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THE BLOCKCHAIN-ENABLED SUPPLY CHAIN AND ITS IMPACT ON SOURCING AND TRANSACTIONAL FUNCTIONS OF THE PROCUREMENT PROCESS

Master Thesis

In partial fulfilment of the requirements

for the degree

"Master of Arts (MA)"

Master Program:

"International Business & Management"

Management Center Innsbruck

Supervisor:

Prof. Dr. Dietmar Kilian

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16.07.2018

Acknowledgment

I would like to acknowledge and thank all those who have supported me and advised me, during the course of this thesis, as well as throughout the whole Master's degree:

Firstly, I would like to express my deepest gratitude to my thesis supervisor, Dr. Dietmar Kilian for his unwavering support and guidance throughout this research.

I would like to acknowledge and express my gratitude also to the expert participants in the interview process for their time and willingness to provide insights on the researched topic.

And, finally, I would like to thank all my close friends and family.

Abstract

The amount of outsourced operations has elevated and supply chains transformed predominantly into global networks. Hence, challenges and bottlenecks critical to business continuation are present in procurement functions. The relevance of procurement in supply chain practice has uplifted due to its significant ability to enhance competitive advantage. Regardless of the past digitalization efforts, low level of transparency and cross-network collaboration characterizes procurement processes. Blockchain as an innovative technology has potential to significantly disrupt complex supply chains. However, the impact of blockchain solution on individual supply chain processes has been omitted from existent academic and non-academic literature. Due to strategic importance of and challenges related to procurement function, this research examines blockchain's significance for sourcing and transactional functions of procurement. Method used for this purpose is qualitative research based on six expert semi-structured interviews, performed through audio-video device. In terms of data analysis, interpretive approach of qualitative content analysis was conducted to deliver major findings. Overall, the potential of blockchain solution for improvement of both sourcing and transactional functions of the procurement is substantial, with implications in varying areas. Blockchain is a valuable solution, simplifying the operations and management, making the entire process of procurement more efficient.

Word count: 196

Key Words: blockchain, supply chain, procurement, souring function, transactional function

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List of Abbreviations

The following abbreviations will feature in the thesis:

EDI= Electronic Data Interchange

ERP= Enterprise Resource Planning

ICT = Information Communication Technology

IT= Information Technology

SC = Supply Chain

TCO= Total Cost of Ownership

1 Preface

1.1 Introduction

Since 2008, a considerable hype has been created after a white paper publication, written under pseudonym Satoshi Nakamoto, describing the development of a fully distributed digital currency system (Nakamoto, 2008). The technology behind this system, however, has been unnoticed for a long time. Nonetheless, today, blockchain is one of the most disruptive innovations, leading a vital shift in digital networks by providing "cyberspace of disintermediated trust and distributed consensus platforms" (Mattila, 2016, p.2).

Distributed ledger technology, has been described as much of a game changer as the internet itself (Umeh, 2016, p. 58). While internet facilitates innovative business models, established on the basis of online processes via world-wide connectivity, blockchain has a potential to resolve the issue of trust more efficiently by way of network computing (Zhao, Fan, & Yan, 2016, p.1).

The blockchain has been paid significant attention not only by researchers but also by the general public. In February 2018, Google search for 'blockchain' returned 63.3 million results within 0.25 seconds, while the results for "bitcoin" search were exponentially higher, returning 327 million outcomes over 0.48 seconds. Thus, bitcoin as a cryptocurrency has been in public perception earlier and more vividly present than the underlying technology it is based on (Umeh, 2016, p. 58).

A systematic mapping study has been conducted in 2016 focusing on all relevant blockchain research. The outcome of the study suggests that 80% focus is on cryptocurrencies, predominantly on the Bitcoin system. Less than 20 % is targeted at other blockchain applications (Yli-Huumo, Ko, Choi, Park, & Smolander, 2016, p. 1). The technology is carrying proof of work and efficiency over the years, detecting its applicability in a wide range of spheres. It has been successfully applied to financial applications, especially cryptocurrency-related, and has enormous future potential in many non-financial areas (Crosby, Pattanayak, Verma, & Kalyanaraman, 2016, p. 8).

Non-financial fields offer some exciting examples of applications (Mesropyan, 2016, para.1). Many of these are processed only theoretically, not having a real-time implementation. For instance, we can foresee establishing proof of existence of all legal documents or health records (Crosby et al., 2016, p. 8), smart contracts which give permission to specific operations, blockchain- based voting systems, social inclusion in

developing world, and transparency of (global) supply chains all created on the basis of blockchain technology (Pilkington, 2015, pp. 242-245). Taking into consideration industry- and enterprise-level, blockchain technology is equipped with a capability to provide efficiency gains on top of already established structures (Matilla, 2016, p. 4).

With the technology, there is a potential to improve supply chain transparency and traceability and decrease administrative costs. Furthermore, blockchain will enable participants to record supply price, date, location, quality, certification, all aspects relevant for higher efficiency of supply chain management (Deloitte, 2017c, pp. 6-8).

IBM recently introduced IBM blockchain, addressing aspects of logistics and supply chain. Other efforts are existent for instance by Oracle or BiTA (Blockchain in Transport Alliance). The product is supposed to guarantee the elimination of errors, improved inventory management, minimize carrier costs, reduce paperwork, and increase consumer and partner trust (IBM, 2016, pp. 2-5). IBM blockchain has been developed on the theoretical ground of work of blockchain's applicability within supply chains. However, as pointed out by Deloitte (2017c) blockchain technology "is still in early trials in supply chains" and effects on individual supply chain processes have not been examined (p.3).

Procurement (Sourcing/ Purchasing) of required resources from partnered vendors has been identified as one of the critical elements of supply chain strategy, necessary for the execution of activities within the network (Klausen et al., 2015, p. 71; Swafford, Ghosh, & Murthy, 2006, p. 171). Nowadays, due to the increasing amount of value chain activities being contracted to external third-party providers, the importance of sourcing as supply chain practice has elevated. Thus, there is a necessity to explore sourcing activities to determine the level of competency and excellence within strategic sourcing (Klausen et al., 2015, p. 71). Businesses should acknowledge the importance of sourcing as a value creator and recognize it as an essential element for strategic growth (Chan & Chin, 2007, p. 1392). Procurement efficiency has a potential to be enhanced by the employment of novel approaches presented within technology solutions (Burke, 2015, p. 10; Tunca & Wu, 2009, p. 763). Employment of information and communication technologies has been recognized as one of the "key characteristics for (global) sourcing excellence" (Klausen et al., 2002, pp. 72-73; McIntosh & Sloan, 2001, p. 231).

1.2 Problem Statement

Research on the blockchain is dominantly concentrated on exposing and enhancing limitations of the technology from privacy and security viewpoints and lacks to prove the effectiveness of proposed solutions. Bitcoin environment has been identified as a major environment base for existing studies. Thus, efficiency within a non-financial sector is poorly represented (Yli-Huumo et al., 2016, pp. 1-2).

Although the blockchain has been developed and introduced in the environment of cryptocurrencies, the same concept has a potential to be utilized in diversified other environments and has a capacity to redefine many aspects of business and everyday life (Foroglou & Tsilidou, 2015, p. 7). Thus, there is a necessity to conduct research in various industrial spheres as better and more efficient operations can be achieved with blockchain utilization (Yli-Huumo et al., 2016, pp. 1-23).

Applicability of the blockchain within supply chains and the related result of higher efficiency has been already addressed on theoretical grounds (Deloitte, 2017c; Kim & Laskowski, 2016; Pilkington 2015, etc.). Blockchain as a solution for supply chain has been developed for instance by IBM, promoting success story of its utilization by Walmart (IBM, n.d.). The blockchain within shipping logistics, food production, luxury manufacturing, and pharmaceuticals has been pointed out, addressing companies pioneering the solution (Deloitte, 2017c, p. 7). What has not been examined yet, is how blockchain-enabled supply chain influences significant operations and activities related to individual supply chain processes, such as procurement.

Technology, such as blockchain, has been labelled as a generator of opportunities and challenges, driving firms towards continuous modification of their procurement strategies (Burke, 2005, p. 10). As purchasing has been identified as one of the main value-adding aspects of supply chain management (Klausen et al., 2015, p. 71), this report will examine how sourcing function changes when blockchain is added to supply chain operations and how transactional process of procurement is enhanced when virtual integration of trading partners is established via blockchain solution.

Nowadays, most organizations encounter increasing customer pressure. The necessity to manage costs and price are stressed as one of the major performance requirements, increasing the importance of worldwide sourcing efforts as a crucial driver of supply chain effectiveness (Trent & Monczka, 2002, pp. 5-8). Procurement process allows

purchasing companies to acquire suitable inputs from external providers (Burke, 2005, p. 10) and establishes linkage between supply chain partners, holding responsibility for quality assurance and supplier management (Novack & Simco, 1991, p. 145). Thus, procurement is a critical determinant of a firm's revenue, costs, and a buyer-supplier relationship.

Increasingly, as addressed by Klausen, Mikkelsen, and Møller (2015), rising amount of activities is outsourced, and supply chains are predominantly global networks, operating worldwide (p.71). As such, challenges arise when dealing with international sourcing. Primary challenges include payment methods, the complexity of shipping procedures and related paperwork, cashflow issues, or managing the relationship with suppliers (Freytag & Mikkelsen, 2007, p. 191). Hence, it is necessary to examine potential solutions with prospects of increasing supplier efficiency and determine an impact of blockchain solution on procurement function.

1.3 Research Objectives & Research Questions

On the basis of aspects identified previously, the following research questions will be addressed in this thesis:

- How does the implementation of blockchain solution into supply chain affect sourcing function of procurement process?
- How does blockchain-enabled supply chain affect the transactional function of procurement process?

This study aims to examine consequences related to the implementation of blockchain into the supply chain, in particular on procurement functions as a critical aspect of supply chain strategy, and to evaluate how both sourcing and transactional function of procurement process are transformed when the solution is integrated into the structure. The primary objective is to theoretically explore what blockchain is and how does it bring value to companies' supply chain, and to examine main issues present within the procurement function; thus, subsequent analysis can be performed of the effects blockchain-enabled supply chain has on procurement function.

Results of the study will be utilized to provide recommendations, whether consideration of blockchain as a SC solution has a strong potential to alter the way sourcing and transactional functions of procurement are executed and will examine the effectiveness of the solution to enhance procurement activities.

2 Literature Review

2.1 The Blockchain Technology

Following subsection provides a brief overview of the concept of blockchain technology and key related aspects.

2.1.1 Historic Development of the Blockchain Technology

The blockchain emerged as a core technology behind the creation of well-known cryptocurrency, Bitcoin (Chen, Xu, Lu, & Chen, 2018, p. 1), firstly introduced in 2008 by an anonymous group of developers known under the pseudonym of Satoshi Nakamoto (Nakamoto, 2008). Maintenance of immutable distributed ledgers in a number of nodes (Chen et al., 2018, p. 1) defines the base of blockchain in the white paper publication "Bitcoin: A Peer-to-Peer Electronic Cash System" [emphasis added] (Nakamoto, 2008). With the vision of eliminating financial institutions out of transactions, Bitcoin, a peer-to-peer digital cryptocurrency was created in 2009 (Zohar, 2015, p.104). The purpose of the Bitcoin cryptographic payment system was to provide a solution to a double-spending problem of digital currency (Nakamoto, 2008, pp. 1-5).

The technology behind Bitcoin encouraged considerable growth of Bitcoin's network and its surrounding ecosystem since released initially, and inspired others' development of cryptocurrencies as well as open source platforms overpassing value transfer system (Zohar, 2015, pp. 1-2)

The current state of the blockchain can be categorized into three generations. These are blockchain 1.0 for digital currency, blockchain 2.0 for digital finance, and blockchain 3.0 for digital society (Swan, 2015, p. 9). The blockchain 1.0 concerns deployment of cryptocurrencies in cash applications. The blockchain 2.0 extends beyond cash transactions and directs focus on the broader use of blockchain, e.g., smart contracts, within financial, market, and decentralized economic applications (Swan, 2015, p. 9). Thus, a distinction is made between the asset of bitcoin and the blockchain as a distributed trust infrastructure. The blockchain 3.0 can be viewed as a logical development of 2.0 incorporating applications beyond the previous two stages. While the blockchain 1.0 retains a high level of maturity, the blockchain 2.0 and 3.0 emerged almost simultaneously around 2015 (Zhao, Fan, & Yan, 2016, p. 1).

2.1.2 What is Blockchain

In general terms, "blockchain is an open and distributed ledger that can record transactions between two parties in a verifiable and permanent manner" (Iansiti & Lakhani, 2017, p. 4). Hence, all the participants in blockchain can edit the ledger by securely creating a new record, shared through a distributed network of computers (Niranjanamurthy, Nithya, & Jagannatha, 2018, p.3).

The blockchain technology is non-controversial, carrying proof of work and efficiency over the years, detecting its applicability in wide range of spheres (Crosby, Nachiappan, Pattanayak, Verma, & Kalayanaraman, 2016, p. 1) in which value is directly transferred digitally without a need for a third-party intermediary (Aste, Tasca, & Di Matteo, 2017, p. 1). The technology offers a variety of applications, having a potential to establish smart societies. Furthermore, blockchain can provide a digital record and signature to agreements, processes, and activities which enables their identification, validation, storage, and sharing. Disintermediation of unnecessary points in the network can take place and facilitated transactions and interactions would be established between organizations, individuals, and machines (Iansiti & Lakhani, 2017, p. 4).

Drescher (2017) in his book established four ways blockchain is defined throughout the existing literature. Firstly, he uses the term to refer to Data Structure, defined within the scope of software engineering as a "way to organize data regardless of their concrete informational content" (Drescher, 2017, p. 34). In the case of the blockchain, this interprets consolidating data into units called blocks. Secondly, blockchain is to represent certain Algorithm (Drescher, 2017, p. 34), "a finite sequence of well-defined instructions for executing a procedure that terminates in a well-defined ending state" (Bode, 2011, p.1). Third interpretation addresses blockchain as a Suite of Technologies. Within this definition, previous two are combined with cryptographic and security technologies to reach integrity within purely distributed peer-to-peer systems. Lastly, term blockchain is used to refer to purely distributed peer-to-peer systems of ledgers (Drescher 2017, pp. 34-35). By defining separate aspects of the blockchain, Drescher (2017) described the technology as a conglomerate of all four interpretations (pp. 34-35).

