supply chain	<a href="http://www.itfglobal.org/en/news-events/news/2016/december/itf-unions-highlight-ikea-supply-chain-abuses/">http://www.itfglobal.org/en/news-events/news/2016/december/itf-unions-highlight-ikea-supply-chain-abuses/</a>
21.12.2016	TWU	Protest At IKEA Highlights Exploitation of Truck Drivers & Profit Off-Shoring	<a href="http://www.twu.com.au/home/campaigns/international/-div--style-type--text-css----style---div---di-(1)/">http://www.twu.com.au/home/campaigns/international/-div--style-type--text-css----style---div---di-(1)/</a>
21.12.2016	ITF SWE	Stora internationella protester mot IKEA	<a href="http://news.cision.com/se/transport-arbetareforbundet/r/stora-internationella-protester-mot-ikea,c2154770">http://news.cision.com/se/transport-arbetareforbundet/r/stora-internationella-protester-mot-ikea,c2154770</a>
22.02.2017	Tidningen Proffs	Protester planeras vid IKEA mot fuskande åkeri	<a href="http://www.tidningenproffs.se/nyhet/2017/02/Protester-planeras-vid-IKEA-mot-fuskande-akeri/">http://www.tidningenproffs.se/nyhet/2017/02/Protester-planeras-vid-IKEA-mot-fuskande-akeri/</a>
23.02.2017	DN	Ikea anklagas för att utnyttja chaufförer	<a href="http://www.dn.se/ekonomi/ikea-anklagas-for-att-utnyttja-chaufforer/">http://www.dn.se/ekonomi/ikea-anklagas-for-att-utnyttja-chaufforer/</a>
23.02.2017	Upsala Nya Tidning	Protest för att få bättre villkor	<a href="http://www.unt.se/nyheter//protest-for-att-fa-battre-villkor-4558162.aspx">http://www.unt.se/nyheter//protest-for-att-fa-battre-villkor-4558162.aspx</a>
23.02.2017	ITF	Pressure builds on IKEA over transport chain abuses	<a href="http://www.itfglobal.org/en/news-events/press-releases/2017/february/pressure-builds-on-ikea-over-transport-chain-abuses/">http://www.itfglobal.org/en/news-events/press-releases/2017/february/pressure-builds-on-ikea-over-transport-chain-abuses/</a>
23.02.2017	Transport Net	Brinkman Trans-Holland dömt för social dumpning	<a href="http://transportnet.se/nyheter/brinkman-trans-holland-atalas-for-social-dumpning/">http://transportnet.se/nyheter/brinkman-trans-holland-atalas-for-social-dumpning/</a>
28.02.2017	Een Vandaag	Opnieuw aangifte FNV tegen IKEA-transporteur	<a href="http://economie.eenvandaag.nl/tv-items/72413/opnieuw_aangifte_fnv_tegen_ikea_transporteur">http://economie.eenvandaag.nl/tv-items/72413/opnieuw_aangifte_fnv_tegen_ikea_transporteur</a>

02.03. 2017	Lloyd's Loading List	Court condemns IKEA haulier for flouting labour law	<a href="http://www.lloydsloadinglist.com/freight-directory/news/Court-condemns-IKEA-haulier-for-flouting-labour-law/68724.htm#.WO0nOaKkJPZ">http://www.lloydsloadinglist.com/freight-directory/news/Court-condemns-IKEA-haulier-for-flouting-labour-law/68724.htm#.WO0nOaKkJPZ</a>
15.03. 2017	DN	Facket: "Vi pratade med Ikea i två år – sedan gav vi upp"	<a href="http://www.dn.se/ekonomi/facket-vi-pratade-med-ikea-i-tva-ar-sedan-gav-vi-upp/">http://www.dn.se/ekonomi/facket-vi-pratade-med-ikea-i-tva-ar-sedan-gav-vi-upp/</a>
15.03. 2017	BBC	'I feel like a prisoner in my own lorry'	<a href="http://www.bbc.co.uk/programmes/p04wxfg">http://www.bbc.co.uk/programmes/p04wxfg</a>
15.03. 2017	ORF	Reportage zeigt Arbeitsbedingungen auf	<a href="http://orf.at/stories/2383412/2383460/">http://orf.at/stories/2383412/2383460/</a>