2.1.3 Varying Definitions of the Concept

The original concept of the blockchain undergone a series of alterations and improvements to establish more scalable technology, flattering to regulations (Hoffmann,

Strewe, & Bosia, 2018, p. 35). In the following section, some broad definitions of the concept, within and beyond the cryptocurrency aspect, will be reviewed. Furthermore, two different streams related to blockchain definition can be observed based on its dependency on the monetary sphere.

Following is the definition of blockchain provided by Vitalik Buterin, co-founder of Ethereum, the world's second most valuable cryptocurrency running behind Bitcoin; and a blockchain platform of smart contracts. Financial- related terms like ledger, money, or transactions are excluded, nor technical process related terms can be found in his definition providing a free pass to non-financial applications of blockchain technology (Buterin, 2015a, p.1).

Buterin (2015a) in Ethereum blog,

> A blockchain is a magic computer that anyone can upload programs to and leave the programs to self-execute, where the current and all previous states of every program are always publicly visible, and which carries a very strong crypto-economically secured guarantee that programs running on the chain will continue to execute in exactly the way that the blockchain protocol specifies (2015a, para. 9)

In his study on principles and applications of the blockchain, Pilkington (2015) counters Buterin's definition with the argument: "it lacks scientific rigor" (p.9). He addresses the concept of 'a magic computer' to be a debatable term. Furthermore, by omitting financial terms, he believes Buterin shifts the core of the blockchain to informational and processual nature; thus, neglects its direct link to the monetary sphere (Pilkington, 2015, p.9). Many experts argue that blockchain cannot exist without an underlying token. This view is supported by Swanson (2015) who advocates for the dependency of blockchain on currency: "the coin is an integral part of the network's incentive mechanism to maintain its security; the two have an existential symbiotic relationship" (p. 8).

Buterin in his definition advocates for the vision within which blockchain does not necessarily relates to a monetary scope and presents definition free from financial terminology. Although Pilkington (2015a) argues Buterin's view, within his paper, he addresses the concepts of crypto-economy, payment finality, or hash function [emphasis added] as features characterizing the blockchain technology rather than defining it. Further, Buterin acknowledges the importance of currency to make blockchain work,

"(…) but the currency is there simply as economic plumbing to incentivize consensus participation, hold deposits and pay transaction fees, not as the center-stage point of speculative mania, consumer interest and excitement" (Buterin, 2015a, para 13).

2.1.4 Drivers of Blockchain Revolution

Chen et al. (2018) presented four main features central to the technical characteristics of blockchain driving its revolution: traceability, decentralization, immutability & security, and currency properties (p.4). In addition, as proposed by Aste, Tasca and Di Matteo (2017), automation is considered to be an additional aspect (p.19).

Traceability refers to the chronological arrangement of all transactions, within which a block is directly linked to two bordering blocks via a cryptographic hash function. Therefore, every individual block is traceable by the mean of examining block information of a hash key (Chen et al., 2018, p.4). Hence, all the records within the blockchain are transparent.

Secondly, the blockchain network does not comprises central authority that determines the rules of interactions between individual nodes, nor decides upon order or approves transactions. Rather, consensus-protocol is implemented by validating nodes (Aste et al., 2017, p.19). Hence, the processes of data verification, maintenance, storage, and transfer within the network are defined by the distributed system architecture. Thus, trust is not built around a central entity, but rather a mathematical algorithm (Chen et al., 2018, p.4).

Immutability of the network has its base in one-way cryptographic hash function (Aste et al., 2017, p.19) by which block-stored transactions are linked (Chen et al., 2018, p.4). Thus, records of the network are irreversible and non-repudiable (Aste et al., 2017, p.19). According to Derose (2015), this resistance to tampering enables blockchain to declare a truth universally, without a need of principal authority (as cited in Pilkington, 2015, p.15).

Related to the fourth feature, any potential blockchain based system encompasses cryptocurrency properties. The essence of transactions is their direct nature excluding a need of a third-party intermediary. Circulation of this digital currency if fixed, avoiding risks of inflation or collapse (Chen et al., 2018, p.4). The currency properties are to be mirrored in the blockchain 2.0 and 3.0 applications in combination with non-financial activities (Chen et al., 2018, p.4; Swan, 2015, p.9). However, as mentioned previously and supported by Buterin's view, blockchain does not necessarily correlate with the monetary scope.

Lastly, the transaction process can be automated to a large extent, without a need for human presence to enforce contractual promises (Sun, Yan, & Zhang, 2016, p. 6). The automation of processes is possible thanks to pre-scribed algorithms that are able to execute or verify "smart" contracts in a self-regulating manner, thanks to the cryptographic keys (Aste et al., 2017, p.19).

2.1.5 Software Architecture & Integrity

As blockchain is a technology software solution, each software corresponds with particular architecture to implement the system (Drescher, 2017, p. 10). The two existent contrary architectures are a centralized software system and distributed system, visible in Figure 1. Regarding the first, one component is central to the whole structure, providing direct linkage to other chain nodes, located around the central component. On the other hand, a network of united components is established within the distributed system, within which no control element is central for coordination. Although there is no component existent with direct linkage to all nodes within the network, all nodes are associated indirectly (Drescher, 2017, p.11).

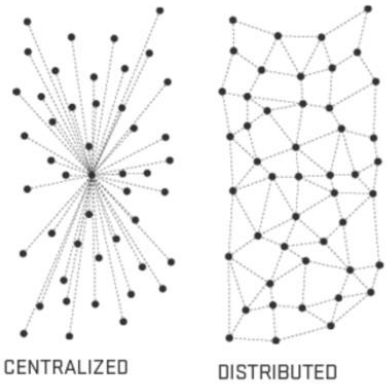

Figure 1: Centralized (left) vs Distributed (right) System Architecture (Swanson, 2015, p. 1)

Choice of specific architecture type will determine the level of system integrity (Drescher, 2017, p.17). Integrity has a vital role in preventing from the occurrence of software failures, such as data losses, irrational performance, or unauthorized access to private information which emerge due to a violation of system integrity (Drescher, 2017, p.6).

Where integrity is to be achieved in distributed software systems, the blockchain is the tool to be implemented (Drescher, 2017, p. 17). In today's society, data is an invaluable asset, strategic for any business decisions across a variety of industries (Gaetani et al., 2017, p.146); therefore, a threat to their integrity is of crucial relevance. Reliance of

computer-aided human activities on data is increasing exponentially (Gaetani et al., 2017, p.146); thus, data accuracy, as well as security, has become a priority that needs to be addressed by software engineers (Drescher, 2017, p. 6).

The blockchain is a technology operating across a peer-to-peer network (PWC, 2016). Rowstron and Druschel (2001) define peer-to-peer systems as "distributed networks in which all nodes have identical capabilities and responsibilities, and all communication is symmetric" (p.329). Hence, even though, users within the network may contribute different computational resources, the functional capability is identical for all the nodes in the system (Drescher, 2017, p. 23).

A key advantage of the peer-to-peer system is that operations are based on direct interactions between contractual partners, where the position of middleman becomes obsolete (Drescher, 2017, pp 22-24; Shollmeier, 2001, p. 102; Shunk, Carter, Hovis, & Talwar, 2007, p. 249). Thus, processing time and costs decrease as the transfer of bits and bytes is performed between two peers (Drescher, 2017, p. 22). Therefore, when the intermediary's position in a process incurs costs higher than the value they provide to the chain, the middleman is eliminated (Shunk et al., 2007, p. 249).

2.1.7 Access to the Blockchain Data

Different types of blockchains might be implemented based on the suitability aspects, depending on who is authorized to write and who can read the information recorded on the ledger (Gabison, 2016, p. 345)

Public vs Private Blockchain

The blockchain initially served as an alternative to a public transaction register or a public ledger. The technology has been designed with a clear purpose of transparency as the core for ownership verification. Nevertheless, the openness of the network clashes with the privacy concept, as users demand transaction data and related account or transferred amount details to be hidden from public reach (Drescher, 2017, p.214).

Resolution between transparency and privacy stands with the decision of *whom to grand reading access* [emphasis added] (Gabison, 2016, p. 345). Based on this factor, it is possible to distinguish between two types of blockchain. *Public blockchain* [emphasis added] is a system without any specific restriction on reading the chain's records and submitting a proposal of a transaction potentially included as a new block (Garzik, 2015, p. 10). Thus, everyone is granted a right to read and create a new transaction. This aspect

of unregulated access to information can be compared to the Internet. Ledger of Bitcoin represents the public access, wherein changes to the chains can be directly observable by all participants (Gabison, 2016, p. 330).

In contrary, in a *private blockchain* [emphasis added] only predefined list of entities is entitled to access the technology's data and submit transactions (Garzik, 2015, p.10); hence, information access is strictly limited and requires credential input (Gabison, 2016, p. 340). The private model provides owners of the blockchain with full control; furthermore, it holds high flexibility in aspects related to a permission level, level of public exposure, decision upon membership, or whether the blockchain is implemented as a separate solution or integrated into an existent system (Kozak, 2018, para. 8-10). Need to obtain permission is a prerequisite for participation. The control mechanism for access can be managed either by already existent participants, a regulatory authority issuing participation licenses, or by a consortium of businesses (Jayachandran, 2017, para. 8).

Each of the two main dichotomies is equipped with certain advantages. While public blockchain can be seen as an instrument for decentralization purposes, utilized in a trustless environment; private model is more business-oriented optimizing efficiency and security (Kozak, 2018, para. 13). Among the advantages of private blockchain we can identify its potential to adapt rules, known identity of validators, low transaction price as only a few nodes are required to verify them, reduced processing time, and of course privacy. On the other hand, public blockchains maintain significant value as they provide for the protection of its participants from developers via restriction of their authority. A variety of hybrid combinations of public and private properties can be achieved by incorporating aspects of both dichotomies (Buterin, 2015b, para. 9-17).

Permissionless vs. Permissioned Blockchain

Blockchain records are both irreversible and non-repudiable (Aste et al., 2017, p.19). Although this feature secures the protection from data manipulation, at the same time it negatively affects the speed of adding a new block of data to the existent blockchain structure (Drescher, 2017, p. 214). However, many blockchain-related applications, especially from the second and third generation (2.0 and 3.0), are dependent on speed and

scalability. Thus, a clash occurs between the security gain based on the lengthy proof of work, and speed and scalability demand of the blockchain users (Drescher, 2017, p.214).

A decision between speed and security is directly associated with a selection *to whom grant writing access* [emphasis added] (Drescher, 2017, p. 216); thus, whether to limit parties who can transact on software by writing new blocks of data into the chain. *Permissionless blockchains* [emphasis added] allow anyone to operate a node and participate in demonstrating a proof-of-work (Cachin, 2016, p. 1). Hence, any entity is granted access to create an address and initiate interaction on the chain by adding blocks to the blockchain data structure (Kadiyala, 2018, para. 4).

Secondly, blockchain technology can be based on *permissioned* [emphasis added] parameters; a closed ecosystem wherein only a restricted group of trustworthy preselected nodes or participants is authorized with writing access (Drescher, 2017, p. 216). This model has control over who takes part in the validation process of transactions and participates in distributed consensus procedure (Cachin, 2016, p. 1). Hence, entities in the permissioned model are held responsible, their activities are often monitored, and they are held legally accountable for their actions (Swanson, 2015, pp. 25-26).

Between private and public blockchain systems, a continuum is existent (Allison, 2015, para, 1-7; Pilkington, 2015, p. 11), addressing partially decentralized technology, not strictly categorized as neither public nor private division. According to Buterin (2015b), this dichotomy is often referred to as Consortium (para. 4), "a hybrid between the 'low-trust' provided by public blockchains and the 'single highly-trusted entity' model of private blockchains" (para. 6). Hybrid/consortium is of permissioned character; hence, only an exclusive group of participants is eligible to make changes (Deloitte, 2017c, p. 5). Thus, augmentation of business systems is anticipated with the permissioned network, optimizing B2B exchange by enhancing trust and transparency (Kadiyala, 2018, para. 13). Privacy of the network participants is ensured, creating value, e.g., for multiple suppliers doing business with the same manufacturer who does not want to share related business information with each other (Kadiyala, 2018, para 17-21).

In the figure below, the two aspects of blockchain are bridged together for a better overview of restrictions that come with varying forms of reading and writing access on

the blockchain data structure. The data included in the table are addressed in the paragraphs above; thus, related sources have been utilized as a basis for the illustration.

Access to Transaction Processing (Writing Access)	*Access to Transactions (Reading Access and Creation of Transactions)*	
	Everyone	**Limited**
Everyone	Public & Permissionless	Private & Permissionless
Limited	Public & Permissioned	Private & Permissioned

Figure 2: Access to Blockchain Data, Author's Representation

2.2 Blockchain- enabled Supply Chain

In the Section 2.2, focus is shifted towards implementation of the blockchain technology into supply chain (SC) management. The main challenges currently present in the SC management are addressed, necessity of digital integration of SC partners is provided and current state of digitalization is described. The section chapter indicates what are the major value-adding capabilities blockchain can bring to SC. In the final subsection of this chapter, key benefits of the blockchain implementation are presented.

2.2.1 Background & Supply Chain Challenges

Supply chains are characterized by the continuous flow of information, goods, and services, as well as financial capital. Despite digitalization efforts of supply chain management, paper-based processes are still in the play, causing lower levels of transparency and cross-network collaboration. Disparate systems complicate the decision-making process among the actors within the network, as they only enable limited visibility into other functions (Deloitte, 2017b, pp. 1-2).

Visibility within the supply chain (SC) is a fundamental challenge for businesses, statement supported by the survey of business continuity professionals, within which 75% reported lack of visibility into their supply practices. The challenge stands predominantly with more extended partners located within the category of second- and third-tier suppliers (Abeyratne & Monfared, 2016, p. 2), concerning risks such as delivery delays, quality issues or social and ethical standards (Bonanni, 2016, p. 1) predominantly related to struggle of mastering procurement and information flows (Deloitte, 2017a, p. 4). SC can be modelled with the help of end-to-end supply chain transparency and visibility,

providing the means to innovative analytics for operations, sustainability and risk. However, transparency requires a collection of accurate data and its secure storage to support the flow of trusted information among the nodes within the supply chain (Abeyratne & Monfared, 2016, p. 2).

Further, an ample number of parties involved in a transaction, or exchange of SC-related documentation results in the transactions being time-consuming, cost-ineffective, and step-loaded procedures (Korpela, Hallikas, & Dahlberg, 2017, p. 4185). Current issues of occurrence within supply networks involve lengthily time spam of payment processing between nodes in the supply network. The necessity of lawyers and bankers' involvement in contract handling is associated with additional costs and delay. Product or components tracing is challenging to monitor; hence defects are complicated to locate and erase (O'Byrne, 2017, para 1-2).

Complex networks comprise of concealed aspects for both supplier parties as well as for consumers which makes it difficult to address monitoring and controlling on the multiple levels of the supply chain. Hidden among these levels, ethically controversial activities can be performed. Such activities can contain exploitative extraction of resources, exploitation of workers, vast environmental footprint or unethical waste handling or production (Baker & Steiner, 2015, para 1-5; Marr, 2018, para 3-4).

Lack of transparency together with information asymmetry in business agreements cause that in many transactions between different parties, this information is kept sealed (Badzar, 2016, p.6). To address the information asymmetry, information should be organized and provided in such a manner, that it is accessible by all individuals or parties utilizing that information (Fung, 2013, pp. 183-184). In order to improve relationships between varying supply chain actors, information has been identified as a fundamental which can contribute to the improvement of transaction coordination, subsequently decreasing related costs and risks (Badzar, 2016, p.7). Furthermore, transparency grants organizations to monitor conditions and practices at production sites of own and contracted supplier parties (Laudel, 2010; as cited in Engels-Zanden & Hansson, 2015, p.378)

2.2.2 Digital Supply Chains

Firms which direct attention towards the development of information technology (IT) infrastructure for supply chain management and leverage this infrastructure to establish a

capability of higher-order supply chain integration, generate sustainable operation gains and revenues growth. The capability of integrated IT infrastructure enables firms to separate information flow from the physical flow (Rai, Patnayakuni, & Seth, 2006, p. 225) The information record does not imply that the material respective to the document has not been tampered with (Apte & Petrovsky, 2016, p.77). Furthermore, the capability enables real-time information sharing with supply partners, related to facilitating movement of physical products as well as streamlining extensive and complex paperwork and financial processes (Rai et al., 2006, pp. 225-226). Thus, for management of effective supply chain activities and partnerships, digital platforms have a vital role.

According to Rai et al. (2006), integration of supply chain comprises of the integration of information flow, optimization and integration of material flow, and streamlining financial operations dependent on supplier-related activities (p. 226). However, such integration represents a challenge for many companies and even the biggest players, do not possess enough power, know-how or capability to themselves deploy end-to-end information/data integration through their supply chain. Thus, digital supply chain collaboration on a multi-stakeholder level is to accelerate integration (Kim & Laskowski, 2018, p.18).

With the purpose of enhancing digital SC integration, a majority of world's leading companies have employed enterprise resource planning (ERP) and SC management software (Brody, 2017, p.11). ERP systems are software tools implemented to manage all the firm's data, having information ready at the point when it is needed and for all groups utilizing that information. These were predominantly designed to help enterprises to manage activities within their supply chains, such as inventory management, shipping, sourcing, or production planning (Ragowsky & Somers, 2002, p. 11). Furthermore, manufacturing equipment is digitally connected, digital shipping notices inform about the state and whereabouts of the deliverable good/part, and RFID chips are implemented throughout the network; thus, products are tracked on computerized systems (Brody, 2017, p.2).

Yet, the majority of firms still have limited transparency and insight into their supply chain and product whereabouts, caused by analog gaps present between systems within the firm and over firm's boundaries. Additional systems such as electronic data interchange (EDI) and XML messaging are utilized with the purpose of maintaining information continuity across system and firm's boundaries. However, these point-to-

point communication systems are far from being entirely effective as the data are transferred only to the one subsequent level down the supply chain, and the information transfer is often out of synchronization, causing nonuniformity of inventory records (Brody, 2017, p.2).

In the current world of continuous digitalization, emerging technologies enable businesses to drive their value through their supply chains. Digital supply chain solutions employed at the time do come with limitations discussed in previous paragraphs of this subsection. The blockchain is a technology which could address and eliminate these issues, while also fulfilling the mentioned requirements of digital SC integration. Global supply chains across industries have a potential to be significantly disrupted and enhanced by the implementation of blockchain (Deloitte, 2017a, p.1; Kim & Laskowski, 2016, pp. 18-20; Pilkington, 2015, pp. 28-30). The technology represents a more efficient and safer method of connecting with partners.

2.2.3 Blockchain Value-adding Capabilities to Supply Chain

Several capabilities of the blockchain technology have a potential to bring value to supply chain related activities. One of the identified is the feature of *auditability* [emphasis added]. This aspect reflects the technology's potential to establish timeless means of record keeping along supply chain nodes and respective operations (Deloitte, 2017b, p. 3); thus, auditable access control management is enabled (Shafagh, Hithnawi, Burkhalter, & Duquennoy, 2017, p. 45). Complete audit trail of data validated with a timestamp would allow participants to effortlessly verify and trace the records previously uploaded to the distributed network, improving supply chains transparency, establishing trust between SC stakeholders (Zheng, Xie, Dai, Chen, & Wang, 2016, p. 6).

Secondly, a capability of *immutability* [emphasis added] has been identified as constructive for the SC related purposes (Deloitte, 2017b, p. 3). The characteristic makes the software tamperproof and protected from any breach (Kshetri, 2017, p. 68), providing non- repudiation of the stored information (Tran, Xu, Weber, Staples, & Rimba, 2017, p. 81). All blockchain transactions are timestamped, serving the purpose of data integrity (Deloitte, 2017b, p.3). The feature is for instance valuable within procurement operations, facilitating a unique value proposition of the blockchain based Everledger service provider (Risius, Spohrer, 2017, p. 395)

Another value-adding capability is *disintermediation* [emphasis added] which allows for trusted peer-to-peer interactions on the basis of digital signature (Deloitte, 2017b, p.3). The technology establishes a way of interaction between "untrusted" participants in a system, without a necessity for inclusion of trusted intermediary (Meijer, 2017, p. 60). Thus, thanks to the blockchain, intermediaries, or their related functions, become obsolete (Mattila, 2016, p. 21).

Lastly, smart contracts have been identified as the key medium of the capability of *programmability* [emphasis added] (Deloitte, 2017b, p. 3). Smart contracts are "self-executing scripts that reside on the blockchain that allow for the automation of multi-step processes" (Christidic, Devetsikiotis, 2016, p. 2295). The conceptual idea of computer protocol based programmable smart contracts was firstly introduced in 1996 by Nick Szabo (Kosba, Miller, Shi, Wen, & Papamanthou, 2016, p. 842). "Smart contracts are written in computer code with embedded rules and actions that execute and enforce an agreement" (Barcus, n.d., p. 44). Supply chain related contracts are often written, lengthy, legally entangled and complicated to implement or adjust; thus complex. Smart contracts are intended to address these (Barcus, n.d., p. 43; Tran et al., 2017, p. 83). When a transaction occurs, the system self- generates related actions without the necessity of an intermediary (Barcus, n.d., p. 44); hence, computational results are verified by the nodes on the blockchain (Tran et al., 2017, p. 83).

Furthermore, thanks to the code-based structure of smart contracts, any change is easily performed electronically, by deploying all-parties agreed version. Overall contract complexity is reduced, and parties become more flexible towards new business models (Barcus, n.d., p. 44).

2.2.4 How Blockchain Will Transform Supply Chain

The blockchain is considered to be a revolutionary solution within supply chain management (Boucher, 2017, p. 4; Kim & Laskowski, 2016, pp. 1-2; Pilkington, 2015, pp. 28-29). Following are the value-adding aspects of implementing blockchain solution into supply chains. These are predominantly established by the consulting corporations, academic articles, and firms focusing on the development of blockchain solutions.

Establishing Trust

Modern supply chains are characterized by a high level of complexity, ample amounts of data transferred across multiple layers, and a shortage of trust (IBM (a), 2016, p. 2).

Trusted intermediaries within the supply network reduce risk. Accountability and trust between partners within the supply chain become guaranteed by verification of provenance by blockchain (IBM, 2016, p. 4). The blockchain technology of distributed ledger network is employed with a feature of creating a permanent and shared record of each and every transaction of to it related asset; thus, having a strong potential to establish an unbroken chain of trust. All the records are appended to the previous transaction recorded to the network (IBM, 2016, p. 2). Furthermore, utilizing blockchain within the supply chains is performed in its permissioned character, where the network is not an open community like is the case of the cryptocurrency related blockchain, but rather closed network of supply chain partners (Banker, 2018, para 6). Establishing trust in the supply chain is enabled thanks to the blockchain features of provided visibility and traceability.

Creating Visibility and Compliance

One of the major benefits of blockchain implementation lies in its ability to increase supply chain visibility. This is achieved by addressing data sharing and consolidation. Greater continuity of information can be accomplished as immutability and irrevocable feature of blockchain will ensure effective information sharing between varying nodes within the supply network (Deloitte, 2017a, p.14). To leverage on the massive amount of data produced throughout the complex supply chains, transparent blockchain technology will provide easy access to all process relevant information (Deloitte, 2017a, p.14). Records of information stored on the network can be simultaneously and securely accessible in a real-time by all parties authorized (Francis, 2018, p.6).

Compliance is ensured thanks to the immutability of data providing a single source of data integrity, facilitating access to the evidence that regulatory standards and conditions are met (Deloitte, 2017b, p. 3).

Thanks to the enhanced visibility, blockchain can indicate the position of an asset within the supply chain at a particular time, ownership of that asset, who is currently handling the asset and what is its current state. These features enable increased efficiency of just-in-time planning, inventory management as well as dispute resolutions, reduction of waste and quality controls (IBM, 2016, pp 3-4). Enhanced transparency, gives the organization the means to comprehend the consequences and effects of product-related decisions (Abeyratne & Monfared, 2016, p. 2). Furthermore, putting the records on the

blockchain can significantly contribute to cost reduction and time saving (IBM, 2016, pp.3-4).

Traceability

With blockchain, it is not only possible to know where products are and what is the state of the product at the moment, but also how products were handled in the past. Traceability refers to the "capability to monitor events and metadata associated with a product" (Deloitte, 2017b, p.3). Thanks to the auditability feature of blockchain technology, supply chain management of businesses can be enhanced via more transparent and accurate end-to-end tracking (Deloitte, 2017c, p.6). By digitalizing all the physical assets, it will be possible to track the asset on its journey throughout the entire supply chain. Hence, the history of the product would be recorded digitally, granting both businesses and consumers with great transparency into the good consumed (Deloitte, 2017c, p. 6). By applying RFID sensors, the state and the environment of the product can be monitored and recorded on the blockchain, having a potential to deliver on high-quality levels in production and distribution. Furthermore, the level of risk associated with defects, faulty products, fraud, or counterfeiting is reduced to a minimum (IBM, 2016, p. 4).

Optimization

Optimization of the supply chain is the next aspect blockchain can provide. This is performed by synchronization of supply partners' decisions in real time, thus allowing continuous and actual-time access to the necessary information. By knowing in advance that a supplier order has been shifted only partially, the firm has the necessary time to check the possibility to buffer from existent inventory levels or support the delivery by an alternative shipment (IBM, 2016, p. 5). Therefore, higher flexibility is achieved as the company is capable to promptly adapt to present events or respond to discrepancies and perform differing scenarios while maintaining approximately the same level of costs without its significant increase (Deloitte, 2017b, p.3). Delays due to unexpected events such as unforeseen weather changes, disputes or errors can be resolved by blockchain optimized process which can instantaneously set off remediation actions (IBM, 2018, p. 4). The main intention of the optimization is to reduce disruptions within the network (IBM, 2016, p. 6).

Another point of optimization refers to the reduction of excessive paperwork as well as administrative costs (Francis, 2018, p. 7; Deloitte, 2017c, p. 6). Concerning the paperwork,

the complex process of sending a purchase order and follow-up lengthy back-and-forth confirmation process, shipment documents and receipts can be replaced by simple access to the information of inventory consumption set against pre-agreed service level. Secondly, reduction of administrative costs is enabled by an effective audit of supply chain related data, reducing the lengthy process (weeks) of manual checks for compliance or credit via utilization of distributed ledger (Deloitte, 2017c, p.6).

The last potential optimization factor is linked to transactions. Challenges addressed are related to incorrect invoices, issues of shipping process, prising-related conditions, or terms and conditions established between participating organizations (Francis, 2018, p.8). These can be resolved by considering blockchain based smart contracts that integrate delivery and payment conditions across SC participants and consolidate with logistics partners and banks (Brody, 2017, p. 5). With smart contracts, each and every variable would be recorded to the system of record as a line of code. As soon as a new record is written, non-compliant conditions are instantaneously determined by the automatic system, and the related record is prevented from being entered (Francis, 2018, p. 8). Smart contract utilization would via proof of delivery from a logistic carrier trigger digital invoicing and payments automatically, avoiding the analog gap between customer and supplier (Brody, 2017, p. 5).

Forecasting & Planning

Customer replenishment system is based on demand forecasting; however, data gathered from the point of sales or point of distribution might be incomplete or not available. Furthermore, the manufacturer rarely distributes received data with other participants in the supply chain. With blockchain, data are widely accessible, and information such as those concerning customer purchase could be available immediately to every node in the production network. This synchronized access has a potential to revolutionize forecasting (IBM, 2016, p. 6). However, collaborative forecasting would also be heavily dependent on other technological improvements of advanced analytics and cognitive systems (IBM, 2016, p. 6; Deloitte, 2017c, p. 6).

Figure 3 represents all the above-mentioned features that can be achieved with the blockchain technology and contribute to SC enhancement.