15.03. 2017	Afton- bladet	Chaufförer vid transportföretag anlitade av Ikea besvikna över lönen	<a href="http://www.aftonbladet.se/nyheter/a/aRLbO/chaufforer-vid-transportforetag-anlitade-av-ikea-besvikna-over-lonen">http://www.aftonbladet.se/nyheter/a/aRLbO/chaufforer-vid-transportforetag-anlitade-av-ikea-besvikna-over-lonen</a>
15.03. 2017	Forbes	Ikea Drivers Reportedly Eat, Sleep And Live In Their Trucks Because They Can't Afford To Stay Anywhere Else	<a href="https://www.forbes.com/sites/jwebb/2017/03/15/ikea-drivers-eat-sleep-and-live-in-their-trucks-because-they-cant-afford-to-stay-anywhere-else/#7b53bfc20ba">https://www.forbes.com/sites/jwebb/2017/03/15/ikea-drivers-eat-sleep-and-live-in-their-trucks-because-they-cant-afford-to-stay-anywhere-else/#7b53bfc20ba</a>
15.03. 2017	ITF	ITF applauds BBC investigation into IKEA supply chain abuses	<a href="http://www.itfglobal.org/en/news-events/press-releases/2017/march/itf-applauds-bbc-investigation-into-ikea-supply-chain-abuses/">http://www.itfglobal.org/en/news-events/press-releases/2017/march/itf-applauds-bbc-investigation-into-ikea-supply-chain-abuses/</a>
15.03. 2017	N-TV	Ikea-Fahrer leben monatelang im Lkw	<a href="http://www.n-tv.de/wirtschaft/Ikea-Fahrer-leben-monatelang-im-Lkw-article19746773.html">http://www.n-tv.de/wirtschaft/Ikea-Fahrer-leben-monatelang-im-Lkw-article19746773.html</a>
15.03. 2017	BBC	Ikea drivers living in trucks for months	<a href="http://www.bbc.com/news/business-39196056">http://www.bbc.com/news/business-39196056</a>
15.03. 2017	DN	Ikea-chaufförer tvingas bo i lastbilarna – får svältlön	<a href="http://www.dn.se/ekonomi/ikea-chaufforer-tvingas-bo-i-lastbilarna-far-svaltlon/">http://www.dn.se/ekonomi/ikea-chaufforer-tvingas-bo-i-lastbilarna-far-svaltlon/</a>
24.03. 2017	Tidningen Proffs	Facklig protestaktion mot IKEA:s fultransporter	<a href="http://www.tidningenproffs.se/nyhet/2017/02/Facklig-protestaktion-mot-IKEAs-fultransporter/">http://www.tidningenproffs.se/nyhet/2017/02/Facklig-protestaktion-mot-IKEAs-fultransporter/</a>
10.04. 2017	ITF	IKEA's new product – EXPLÖITED trückdriväer!	<a href="https://www.youtube.com/watch?v=RogUu3jyS7Q">https://www.youtube.com/watch?v=RogUu3jyS7Q</a>

10.04. 2017	Het Belang van Limburg	“Maakt Ikea zich schuldig aan sociale dumping?”	<a href="http://www.hbvl.be/cnt/dmf20170410_02826631/maakt-ikea-zich-schuldig-aan-sociale-dumping">http://www.hbvl.be/cnt/dmf20170410_02826631/maakt-ikea-zich-schuldig-aan-sociale-dumping</a>
11.04. 2017	Tidningen Proffs	IKEA-kunden villig att betala mer för schysta transporter	<a href="http://www.tidningenproffs.se/nyhet/2017/04/IKEA-kunden-villig-att-betala-mer-for-schysta-transporter/">http://www.tidningenproffs.se/nyhet/2017/04/IKEA-kunden-villig-att-betala-mer-for-schysta-transporter/</a>
11.04. 2017	SvD Näringsliv	Protester mot Ikea för chaufförers villkor	<a href="https://www.svd.se/fortsatta-protester-mot-ikea-for-lastbilschaufforers-villkor">https://www.svd.se/fortsatta-protester-mot-ikea-for-lastbilschaufforers-villkor</a>
14.04. 2017	Grans- kning Sverige	Skottlossning mellan chaufförer i Malmö	<a href="https://www.youtube.com/watch?v=DDigR6U0tME&amp;feature=youtu.be">https://www.youtube.com/watch?v=DDigR6U0tME&amp;feature=youtu.be</a>