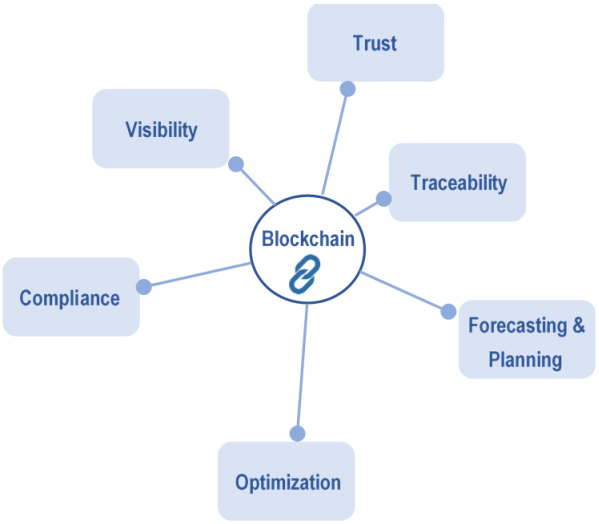

Figure 3: Blockchain Features for SC Enhancement; Author's Representation

2.3 Procurement & Sourcing

2.3.1 Importance of Procurement/ Sourcing

Procurement has been identified as one of the critical elements of supply chain strategy (Swafford, Ghosh, & Murthy, 2006, p. 171) and an integral part of business practices (Chan & Chin, 2007, p. 1408), fundamental for execution of activities within the supply chain network (Klausen et al., 2002, pp.71-73). Previous in-house production tasks have transformed into sourcing tasks holding responsibility with external subcontractors. Hence, as a result of increasing amount of value chain activities being contracted to the outside third-party providers, the significance of sourcing as a supply chain practice has elevated (Klausen et al., 2002, p. 72). According to Burke (2005), the strategic importance of procurement activities is a crucial driver of SC effectiveness (p. 10). Thus, companies should direct their focus on exploring sourcing activities to determine the level of competency and excellence within strategic sourcing (Klausen et al., 2002, p. 73).

Changes performed in the procurement process area are mirrored directly in the entity's financial results (Klausen et al., 2002, p. 72). Thus, management of cost and price are stressed as one of the vital performance requirements, escalating the importance of worldwide sourcing efforts as a part of SC strategy (Trent & Monczka, 2002). On average, 70 % of entity's sales revenue or total manufacturing costs is spent on procurement activities related to purchasing and sourcing of raw materials, components/finished goods and services (Presutti, 2003, p. 219). The procurement process establishes connections

between supply chain partners and holds responsibility for suppliers' quality assurance and management. Quality level of input materials and services determines the overall quality of the finished good; hence, customer satisfaction and to it related revenue is affected (Novack & Simco, 1991, p. 145). As procurement is a strong determinant of revenue, costs, and buyer-supplier relationship (Novack & Simco, 1991, p. 145).

Global procurement trends of external subcontracting are causing that supply chains are becoming more extended and fragmented (Christopher, Mena, Khan, & Yurt., 2011, p. 77); thus, companies are bearing greater costs and are exposed to higher risk levels (Christopher & Lee, 2004, p. 388). Critical bottlenecks have been identified by Van Weele (2010) that can arise within the sourcing process. Firstly, inadequate supplier selection (p. 47) can result in an inability to deliver on quality requirements or in deviation from warranty obligations (Christopher et al., 2011, p. 69). The second problem is directly related to lack of good contractual arrangements, within which week identification of product or supplier requirements is provided. Additionally, the bottleneck arises when the emphasis is put on price rather than total cost of ownership (TCO); thus, a buyer should decide on the grounds of a model within which the initial equipment costs are balanced against lifecycle costs. Poor administration of purchase related documentation also causes discrepancies in the process. Finally, problems related to delivery might occur, associated with delay, incomplete supply, delivery of damaged goods or violation of quality standards (Van Weele, 2010, pp. 47-48).

Generic strategies for sourcing- risk management have been proposed by Christopher et al. (2011), among which network re-engineering and tighter partner collaboration has been identified (p. 77). Increasing number of tiers of business relations need to be managed simultaneously; hence, managers concerned with business enhancement are required to explore novel possibilities for establishment and improvement of B2B partner relationships throughout the entire value chains (Seshadri, 2005, p. 5).

2.3.2 Procurement Concept in Literature

In terms of business and managerial organization in firms, the terms of procurement and sourcing are many times used interchangeably referring to the same process scope (Anker, 2017; Suresh & Kocabasoglu-Hillmer, 2015, pp.1-3). Both functions can be characterized by strong interrelationship with organizational supply partners and likewise

contribute to the entire source-to-settle continuum (Dula, 2017, para. 1). However, in a real business sphere, a slight difference is existent in the focus of the two concepts.

The primary objective of sourcing process is to find and contract reliable and affordable suppliers which further engage in close collaboration on the procurement of goods and services (Dula, 2017, para 2). Hence the role of sourcing is strategic in nature. The function is predominantly tasked with the evaluation of purchase needs, the establishment of sourcing plan, market research, vendor identification and evaluation, and subsequent selection of the most suitable candidate (Absoft, 2015, para. 6; Dula, 2017, para 3). Subsequently, procurement holds responsibility over supplier communication and monitoring, budgeting and ordering, product specifications, and invoice handling (Dula, 2017, para. 3). Hence, procurement is operational in nature. However, the two functions might not always be separated, and single department holds responsibility for all procurement-related handling; moreover, many times, procurement or sourcing individually perform all purchasing needs (Dula, 2017, para. 4).

Likewise, a multitude of definitions can be observed in academic literature regarding the field. Terms of procurement, sourcing, and purchasing are often used simultaneously (Banfield, 1999; Chan & Chin, 2007, p. 1391; O'Brien, 2009, p. xix). Some consider 'procurement' to be more transactional, while the focus of 'purchasing' covers more of strategic activities; however, in many cases the understanding is reverse. Still, the preference of many lies with the name 'sourcing' (O'Brien, 2009, p. xix). Hence, the definition provided by Klausen et al. (2002) in line with Van Weele (2010) will be utilized for the purpose of this paper: "Sourcing is the process related to the procurement of resources including goods, services, competencies, and knowledge that enable the company to add value and reduce costs while fulfilling the clients' needs" (p. 75). Procurement provides a critical linkage between suppliers and manufacturing process, holding responsibility over quality material purchase and delivery, supporting material requirements of the firm (Swafford et al., 2006, p. 174).

Due to the confusion that comes with the related terms of procurement and sourcing, a different number of stages in the process of goods' procurement can be observed in varying sources. The process description of some contained stages of supplier contracting and follow-up order delivery, while the focus of other was solely on the delivery process (Deltabid, n.d.; Presutti, 2003, pp. 221-222; Murphy, 2017, p. 1-3; Kolenko, 2014, para.

1-17). Following is the overall procurement process that will be utilized throughout this report.

The stages of the procurement process can be defined as followed:

- **Identification of Needs**: Need for a specification for a required type of product or service, either material to run a business or a product to be sold (Presutti, 2003, p. 221; Murphy, 2017, pp. 1-2). This can concern re-order of already utilized product, or a need for a brand-new item (Kolenko, 2014, para. 8).
- **Exploration of Vendor Options:** The stage refers to the sourcing of potential suppliers and evaluation of their capability to provide the best value and quality (Chan & Chin, 2007, p. 1395; Deltabid, n.d., para.8; Presutti, 2003, p. 221; Murphy, 2017, p. 2;)
- **Requesting proposals:** Request for proposal (RFP) is generated and current market capability of potential suppliers is evaluated, via assessment of supplier characteristics based on certain selection criteria and negotiations with the most suitable vendor/s are initiated (Araz & Ozkarahan, 2006; Deltabid, n.d., para. 9; Presutti, 2003, p. 221).
- **Supplier Negotiation:** General conditions, price, and delivery terms are negotiated at this stage. This function is of crucial importance, especially when dealing with the vendor for the first time (Deltabid, n.d., para. 10; Presutti, 2003, p. 222).
- **Contracting:** If both parties agree on the terms, contract is signed (Deltabid, n.d., para. 11; Presutti, 2003, p. 222).
- **Delivery:**
    - *Submission of Purchase Requisition:* Internal document requesting purchase o shared with other company departments for review and approval (Murphy, 2017, p. 2).
    - *Creation of Purchase Order (PO):* PO is issued by finance department to the vendor. Typically, electronic purchasing system is utilized to submit and track PO (Murphy, 2017, p. 2).
    - *Invoice and Order Delivery*: This might not happen simultaneously. In general, invoice describing the order is sent to the purchaser. By receiving the invoice, the sale is confirmed and due date of payment is settled. As soon as the order is received by the buyer, purchase order, order receipt

and vendor invoice are reconciled to unveil any discrepancies (Murphy, 2017, p. 3).

- *Payment:* Payment to the vendor is executed, performed within the specified due diligence (Murphy, 2017, p.3).
- *Record Keeping:* Thorough documentation of all relevant documents for each completed purchase *is* completed at the last stage of delivery process, valuable notably for audit purposes (Murphy, 2017, p. 3).

- **Performance Analysis:** Lastly, evaluation of the procurement process with particular vendor is executed. The records can be further utilized for future projects or serve for reporting purposes to the higher management (Deltabid, n.d., para 13; Presutti, 2003, p. 222).

In the Figure 4 below, the overall process of procurement of goods is presented, containing the *sourcing function of supplier selection* as well as *transactional function* of delivery.

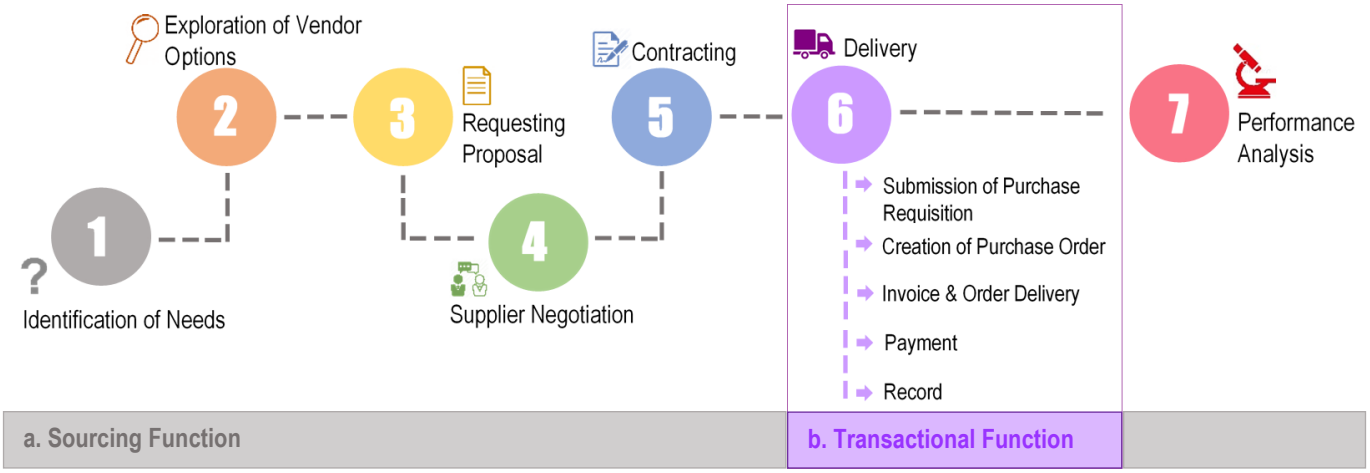

Figure 4: Overall Procurement Process (a. Sourcing Function, b. Transactional Function), Author's Representation

2.3.3 Major Decisions Related to Sourcing Function

Increased dynamics of globalised corporate strategies result in an escalated share of SC activities being outsourced, shifted outside the organizational boundaries (Klausen et al., 2002, pp. 71-90). According to study by Arlbjørn, Lüthje, Mikkelsen, Schlitter, and Thom's (2013), this dynamic expands the importance and responsibility of procurement function (as cited in Klausen et al., 2002, p. 90). Purchase of the material necessary for

supply chain operations corresponds to the voluntary decision among existent sourcing strategies (Quayle, 2002, p. 208).

The two existent dominant sourcing strategy options are single sourcing and multi-sourcing (Dubois & Fredriksson, 2008, p. 171; Quayle, 2002, p. 208). Single sourcing can be defined as "fulfilment of all of an organization's needs for a particular purchased item from one vendor by choice, (…) or from a single production facility" (Treleven & Schweikhart, 1988, pp. 95-96). In the case choice of a single supplier cannot be exercised, e.g., for the monopolistic market position, the operation is termed sole sourcing. On the other hand, if an identical item is purchased by two or more vendors strategic option of multiple sourcing is exercised, with further specification of dual sourcing if precisely two vendors are engaged (Treleven & Schweikhart, 1988, pp. 95-96; Quayle, 2002, pp. 208-209).

Certain risks and benefits, however, relate to both of the mentioned far-end strategic options. With single sourcing, the motivation of the supplier to comply with supply terms is elevated as an effective partnership is established to foster cooperation and attain shared benefits (Burke, Carillo & Vakharia, 2007, p. 96). However, this gain is offset by vendee's high level of exposure to the probability of disruption of supply, which can be avoidable in multi-sourcing approach. Established contingency plans have a potential to lessen the magnitude of impact for both single and multi-sourcing (Burke et al., 2007, p. 96; Treleven & Schweikhart, 1988, p. 99). Single sourcing is beneficial if "deliveries are consistently accurate (…) and schedules are frozen and shared". If this is not the case, multi-sourcing gets more appropriate (Treleven & Schweikhart, 1988, p. 102). In the case of multi-sourcing, the relationship between vendee and vendor is looser, causing discrepancies in communication which can result in product variations concerning quality, the situation avoidable with a single vendor (Treleven & Schweikhart, 1988, p. 105). Determinants of a strategic choice between the two are variables such as economics, geography, organizational culture, quality, and trust, or price competition; hence, sourcing decision is to be made on the specifics of the situation (Quayle, 2002, p. 211).

In addition to the two previously mentioned far ends of sourcing strategies, a hybrid possibility to establish a combination of single and multiple sourcing is existent, labeled parallel sourcing (Dubois & Fredriksson, 2008, pp. 171-172; Quayle, 2002, p. 207). The strategy was firstly introduced by Richardson (1993), wherein, two or possibly more vendors with comparable capabilities are simultaneously single-source vendors for much-

alike items. “While using a sole source for a component, the assembler establishes parallel sources to provide performance comparisons and competitive bidders for the next model cycle” (p.342). The method establishes close cooperation between the vendee and each supplier while maintaining the competitive aspect between vendors (Dubois & Fredriksson, 2008, p. 171).

2.3.4 Importance of Technology in Procurement

The importance of continuous evaluation and adaptation of a firm’s sourcing strategies has been elevated, as new opportunities as well as challenges are present due to constant technological innovations and escalated global competition. Procurement efficiency has a potential to be improved by employment of new approaches utilizing information and communication technologies (ICT) (Tunca & Wu, 2009, p. 763). Integration via ICT has been identified as one of the “key characteristics for (global) sourcing excellence” (Klausen et al., 2002, pp. 72-73; McIntosh & Sloan, 2001, p. 231).

Adequate structures and suitable instruments are of critical importance for the procurement function to operate in both efficient and effective manner (Burke, 2005, pp.2-5; Tanner, Wölfle, Schubert, & Quade, 2007, p. 729). In this regard, the importance of information technology is irrefutable, providing for smoother and less time-consuming process flow, adequate information distribution, and increased transparency. As such, not only the support of internal processes is enabled, but also processes involving business partners are supported (Tanner et al., 2007, pp. 729-730).

Coordination of individual links is of vital importance. Virtual integration of trading partners can be established, allowing for real-time communication and facilitation of transaction of digital dealings. The implementation of information technology solutions simplifies the integration of multitudes of organizational channels; wherein, more informed decision making and more efficient, automated order-related processes can be established (Burke, 2005, pp. 2-5). Consequently, innovative technology solutions have a potential to disrupt companies’ perception of sourcing strategies. Single sourcing is generally preferred for its ease of management; however, with information technology-based applications, a possibility of multi-sourcing can be embraced as a strategy able of capturing risk-pooling benefits (Burke et al., 2006, p. 96).

The volume of applications for utilization in procurement functions based on information technology is constantly expanding. Supplier evaluation and selection of final vendor

through the means of internet technology is referred to as e-sourcing (Presutti, 2003, p. 221). The advantages of technology in e-sourcing can be exploited for instance, in online bidding events called reverse auctions which enable industrial buyers to identify the best and lowest-cost supplier (Tunca & Wu, 2009, p. 763). E-procurement solutions also cover other process aspects such as contract-based transactions, monitoring, and final supplier performance analysis. The mentioned solutions enjoy the benefits of overall cost reduction thanks to the replacement of labour-intense paper-based processes and decrease in material costs is realized due to the use of qualified sources of supply. Furthermore, sourcing cycle times are reduced, positively affecting revenue generation due to fast market reach (Presutti, 2003, pp. 222-224).

3 Research Process & Methodology

3.1 Literature Review

The literature review was conducted on the basis of desk research providing a portrayal of particular characteristics related to utilized concepts of blockchain as an innovative technology solution and procurement function of the supply chain process. Using the desk research, also an overview of the value-adding aspects of integrating blockchain solution into supply chain has been examined. To address background of blockchain solution relevant for defined research questions, published scholarly literature was collected and reviewed (Risius & Spohrer, 2017, p.386), to examine the current state of research and blockchain's applicability within the supply chain. Data were collected from existent secondary sources, e.g., journals, editorials, books, research papers, etcetera. However, due to a high degree of novelty in the examined technology, scarcity of expertise and of knowledge regarding the technology itself, and areas of blockchain's effective applicability outside the financial sphere is existent (Risius & Spohrer, 2017, p. 385.; Yli-Huumo et al., 2016, pp. 1-2). Thus, in addition to scholarly articles, non-scientific literature, such as business reports and white papers, of the entities pioneering solutions of blockchain enabled supply chains have been reviewed and utilized to provide the basis for the further empirical exploration of the research questions.

3.2 Empirical Research

In terms of answering defined questions, qualitative research will be utilized as a source of primary research in addition to information gathered using hermeneutics within the literature review. According to Denzin and Lincoln (2005), qualitatively focused researchers examine elements in their natural surroundings; thus, the analysed phenomenon is interpreted on the basis of the meaning assigned to it by participants of the research (p. 3; Fick, 2014, pp. 18-20). Qualitative research is valuable for capturing expressive information referring to effects, beliefs, observations, relying on reflections (Berkwits & Inui, 1998, p. 195). Understanding of social and cultural contexts, wherein, holistic approach guides decisions and actions is the major objective of qualitative research (Myers, 2013, p. 5). Through differing perceptions of reality, an in-depth study of specific phenomena is enabled (Hancock, Ockleford, & Windridge, 1998, p. 6).

3.2.1 Qualitative Interview as a Data Gathering Method

The character of the study is exploratory, within which the influence of blockchain-enabled supply chain on the procurement process is examined. The suitability of qualitative research in an exploratory study is of a high relevance in case the examined topic is innovative and limited previous research is existent (Myers, 2013, p. 9). Concerning the business and managerial sphere, Myers (2013) believes in the high potential of the qualitative approach, addressing both relevance and rigorousness; however, he also realizes the benefits of combining it with quantitative approaches (p. 13). In order to gain valuable in-depth insights into the topic, experts knowledgeable in the field of blockchain, business consultancy and firms offering blockchain solutions for supply chains were contacted. The gained information provided a clear understanding of the blockchain-enabled supply chain and helped to portrait implications such technology-based SC has on procurement both in terms of sourcing and transactional function.

Hence, the reasonable qualitative method utilized for this research is Interview which allows for separate consultancy of various specialists. Approach wherein one-on-one interaction between interviewer and another person acting in the role of the interviewee is performed (Miller & Glassner, 2016, p. 52). The method is highly valuable when a researcher seeks rich and detailed exploration of participant's viewpoints and experience on a particular topic (Turner III, 2010, p. 754).

The familiarity of the interviewer with the subject and the nature of the study, either confirmatory or exploratory, determined the structural level (Drew, Hardman, & Hosp, 2008, p. 189). Concerning the degree of structure, semi-structured interviews were performed. In this format, certain questions are pre-determined; however, neither questions nor their order is fixed. Hence, the format is characterized by a high degree of flexibility with a potential to modify the flow of the interview interaction (Flick, 2014, p. 199). Other advantages of the method are in the provision of guidance for a participant in selecting what information to address (Heigham & Croker, 2009, p. 49) and the fact that semi-structured format allows for clarification and shared understanding. On the contrary, limitations of the method include the aspects such as the dialogue between two parties are exposed to manipulation by the respondent, diverting the conversation from the main aspects, and the process can be time-consuming as transcription and interpretation are demanded. Furthermore, the method is not of a value where a broad exploration of general attitudes is needed (Drew et al., 2008, p.190). The nature and objective of the

investigation were thoroughly communicated to the interview participants and sample questions delivered in advance to give the respondents notion about the answers sought, in order to increase the quality of results (Heigham & Croker, 2009, p. 49).

For the purpose of this thesis, personal interaction with the interviewed parties was carried out by audio/ video call, as aspects such as distance and availability of participants were determining factors. In the interview process, audio recording program on the mobile phone device was used to record the interview duration for the later purpose of transcribing, while the interview itself was conducted through the computer or vice versa. Simultaneously, handwritten notes were taken with the purpose of portraying essential observations. Transcripts of the interviews, together with the information about the participating professionals are provided in the Appendix.

3.2.2 Expert Interviews

As for this research experts knowledgeable in the field of blockchain, business consultancy and firms offering blockchain solutions for supply chains were contacted, a particular interview type performed was an expert interview.

Expert interviews are being identified by Meuser and Nagel (2009) as a distinct method of applying semi-structured interviews (p. 44). In contrary to biographical interviews, instead of the focus being put on the interviewee persona, their capacity and experience as experts in a particular field are highlighted. The expert contribution is integrated into research not as a single case exhibit, but rather as representing knowledge of a class, usually specific field- focused experts (Flick, 2014, p. 227). Expert knowledge is characterized by Bogner and Menz (2002) as "to become hegemonial in a certain organizational and functional context within a field of practice" (as cited in Meuser & Nagel, 2009, p.19); thus, also professional knowledge is treated as an expert knowledge (Meuser & Nagel, 2009, p. 24). It is upon the researcher to decide who will be subjected to the interview as an expert; however, the individual considered needs to be particularly competent in a certain matter of facts within his field of action (Meuser & Nagel, 2009, p. 18).

The type of expert interview utilized for the purpose of this research is systematizing. Concerning systematizing interview, the focus is on the experience and knowledge base derived from practical every-day actions of the respondent and his/her capability to supply the researcher with knowledge and opinions related to the investigated question/s.

However, aspects of the theory-generating expert interview were incorporated, in particular, characteristics of communicative candidness and reconstruction of the subjective expert knowledge by analytical means. In this case, the goal of the researcher lies in the conceptualization of implicit knowledge (Bogner & Menz, 2009, pp. 46-48).

The interviewer is expected to build up a knowledge base before initiating contact with the expert, in order to be able to follow the discussion. Thematic competence is generated as a result of thorough effort dedicated to the topic guide, enabling the interviewer for a productive interviewing. Open questions are the most suitable method for expert contribution as these enable interviewee to expose own perspectives and reflections (Meuser & Nagel, 2009, pp.31-32); hence, the semi-structured format was chosen as a method suitable for this research.

3.3 Qualitative Content Analysis (Data Analysis)

To achieve the objective of the research, a qualitative interpretive approach of qualitative content analysis was conducted (Mayring, 2014, p. 19) on the basis of literature review and qualitative interviews, examining the phenomena of blockchain enabled supply chain and its direct implications to the separate function of procurement. The method is one of the multiple existent approaches utilized to analyse text data, with a preliminary focus on the content or contextual meaning of the examined artefacts through classification process of coding and themes identification (Hsieh & Shannon, 2005, p. 1278; Kondracki & Wellman, 2002, p. 224). The main purpose of the content analysis lies in the "provision of knowledge and understanding of the phenomenon under study" (Downe-Wamboldt, 1992, p. 314).

In this particular research, utilized content analysis technique lies on the interface of Conventional and Directed type. Conventional approach is considered suitable when existing research literature on particular phenomenon is limited (Hsieh & Shannon, 2005, p. 1279), aspect in line with Yli-Huumo et al. (2016) whose study suggests that only 20% of all blockchain- related research targets applications outside cryptocurrency environment (pp. 1-2); thus, blockchain enabled supply chain qualifies for the conventional approach. Within this method, new insights emerge using an inductive approach within a text analysis (Kondracki & Wellman, 2002, p. 225). However, non-academic white papers addressing the benefits of blockchain utilization in supply chains are existent; hence, the impact on overall SC is outlined. What has not yet been analysed

though is the impact on specific SC functions, such as procurement. Thus, opting for directed content analysis can also be argued, as its goal is to extend the existent theoretical framework (Hsieh & Shannon, 2005, p. 1281). However, due to the scarcity of academic literature of blockchain's impact on procurement function, the conventional approach is of greater fit. With the conventional approach, the major research findings are presented in the analysis & discussion section of the research paper (Hsieh & Shannon, 2005, p. 1279).

Concerning analysis of experts' interviews, the focus is directed on thematic units. The analysis is commenced by transcription, followed by coding of the aspects of discussions which bring significant relevance to the researched topic. The subsequent step in abridging the material provided by various expert interviews is to conglomerate the passages and compare gathered viewpoints thematically; hence, the thematic comparison is staged. The results of this phase need to be in accordance, in terms of completion and validity, with other passages of the interviews. Shared and varying features are elaborated and particular specifics of the commonly shared knowledge of varying experts empirically generalized while establishing linkage to the previously examined academic and non-academic discourse (Meuser & Nagel, 2009, pp. 35-36).

3.4 Limitations

Several limitations can be attributed to this research. Firstly, academic literature on the blockchain-enabled supply chain is scarce; thus, non-academic expert literature has been utilized as an addition, represented by white paper publications and business reports.

Secondly, regarding primary research, personally as an interviewer I have limited experience in conducting interviews over an audio/video device; hence, the quality of the interview interactions may have suffered. Additionally, the quality of audio recordings in several cases encountered bad connection; thus, aspects of the interview conversation are not entirely understandable. Hence, valuable information might have been missed.

Furthermore, the number of interviews gathered is six, which might not be perfectly representative; however, little experts with the blockchain focus concerning supply chains are existent, and their availability is restricted. Moreover, although the number of interviews could be higher, the time-range of the discussions and quality of the interview subjects regarding their expertise can make up for the aspect of low quantity.

Lastly, evidence grounded in both qualitative and quantitative data is more effective in terms of research. Only primary qualitative research has been conducted for this thesis, due to limited availability of the enterprises with an implemented solution of blockchain technology.

4 Analysis & Results

In this section of the study, aspects of interview discussions with varying expert participants will be elaborated, the findings will be compared and patterns depicted based on similarities and differences of obtained opinions and perspectives.

4.1 The Blockchain-enabled Supply Chain

Firstly, general aspects concerning blockchain-enabled supply chain were sought in order to provide a base for interview discussions and immerse into the subject.

4.1.1 Type of the Blockchain for SC

Within this interview theme, opinion about the most suitable type of blockchain for supply chain utilization concerning reading and writing access have been explored.

Majority of respondents is of the opinion that the type of blockchain suitable for supply chains is determined by the level of confidentiality of transactions between different actors in SC. When the focus is on the particular business and its dealings with multiple suppliers, some interviewees consider private permissioned blockchain to be the most suitable alternative as it restricts both reading and writing access to the blockchain. Thus, valuable information about dealings with varying partners will not be disclosed to competing vendors, neither will confidential information about the entity be publicly available (Bruneton, 2018; Kubaev, 2018; Yelland, 2018).

According to Bob Yelland (2018) representing the IBM blockchain solution, one of the first technology vendors of blockchain for supply chains, the majority of clients “ask for a private permissioned platform, because they do not want details of their business transactions to be held on a public ledger” (para. 19). Vyacheslav Kubaev (2018) even highlighted information to be “strategic leverage of business negotiation (para. 15)”.

However, some interview respondents were of entirely opposing opinion, against the platform being private. Their argument was rooted in the fact that when using the private network for business operations, it will not scale. Furthermore, private chains would eliminate many benefits of blockchain technology as such and would cut out on the opportunities for SCs. Nevertheless, they do realize that companies are not willing to give up their competitive advantage rooted in their operations and that some aspects of the network need to be kept private (Brody, 2018; Crook, 2018).

The option of having varying configurations for different supply chain scenarios has been proposed by Otto Schell (2018) and other interviewees when asked about the privacy of information, concurred with the alternative of some parts of SC being held on public and some on a private network (Crook, 2018; Kubaev, 2018). Only selected participants in the network should be granted with full visibility into the ledger and perhaps different blockchain ledger configurations can be established within one particular supply chain for dealings with varying partners (Kubaev, 2018).

However, according to Paul Brody (2018), public blockchain is the only possible alternative to be utilized in the business environment; otherwise, a result is lots of overlapping predominantly private ledgers, increasing the complexity of managing the solution. Furthermore, private blockchains are not capable of reaching the desired network effect (Brody, 20118). According to experts at EY, with Zero Knowledge Proof technology, all blockchain-related capabilities will remain to benefit supply chain operations and "entirely secure private transactions over public infrastructure" will be enabled (Brody, 2018, para. 11). With this kind of technology, certain data can be shared between parties, without the necessity to disclose unrelated information. Vyacheslav Kubaev supports this alternative by providing a perspective of establishing restrictions of determined aspects across public ledger network (Kubaev, 2018).

4.1.2 Organizational Interest

Secondly, interviewees were asked whether based on their personal experience with clients, companies are willing to implement blockchain solution or skepticism prevails. The participants agreed on the aspect that the interest in the technology is tremendous; however, there are very few enterprises proactively engaged in the exploration of the possibilities, specifically for their business operations (Brody, 2018; Crook, 2018; Yelland, 2018). Regard already previously supported by theory. According to Roger Crook (2018), category, wherein in-depth investigation or objective of implementation within the foreseeable future, is represented only by 1% of the companies in total. At the moment concerns about the solution are existent among the general public regarding the scalability; however, with more and more successful showcases the understanding is expected to expand (Schell, 2018).

Business dependency on multiple suppliers and intention to drive down additional costs and time that accrue from failed or broken buyer-supplier operations have been identified

as main drivers of the interest in the blockchain solution (Yelland, 2018). However, according to Paul Brody (2018), "companies are not organized enough to take advantage of the technology yet." The current barrier for companies is the requirement to get everyone in the network on board. Thus, support of the currently participating nodes in the SC is inevitable so the transformation can be executed on the level of entire operations (Bruneton, 2018; Yelland, 2018). "You do not build a blockchain and then tell the people to sign up. You have to build it with your partners" (Yelland, 2018, para. 22). Hence, collaboration to determine the standards and configuration of the network, and implementation itself is a time-consuming process that can take around 1-3 years (Yelland, 208). The transformation of IT infrastructure and a company's architecture is related to a considerable investment, difficult to handle by small enterprises (Bruneton, 2018).

4.1.3 Decisive Factors for Implementation

Thirdly, decisive factors for an enterprise to consider blockchain implementation have been examined. Quite varying opinions resulted from this question. According to Bruneton (2018), the return on investment should be the key determinant, within which not only financial benefits are to be considered but also operational convenience and overall positive impact on the enterprise.

Process mining and the level of automation are the main determinants according to Schell (2018). By process mining, he refers to the screening of the enterprise's capabilities for the tools necessary to implement the solution. Concerning process automation, Schell highlights the necessity of Internet-of-Things (IoT) applications and robotics present in the business operations as the precondition for successful blockchain exploitation (Schell, 2018).

According to Yelland (2018), multiple participants involved in each transaction and cross-border aspect of these transactions are required for blockchain to be considered beneficial. If an enterprise is working individually on separate contracts, blockchain is not necessarily the right technology. The value of blockchains is dominant if multiple stages are involved, perhaps within few process steps, whereby confusion occurs easily, and information might get corrupted in the flow.

"Any company that engages in substantial procurement activity is going to use blockchain" (Brody, 2018). According to Brody's opinion, for an entity with a business-

to-business contract dependent on more than one tier of suppliers, the question is not ‘if’ it will adopt the blockchain, but ‘when’ (Brody, 2018).

Three filters are to be applied when considering blockchain for a particular business case (Kubaev, 2018). According to Kubaev (2018), the blockchain is a suitable solution for a business which is based on tide connections within extended network of supply chain participants among which trust needs to be established, when the transactions between participants are to be shielded, and lastly, when the sensitivity level of data is high, so distribution storage is required in order to recover data and protect from physical destruction. If the three measures are not required simultaneously, then most probably other more traditional technologies are suitable rather than blockchain. “Only when all three criteria are in place then blockchain is the right solution” (Kubaev, 2018).

4.1.4 Blockchain as Ultimate Solution or a Support System

Lastly, there is a lot of existent technologies present in today’s supply chain operations such as ERP, Vendor Managed Inventory, EDI, management software. Interviewees were faced with the question whether blockchain has a potential to replace all these technologies, and hence, reduce complexity or it will play a supporting role for the organizational processes alongside these solutions.

Generally, the opinion was more inclined to the supporting role of established SC functions. Majority of the respondents do not think that the existent technologies will disappear nor will be completely replaced by the blockchain technology. The blockchain is only intended to provide support to already existent internal systems (Bruneton, 2018; Crook; 2018; Schell, 2018; Kubaev, 2018; Yelland, 2018). According to Yelland (2018), the technology is intended to manage the communication between the vendee and the supplier and ensure no confusion is present over the placed order. Furthermore, all related activities, including delivery, invoice handling, payment process, etcetera, are to be facilitated (Schell, 2018). Thus, direct interaction would be established between internal systems and blockchain network (Schell, 2018; Yelland, 2018). Bruneton (2018) marked the blockchain trend to be “more used as leverage for a company’s strategy.”

In contrast, Brody (2018), global innovation blockchain leader, claims that blockchain is a solution that has to replace all the existent technologies as supply chains are flooded with redundant overlapping solutions. He considers blockchain to be an ultimate technology for supply chain coordination. Although Schell (2018) advocates the

supporting role of the blockchain, he is also curious about the future opportunities of complete disruption of current methods and processes and sympathizes with the idea of blockchain as a single SC solution. According to Crook (2018), initial investment into blockchain technology is high not due to the solution cost itself, but due to transformation required in already existent processes and systems. He believes blockchain and internal systems will be utilized in parallel, until the point when blockchain technology would take over the entire SC coordination.

However, it will take time till complete switch to blockchain will become a reality as currently, companies cannot do so, especially transaction-wise. The entity is required to create a duplicate of a standard process as obliged by legislation (Kubaev, 2018).

4.2 Transactional Function of Procurement

In the following section, an overview of the experts' perception of the impact blockchain technology has on transactional function of procurement will be presented.

4.2.1 Order Management

Order management can be attributed to the transactional function of the procurement and based on the interviewees' statements has a potential to be improved by blockchain technology (Brody, 2018; Bruneton, 2018; Crook, 2018; Schell,2018; Yelland; 2018). According to Brody (2018), it can be anticipated that blockchain will become the "primary mechanism for business-to-business contracting." Crook (2018) supports this argument by stating that blockchain has a potential to improve the entire process from placing an order through the cash collection, ultimately creating "one seamless process" with all the transactions and process steps communicated through and recorded on the blockchain. He adds, "it will speed up that process, it will speed up payment; therefore, cash flow will improve" (Crook, 2018).

Furthermore, barriers to confusion can be established via blockchain. Issues occur predominantly in supplier orders at the cross-country level, with multi-currency character, multiple languages involvement, and multiple legal systems. In terms of order management, blockchain enables almost real-time view, within which all participants of the transaction have access to identical records; thus, ordered quantity, quality, price, and conditions are clearly communicated, eliminating the aspect of confusion (Yelland, 2018).

However, Bruneton (2018) & Schell (2018) point out that blockchain separately cannot work alone. For the technology to be truly efficient and used up to its full potential, interdependency with Internet-of-Things (IoT) needs to be established.

Furthermore, companies struggle with keeping track of purchase volumes they drive across business partners, subsidiaries and other participants in the supply chain network. According to Brody (2018), blockchains should be helpful in this area. With distributed ledger technology, visibility into total volume will be provided without a particular user who directed the purchase needing to share operational data with the rest of SC participants (Brody, 2018).

4.2.2 Smart Contracts

Secondly, smart contracts are considered to provide a tremendous benefit for supply chains in general (Section 2.2.3 & 2.2.4). Interviewees were asked how smart contracts benefit procurement function specifically and whether they can lead the way towards automation as well as streamline processes. Again, automation of procurement processes met with the consent on the part of all the participants (Brody, 2018; Bruneton,2018; Kubaev, 2018; Schell, 2018; Yelland, 2018). Brody (2018) points out that the degree of automation that can be expected is high; however, does not result in complete automation of procurement processes.

Based on the work with clients pioneering the solution, Yelland (2018) identifies the potential of smart contracts to be related predominantly to activities performed on a regular basis, e.g., an order of particular identical quantity of a specific item on a monthly basis. Furthermore, automated can be contracts which require agreement and signature of multiple parties. Thus, the benefit of smart contracts is particularly rooted in the simplification of complex orders and repeat orders (Yelland, 2018).

Kubaev (2018) refers to smart contracts as “a great mechanism for a new type of contract relations.” Instead of renegotiating prices due to a change in currency exchange rate, agreement on the source of the rate for a blockchain can be established for instance. Smart contracts are considered to be a tool with a high level of flexibility concerning configuration and scalability, with a strong potential for self-execution of programmed actions (Kubaev, 2018). Hence, Kubaev (2018) considers the potential of smart contracts to be tremendous in terms of procurement function; however, electronic data on a blockchain as a base for smart contracts is highlighted as a prerequisite. Thus, when

applying blockchain solution to traditional areas, consideration is required to determine "which databases need to be mirrored, copied, or somehow replicated in the blockchain, so your smart contract eventually works properly" (Kubaev, 2018).

According to Schell (2018) with smart contracts every section of the operation where process break, or data flow break occurs will be automated; thus, every point in the business activity where interruption is present, e.g., due to an intermediary, will be taken out of the process.

4.2.3 Intermediaries and Cost & Time Associated with Transactions

Thirdly, the necessity of intermediaries in contract handling and manual settlement processes of banks and payment service providers are time-consuming, and innumerable fees associated with transactions are present (O'Byrne, 2017, para 1-2). How could blockchain help to address these particular issues? Would it assist in saving time and costs?

Overall, interviewees confirmed the blockchain's capability to reduce time and cost related to the transactional function of procurement (Bruneton, 2018; Brody, 2018; Kubaev, 2018; Schell, 2018; Yelland, 2018). The blockchain's system-to-system rather than people-to-people scenario together with artificial intelligence will establish a trigger on more efficient processes, resulting in both time and cost reduction (Schell, 2018).

According to Bruneton (2018), many intermediaries are going to be bypassed. These will not be eliminated as such, but rather the whole process of contract handling and payment settlement will be streamlined, and more trust will be established between the parties involved. Hence, "more trust decreases the cost" (Bruneton, 2018). Concerning intermediary elimination, according to Yelland (2018), if the actor does not add value to the process then blockchain would get rid of him; however, if the intermediary is adding value, he will remain. "Companies estimate between 10-20% of their final costs to be due to bureaucracy" (Yelland, 2018); thus, this is the percentage they would save by streamlining points in the network.

Kubaev (2018) also advocates for the blockchain's ability of cost and time reduction thanks to disintermediation; however, in future terms. Right now, legal limitations restrict this operation. As soon as proof is existent of thorough safety and scalability of blockchain technology, change in legislation will follow as a subsequent step. Nowadays,

a duplicate of standard process needs to be created, instead of a complete transformation to blockchain network because of the current obligation by legislation (Kubaev, 2018).

Besides the reduction of paper-based processes in delivery related activities, a significant reduction in order processing time can be achieved. Time-saving has been identified as one of the vital blockchain capabilities, steaming from the customer experience of IBM blockchain solution (Yelland, 2018).

According to Brody (2018), dramatic reduction of 90% can be achieved in terms of time and costs with the assistance of blockchain. Affected are all order-related activities including, the state of the inventory, the delivery time of ordered material, financial aspects of a transaction, compliance with terms and conditions, due diligence compliance, payment itself, etcetera. However, the payment process established purely on the blockchain capabilities is not yet legally addressed (Brody, 2018). "Ultimately, we will be able to tell our clients; it is safe and legal for you to transact online through the blockchain infrastructure" (Brody, 2018).

4.2.4 Disruptions in the Network (Delivery-related Risks)

Deliveries are many times negatively affected by disruptions in supply chain networks. Experts participating in this research were asked whether blockchain as a promising technology for SC enhancement can mitigate risks associated with supplied goods.

Dominant opinion in this sphere was favorable. However, some important remarks have been addressed. Bruneton (2018) and Schell (2918) highlight the necessity of the IoT or human interaction alongside blockchain solution. According to Yelland (2018), procurement of goods and delivery itself are the most significant areas for blockchain due to numerous parties involved in the process. Hence, huge network effect creates a more extended ground for risk occurrence, for confusion, fraud, etcetera. The visibility into the network enables complete transparency of the operations and control over potential threats. Thus, trust is established between network participants as visibility reinforces competence and compliance (Yelland, 2018).

Furthermore, communication between vendor and vendee as well as other network participants is enhanced. Thus, it becomes easier to resolve issues, as clear visibility is provided where the breakdown occurred (Yelland, 2018).

Three criteria are of high importance concerning procurement of items, including quality of goods supplied, quantity, and on time delivery. The impact is especially of high

significance when considering large volume contracts, wherein delays of supplier results in postponement of particular production plans; thus, in unmet customer demand. the blockchain enables for greater supply chain transparency. If a company knows enough in advance that issues are present in the supplier facility, the problem can be addressed, and alternatives can be discussed (Kubaev, 2018).

Brody (2018) accentuates the visibility provided by distributed network technology. At the moment, companies already have a great insight into one tier down in their supply chains. “What they do not know is what their suppliers’ suppliers’ suppliers are doing” (Brody, 2018), and this is where the majority of problems occur. By the time 1st tier supplier shares the information with the company about the network problem, it is already too late. “I think that blockchains contribution itself is in handling issues that are 3 or 4 tiers down the network” (Brody, 2018).

4.2.5 Additional Remarks

Last observation of the transactional function of procurement has been addressed by Yelland (2018). For him, one of the most important aspects of blockchain for procurement concerns payments. Payment for supplied goods is usually associated with delay of 30, 40, even 90 days. “It can take a long time before the money transfers from buyer all the way down the chain until the seller gets his final cut” (Yelland, 2018). With the blockchain technology, supplier and all participants in the process can be paid directly, without the payment cascading down the chain. The blockchain enables an immediate split of an invoice so that everybody can get paid on the same day. So, 20% is paid to a warehouse, 10% is assigned to a shipping company, 5 % goes to an insurance company and so forth. This capability makes a huge difference, as delays in payments obstruct suppliers from keeping up with production plans; thus, if the supplier gets paid at the same time as sale/delivery happens he can become more productive. Hence, blockchain can speed up the transaction process as well as increase productivity (Yelland, 2018)

4.3 Sourcing Function of Procurement

Influence of blockchain on sourcing function of procurement process based on experts’ view is examined in the following section of the research.

4.3.1 Supplier Selection

The blockchain technology has a significant potential to improve transparency within the supply chain; statement addressed in theory (Section 3.3, 3.4) and mentioned in previous

parts of the interview analysis. Experts were asked, how this transparency can affect the sourcing function and whether it facilitates the supplier selection process.

“Business should be very selective with their suppliers” (Bruneton, 2018). Choice of a potential vendor is an important business strategic decision. The blockchain attribute of auditability, establishing timeless means of record keeping can be utilized as a tool to select a supplier for a particular item. Complete audit trail of data enables screening of the existent partners, allowing vendee to observe supplier’s past performance and comparison with other potential candidates (Bruneton, 2018). The company would even have access to information regarding recent supplier inspection or certification, facilitating the selection process (Yelland, 2018). Thus, risk can be managed by making the appropriate choice based on thorough inspection (Bruneton, 2018).

“Over time blockchain will make payments and selection of vendors so much simpler that (…) eventually, it could lead to vastly more kind of intense competition between different vendors” (Brody, 2018).

Crook (2018) highlights blockchain’s relevance in the tender process between a product manufacturer/buyer and supplier. With all the relevant information recorded on the blockchain, the selection process would be less time-consuming. However, enterprises choice would be restricted as only businesses with the necessary capabilities to adopt blockchain would be targeted (Crook, 2018).

The problem emerges when a company has an entirely new item to be sourced from an unknown supplier for which no information resulting from past trade experience can be obtained from blockchain. When faced with this question, interviewees directed their attention towards the type of blockchain configuration. If the blockchain is public, then any new partner can join the blockchain and record data onto the network. However, private blockchain creates a barrier in examining new suppliers. Special configurations are required to address access options (Bruneton, 2018; Kubaev, 2018). Pilot solutions will uncover bottlenecks in the technology, so eventually, a fully scalable solution can be designed targeted to a company’s needs. A company can have a combination of different ledgers for varying purposes; however, tradeoffs of capabilities need to be performed in order to prevent complex configurations (Kubaev 2018).

4.3.2 Single vs. Multiple Sourcing

Secondly, the aspect of blockchain-enabled transparency can be also utilized to examine the effect on the strategic decision of single sourcing vs. multiple sourcing. Here, both options can be argued.

On the one hand, transparency provides a better overview of that one single supplier and if an issue occurs and delivery will be postponed the company will have the information well in advance to consider alternatives or buffer from existent resources. On the other hand, it is the same transparency that enables to credit more suppliers with the opportunity to enter into a business with the company as with blockchain it would be easier to manage and control activities of multiple vendors (Brody, 2018; Bruneton, 2018; Crook, 2018; Kubaev, 2018).

Thanks to the blockchain, "companies will get much better insight into quality of their suppliers today" (Yelland, 2018). They will have a better overview of the suppliers who deliver on time, who is at the right quality level, if there is a break in the system which supplier is causing that break. Particular suppliers might even be taken off of the chain, as with blockchain they could be easily identifiable as problematic. There is a huge interest in blockchain on the part of suppliers as it allows them to demonstrate that they are "quality providers, that they are the best people to work with." On the other hand, it would also allow to onboard new suppliers, due to ease of management without an increase in costs (Yelland, 2018). "Companies often limit their suppliers because for every supplier that is on board there is a cost of managing that supplier" (Yelland, 2018).

Established trust within the supply chains thanks to blockchain technology would make the act of outsourcing much easier, and the ratios of outsourced activities will increase in the future (Yelland, 208).

Although benefits emerge for both single and multiple sourcing, Yelland (2018) is of the opinion that blockchain will result in a reduction of the supplier base and will establish opportunities for smaller companies to become integrated into large corporate networks. On the contrary, Crook (2018) is of the opinion that in the future even more multisourcing will be existent if companies will be willing to participate in the distributed network. Suppliers might be cut out, purely due to their unwillingness to be part of the blockchain. Hence, the opportunity will be created for new potential vendors, and companies who are

not technically capable of exploiting blockchain benefits will be disadvantaged (Crook, 2018).

5 Discussion

In this section of the research, the significance of the findings will be provided, and new insights stemming from the findings will be explained. The section also relates to the aspects previously examined in the literature review and describes how the results answer to the research questions while discussing the relevance to the existing knowledge.

More and more of the value-adding activities in supply chains are being performed by outside-providers, elevating the importance of supplier-related activities of procurement (Klausen et al., 2002, p.72). According to Burke (2005), the strategic importance of procurement activities is a crucial driver of SC effectiveness (p. 10). Novack and Simco (1991) defined procurement as a strong determinant or revenue, costs, and buyer-supplier relationship (p. 145), and labelled management of extended supply chains as tremendously complex (Novack, & Simco, 1991, p. 145). Thus, companies should direct their focus on the enhancement of procurement activities concerning both transactional and sourcing function to generate a competitive advantage and be ahead of their competitors.

The blockchain solution of distributed ledger technology offers a possibility to significantly disrupt current supply chains and transform the way business-to-business operations are performed in today's world. The technology's effects on the supply chain as a whole have been already examined, and value-adding capabilities of blockchain to SC defined. The impact on individual supply chain processes, however, has been omitted from the existent academic as well as non-academic literature. The purpose of this research has been to examine the impact of the blockchain-enabled supply chain on both transactional and sourcing functions of procurement. Below are the benefits achievable in terms of procurement functions by blockchain technology.

5.1 Impact on Sourcing Function of Procurement

Implementation of blockchain technology seems to affect the sourcing function positively. Variety of benefits can be identified stemming from value-adding capabilities of auditability and immutability described in the literature, with the aspect of auditability having a dominant impact. Following are the prospects blockchain technology offers regarding sourcing.

The technology's attribute of auditability enables the establishment of the timeless means of records; thus, full audit trail of data can be provided (Deloitte, 2017b, p.3), having a

strong potential to establish an unbroken chain of trust (IBM, 2016, p. 2). This has important implications for the feature of transparency. According to Abeyratne & Monfared (2016), transparency requires accurate data collection and secure storage to support the flow of trusted information (p. 2), and this is indeed what blockchain is promising to deliver.

5.1.1 Supplier Selection

Firstly, the aspects of supplier selection are positively impacted by blockchain technology due to increased transparency. Improved transparency of the operations related to the company's network participants allows making healthy sourcing decisions. Thus, blockchain can be used as a tool for screening performance of existent vendors and access information about supplier inspection and certification, in order to determine the participants causing breaks in the system. Better insight into supplier quality is established, helpful in the identification of problematic suppliers. This is a crucial aspect of improvement as procurement holds responsibility for supplier's quality assurance and management (Novack & Simco, 1991, p. 145). The quality level of input materials and services determines the overall quality of the finished good; thus, customer satisfaction and to it, related revenue is affected (Novack & Simco, 1991, p. 145). Hence, the critical decision about which suppliers to keep and which vendors to finish business with to establish efficient and flawless material/product flow can be achieved by blockchain. Screening of the current operations and the operation providers helps to address risks such as delivery delays, quality issues, or social and ethical standards identified by Bonanni (2016) as the most relevant in terms of procurement challenges (p.1).

Furthermore, network and content management are enabled thanks to the feature of auditability. Positive relationship is existent between utilization of blockchain and simplification of the process of supplier selection. Supplier's prices, specifications, conditions, etcetera are uploaded in the system's list in real-time, also providing a real-time examination of the data helpful in determining future business contract with a specific vendor. Making a right decision regarding supplier selection is crucial for business as around 70 % of total manufacturing costs is spent on procurement activities related to sourcing and purchasing (Presutti, 2003, p. 129) and blockchain is able to facilitate this decision.

Concerning sourcing decisions of entirely new product/material item provided by wholly unknown potential vendors can be addressed by blockchain as well. However; the type of network structure needs to be configured in a way that reading and writing access to the network is granted to individuals authorized to participate in the chain, as no previous information on blockchain can be found about these potential vendors due to no previous business.

In the Figure 5, areas of improvement in terms of supplier selection are summarized.

Supplier Selection	Increased supplier transparency thanks to the feature of auditability
	Healthy decisions in terms of supplier collaboration
	Establishing proof of quality
	Simplification of selection process via network and content management
	Facilitation of selection process among unknown potential vendors

Figure 5:Improvements Concerning Supplier Selection; Author's Representation

5.1.2 Single Sourcing & Multiple Sourcing

Secondly, the feature of increased transparency is also constructive in terms of addressing strategic decision of single sourcing and multiple sourcing, identified as the two existent dominant sourcing strategy options (Dubois & Fredriksson, 2008, p. 171; Quayle, 2002, p. 208). Although some experts provided their opinion on which of the two will dominate thanks to blockchain technology, the decision will be based solely on the individual enterprise preferences. Both, however, can be more easily managed.

Concerning single sourcing, blockchain reduces the risk related to compliance of the single supplier, stimulated by greater visibility and by control opportunities granted to a buyer. Although, as suggested by Burke et al. (2007), with a single vendor, a buyer is exposed to high level of probability of supply disruption (p. 96; Treleven & Schweikhart, 1988, p. 99). However, with the transparent blockchain-based view into the operations, disruptions (risks) can be addressed soon enough, and alternatives can be secured. Concerning multiple sourcing, increased potential for supplier onboarding results from blockchain technology, thanks to greater controllability and easier management established by transparency, which is in line with the theory stating that innovative

technology solutions have a potential to disrupt companies' perception of sourcing strategies (Burke, et al., 2006, p.96). Thus, the challenge of loose relationship with many partners causing discrepancies in communication resulting in order confusion (Treleven & Schweikhart, 1988, p. 105) can be efficiently managed by blockchain solution.

In the Figure 6, areas of improvement in terms of single sourcing & multiple sourcing are summarized.

Single Sourcing &	Increase in the compliance on the part of a supplier
	Greater visibility and control granted to a buyer
	Disruption of supply identifiable in early stages (Alternatives can be sought)
Multiple Sourcing	Increased prospects for supplier onboarding
	Greater controllability and easier management of multiple suppliers
	Elimination of discrepancies in communication resulting in confusion

Figure 6: Improvements Concerning Single Sourcing & Multiple Sourcing; Author's Representation

5.1.3 General Aspects of Sourcing Practice

Thirdly, blockchain can be utilized as a tracking tool allowing the sourcing team to determine the commodity's place of origin, establishing visibility and control. Thus, risk related to fraud will be reduced and an enterprise's regulatory compliance will be ensured. The feature of traceability within the company's supplier network also allows for advocation of the company's corporate social responsibility and ethical sourcing principles. The feature of traceability has been identified as one of the major transformation aspects of supply chains in general when implementing blockchain solution, reducing risk associated with fraud and counterfeit (IBM, 2016, p. 4).

Furthermore, replacement of paperwork by smart contracts can reduce sourcing related costs; thus, bureaucracy related-costs will diminish.

Information exchange across entire supply chain network will be established based on the real-time data sharing and consolidation (Deloitte, 2017a, p.14), eventually improving overall control of outsourced contract manufacturing, as access to the identical information is provided in the buyer-supplier relationship, reducing confusion, communication efforts, and errors caused by transferring data. Thus, the time spent on data validation can be used more productively on strategies enhancing the strategic

position of a business. Hence, as suggested by Burke (2005), virtual integration through innovative technology is established, allowing for real-time communication (pp. 2-3).

Figure 7 summarizes areas of improvement concerning general aspects of procurement practice.

General Aspects of Sourcing Practice	Track-and-trace tool to determine commodity' place of origin
	Reduction of risk related to fraud & regulatory compliance
	Advocation of corporate social responsibility and ethical sourcing principles
	Reduction of sourcing cost via replacement of paper work by smart contracts
	Information exchange based on real-time data sharing and consolidation
	Better control of outsourced contract manufacturing
	Reduction of confusion, communication efforts, and errors caused by data transfers

Figure 7:Improvement Concerning General Aspects of Procurement Practice; Author's Representation

5.2 Impact on Transactional Function of Procurement

In the following paragraphs, the second research question will be answered based on the empirical findings related to aspects of the literature review.

Concerning transactional function of procurement, blockchain also seems to impact positively and overall improve procurement performance. Identified benefits are steaming from all blockchain capabilities recognized as value adding in terms of supply chains: auditability, immutability, programmability, and disintermediation (Deloitte, 2017b, p.3). Subsequent are the prospects blockchain technology offers in terms of transactional function of procurement.

5.2.1 Order Management

Firstly, the activity of order management will be addressed. Here the blockchain features of establishing a full audit trail of data as well as immutability of these data (Deloitte, 2017b, p.3) are valuable. With the technology, all transaction and process steps can be communicated through and recorded onto the blockchain, enabling virtual integration of

the trading partners, identified by Burke (2005) as crucial for managing diversified supplier base, allowing for facilitation of transactions of digital dealings (pp. 2-5). Furthermore, the feature of auditability allows for traceability (Deloitte, 2017b, p.3), enabling an entity to track payment information such as a purchase order. Existent is also the benefit of greater control over the management of trade documentation, when blockchain technology achieves direct and real-time exchange of purchase-related documents. General overview, control, and facilitated management over the entire process from placing the order through cash collection will speed up the process, resulting in speeding up the payment which will eventually improve cash inflow. These aspects address the issue mentioned by Korpela, Hallikas, & Dahlberg (2017), wherein a great number of parties involved in a transaction, or in exchange of procurement-related documentation results in transactions being slow and cost-ineffective (p. 4185).

Other improvements concerning order management include immediate goods and receipt confirmation. Payment processing also has potential to be improved as more security will be guaranteed for suppliers in updating their information, e.g. banking information for accounts payable; furthermore, integration of dynamic discounting methods with receipt and automated payment triggering will be enabled by blockchain, a statement in line with Lynch (2018, para.15).

In the following Figure 8, areas of improvement concerning order management are summarized.

Order Management	Transaction and process steps communicated through and recorded onto the blockchain
	Facilitation of transactions of digital dealings
	Tracking of payment information
	Greater control over management of trade documentation
	Speeding up the transactional process → Improvement of cash inflow
	Immediate goods and receipt confirmation

Figure 8:Improvements Concerning Order Management; Author's Representation

5.2.2 Intermediaries and Cost & Time Associated with Transactions

Secondly, intermediaries and cost & time associated with transactions are significantly affected by the blockchain-enabled network. Concerning intermediaries, blockchain capability of disintermediation is of high relevance (Deloitte, 2017b, p.3). Based on the theory, cooperation and transactions between 'untrusted' parties within a network are enabled, without a necessity of trusted intermediary (Meijer, 2017, p. 60); thus, intermediary-related functions become obsolete (Mattila, 20116, p. 21). Based on the empirical findings, legally required third-party intermediaries, such as banks, will be eventually eliminated from the network and blockchain will be able to facilitate this process with a much lower level of complexity thanks to verifiability of transactions by participants of the network. However, this is not possible yet. At this point in blockchain development, a reflection of agencies and banks in the distributed network rather than their complete replacement is required to be legally compliant. However, non-value adding intermediaries, not legally required, will be easily identified by blockchain and eliminated from the network.

The necessity of intermediaries in contract handling, such as lawyers and bankers, and manual settlement processes of banks and payment service providers are time-consuming, and innumerable fees associated with transactions are present (O'Byrne, 2017, para 1-2). The general idea is, that when transactions occur, the smart contract-based system will be able to self-generate actions, without the necessity of the intermediary; thus, the entire process of contract handling and payment settlement will be streamlined and more trust will be established between parties involved, decreasing costs. Despite present digitalization efforts of supply chain management, paper-based processes are still in the play, causing lower levels of transparency and across-network collaboration (Deloitte, 2017b, pp. 1-2). With blockchain, streamlining of procurement activities is also related to the elimination of paper-based processes.

Furthermore, blockchain distributed network can achieve a significant reduction in order processing time as well as time related to payment processing, solving the current issues of occurrence within supply networks involving lengthily time spam of payment processing between nodes in the supply chain (O'Byrne, 2017, para 1-2). the blockchain enables an immediate split of an invoice; thus, every participant in the transaction is paid on the same day, without the payment cascading down the SC.

Figure 9 summarizes areas of improvement in terms of intermediaries and time & cost.

Intermediaries	Elimination of third party- entities (banks, brokers, etc.)
	Elimination of non-value adding intermediaries
	Elimination of paper-based processes
	Streamlining of the transaction process
	Trust established between parties involved
Time & Cost	Decrease in cost
	Reduction of order processing time
	Reduction of time related to payment processing

Figure 9:Improvements in Terms of Intermediaries and Time & Cost; Author's Representation

5.2.3 Smart Contracts

Thirdly, smart-contracts can significantly benefit the transactional function of procurement. Smart contracts have been identified as the essential medium of the blockchain capability of programmability (Deloitte, 2017b, p. 3). With this technology, a high degree of automation of buyer-supplier related activities can be established, in line with theoretical self-executing scripts of programmable actions (Christidic, Devetsikiotis, 2016, p. 2295). Whenever a particular operation is reached in the procurement or delivery process, the blockchain will record this particular activity, thanks to IoT, and automated actions will be self-executed through smart contracts, e.g., issuance of payment upon delivery notice. The blockchain solution can achieve automated ordering and replenishment, within which predominantly management of complex and repetitive orders will be simplified.

In the following Figure 10, areas of improvement thanks to smart contracts technology are summarized.

Smart Contracts	Establishing high degree of automation
	Facilitated management of complex and repetitive orders

Figure 10:Improvement Areas Thanks to Smart Contracts; Author's Representation

5.2.4 Disruptions in the Network

Lastly, disruptions in the network can be addressed by blockchain, enabled by the capability of auditability. Improved supplier monitoring and verification thanks to the blockchain transparency has a strong potential to mitigate the risk. The visibility in the network enables a complete overview of the supplier operations and control over potential threats. Furthermore, thanks to enhanced communication via distributed ledger it becomes easier to resolve issues when a breakdown occurs. These blockchain aspects attempt to solve the issue of extended and fragmented supply chains (Christopher et al., 2011, p. 77), within which companies are bearing much higher exposure to risk situations (Christopher & Lee, 2004, p. 388). the blockchain enables, reduction of disruptions related to the entity's suppliers and timely identification of risk situations.

In the following Figure, areas of improvement in terms of disruptions in the network are summarized.

Disruptions in the Network	Mitigation of risk
	Complete overview of supplier operations
	Control over potential threats
	Easier handling of risk/ breakdown- related situations

Figure 11:Areas of Improvement in Terms of Disruptions in the Network; Author's Representation

5.3 Additional Remarks on the Blockchain-enabled Supply Chain

Regarding the most suitable type of blockchain for supply chains, the empirical study showed that the majority of experts interviewed are inclined towards private, permissioned network. Permissioned character is supported by literature review, wherein according to Banker (2018) utilizing blockchain within the supply chains is performed in its permissioned character, where the network of SC partners is rather closed (para 6).

However, as highlighted by some blockchain specialists, by keeping the network private the scalability of the blockchain is reduced; thus, companies should opt for a public solution. Nevertheless, with public blockchain, configurations are required to hold sensitive information away from the reach of public and competitors. One of the solutions could be a variety of ledgers within one network with different configurations; however, such solution can end up being tremendously complex. Solutions are existent, such as

Zero Knowledge Proof, aimed at improving the privacy of public ledger to increase protection of competitive information and still guarantee proof of integrity to the data. In my opinion, public-permissioned blockchain operated by such solution is the most suitable supply chain configuration, as some aspects of SC can be shared while others are too sensitive.

Option not mentioned by any of the interviewee participants, but presented in the theory are Consortiums (Cachin, 2016, p.1; Kadiyala, 2018, para. 13). Although in my opinion forming a consortium to run blockchain might be quite challenging, probably easier to handle by well-established global companies, it would be the best way to utilize blockchain technology regarding business to its fullest potential. In such a case governance is more equally distributed and not held by a single company as in private network and at the same time restrictions on reading access are established.

Furthermore, blockchain seems to require the presence of IoT applications in the business operations as a prerequisite for successful blockchain exploitation. Interdependency with IoT needs to be established to magnify the benefit of automation concerning procurement-related activities.

Moreover, many existent technologies are currently present in supply chain operations (Brody, 2017, pp. 2-11). With today's level of development of blockchain solution and related legislation, blockchain technology will not be able to completely replace these existent internal systems. the blockchain is currently intended to provide support to these and to internal processes. Thus, direct interaction is to be established and blockchain is to be used as a leverage for a company's strategy. Eventually, with the current pace of the development and engineering related to the solution of ledger technology, blockchain will replace the existent technologies and deprive supply chains of redundant overlapping solutions. However, for now, the support that blockchain provides is significant enough for companies to consider its utilization.

The important remark has been presented, wherein the blockchain contribution itself lies in coordination and visibility within an extended network of suppliers, three/four tiers down the chain. I found this, more than suitable as companies usually do not have problems with the visibility into the operations of their direct supplier, but information regarding supplier's supplier is unavailable, incomplete, or delayed causing problematic situations. Supported by theory, visibility within SC is a fundamental challenge for

businesses, standing predominantly with more extended partners located within the second- and third-tier supplier category (Abeyratne, Monfared, 2016, p. 2).

Lastly, the blockchain enables for virtual integration of supply chains. According to Rai et al. (2006), SC integration encompasses integration of information flow, optimization of material flow, optimization of SC partners plans, and streamlining financial operations in buyer-vendor relationship (p.226). However, such integration is challenging for many enterprises as they usually do not possess know-how or capabilities to themselves deploy end-to-end data integration through their SCs (Kim & Laskowski, 2018, p.18). The blockchain technology offers a great opportunity to address all of the integration aspects in terms of supply chains and finding prove the technology's abilities to improve the individual procurement function.

5.4 Critical Bottlenecks in Procurement Process

In the section Importance of Procurement of the literature review, bottlenecks that can arise from procurement process critical to the continuation of business operations have been identified by Van Weele (2010, p. 47). With the help of blockchain technology applied to the procurement process, four out of five bottleneck areas can be addressed and risks to them related mitigated or significantly reduced. Inadequate supplier selection can be replaced by healthy and knowledgeable decisions related to the selection of vendors due to the improvements the ledger technology brings to the network concerning the sourcing function of the procurement.

Secondly, lack of good contractual arrangements (Van Weele, 2010, pp. 47-48) within which confusion occurs between buyer and vendor regarding the order placed can be also eliminated thanks to the auditability of the data. Real-time data sharing and consolidation will enhance information exchange across the network; hence, providing both vendor and vendee with access to identical information. Moreover, smart contracts can be utilized to automate complex and repetitive orders, and order processing, as well as the payment process, have a potential to be streamlined.

Thirdly, poor administration of purchase related documentation (Van Weele, 2010, pp. 47-48) can be mitigated. Specifically, benefits mentioned in the transactional function of procurement, including elimination of the paper-related processes, real-time data sharing, automation of purchase orders, etcetera resulting in greater management of trade documentation, address this issue.

Lastly, blockchain has also a capacity to deal with the bottleneck concerning problems related to delivery, associated with delay, incomplete supply, violation of quality standards (Van Weele, 2010, pp. 47-48). The reduction of risk can be linked to the benefits of the blockchain for both sourcing and transactional functions. By making the right choice in terms of supplier selection, the number of potential threats related to deliveries should be reduced. Furthermore, the increased level of visibility and communication realized through the blockchain enables greater control over potential threats.

The fifth of the aspects identified by Van Weele (2010) refers to a bottleneck arising when the emphasis is put on a price rather than TCO (pp. 47-48). In this case, blockchain is not able to directly reduce challenges presented by this bottleneck; thus, here is the technology's limitation.

Thus, considering the aspects mentioned in the Discussion section, related to areas of improvement and mitigation of procurement bottlenecks, blockchain solution in terms of SC has a strong potential to alter and enhance the way sourcing and transactional procurement functions are executed.

6 Conclusion

Rising amount of entities' operations is being outsourced, and supply chains had transformed principally into global networks with established worldwide operations. In-house production tasks have transformed into sourcing tasks, shifting responsibility to the management of external contractors. Supply chains span over multiple of stages, across numerous locations, a multitude of participants is involved, and a number of orders need to be processed often spreading over an extended time period. Thus, challenges arise when dealing with international procurement. Identified as one of the critical elements of company's strategy, the significance of procurement as a supply chain practice has elevated. Procurement is a complex process the importance of which stands in its significant ability to enhance the entity's competitive advantage.

Regardless of the past digitalization efforts, low level of transparency and cross-network collaboration characterizes supply chain processes. Redundant and overlapping internal solutions and analog gaps present between systems within and over firm's boundaries enable only limited visibility into varying network functions. Visibility shortage has been identified as the source of risks in extended supply chains, especially associated with the struggle of mastering procurement and information flows. Transactions incorporating a large number of parties involved are slow and ineffective. Furthermore, bottlenecks are existent within the procurement process critical to the continuation of business operations.

Complex supply chains have a potential to be significantly disrupted by the utilization of innovative blockchain technology. The prospects blockchain brings to such networks have been already examined and solutions have been proposed by pioneering enterprises, although academic examination is scarce. The impact on individual supply chain processes, however, has been omitted from the existent academic as well as non-academic literature. Due to the strategic importance of the procurement function, blockchain's significance for procurement has been researched.

The potential of blockchain solution for the procurement process is substantial. The technology has a strong capacity to alter the way sourcing and transactional functions of procurement are executed today. Identified blockchain capabilities improve overall visibility and provide complete transparency in the network as well as control over potential threats, and confusion and discrepancies in the communication are reduced. Many benefits for procurement arise from the implementation of the solution, addressed

in areas of supplier selection & management, improvement of sourcing practice, cost and time reduction, streamlining of the financial processes, order management improvements, process automation, and enhanced risk management. Furthermore, many challenges addressed in terms of the procurement process and critical bottlenecks for procurement operations can be mitigated by the distributed ledger technology. The blockchain offers a great opportunity to establish close virtual integration.

Most benefits, however, incur to entities operating very extended supply networks. For any company that engages in substantial procurement activity with a business-to-business contract dependent on more than one tier of suppliers, blockchain is an appropriate solution, simplifying the operations and management, making the entire process of procurement more efficient. Thus, overall supply chain complexity is lowered.

However, initial investment into the technology is high, not only due to the cost of the solution but also due to the transformation of already existent company processes and internal systems. Future prospects of the blockchain, however, refer to the solution to be the ultimate technology for supply chain coordination, helping companies to drive their value through their supply chains. Today, blockchain technology for businesses is still in the stages of early development, with many companies experimenting with the engineering of the most appropriate solution. However, the technology expectations are huge, considered to provide companies pioneering the solution with significant competitive advantage.

7 Recommendations

This research, given its exploratory nature, examined the significance of the blockchain for procurement process both in terms of sourcing and transactional functions identified by the literature review. The basis for empirical findings has been expert interviews with the professionals in the fields of blockchain technology designed for supply chain purposes and technology innovation experts for enhancement of business operations. The qualitative research provided a great deal of valuable information. However, for more significant evidence supporting the technology's benefits in procurement functions, quantitative research should be executed with the companies who implemented the solution into their supply chain. Thus, logical statements can be confirmed by numeric representation stemming from real-life operations. However, as not many pioneers of the solution are existent, and the ones already engaged with the solution cannot yet see viable results over the years, this opportunity might be yet limited.

Furthermore, several additional recommendations for future research include:

1. Research focused on other individual functions of the supply chain process and blockchain benefits.

2. Research focused on the examination of blockchain's potential in coordination with IoT technology.

3. Research focused on blockchain's prospects in terms of varying industries. For instance, healthcare has been already examined academically; however, other fields such as electricity provide strong potential for blockchain technology.

4. Research into how activities arising from blockchain technology are covered on legal grounds.

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Appendix

Transcript of the Interview 1

Bob Yelland

IBM Blockchain Specialist (the blockchain Marketing for IBM), IBM is one of the first companies developing blockchain solution for supply chains already pioneered by Walmart and Maersk

15.06. 2018, 10:30

Time range: 44:23

Barbora Sulikova: Hello

Bob Yelland: There we go. Good morning.

Barbora Sulikova: Good morning. First of all, thank you very much for your willingness and time, I appreciate it a lot.

Bob Yelland: That's not a problem. Do you want to tell me what are you trying to uncover in your dissertation or is it just a general understanding of the area? Are you onto something, to discover something?

Barbora Sulikova: Basically, what I am trying to do and what we have been discussing with my supervisor is that currently, blockchain has so much potential and that potential outside cryptocurrencies are not fully examined. There are alternative solutions existent, for example directly by IBM or articles are existent describing outcomes of blockchain implementation into supply chain in general. But, what we are trying to focus on is how the blockchain would affect sourcing in particular and the decisions related to from who to source, whether communication with supply partners would be enabled in more efficient manner, or how transactions in terms of deliveries and paperwork will be handled. So basically, what we are trying to do, is to discover what potential impact would blockchain have for the procurement function in specific.

Bob Yelland: Okay. It is interesting. I am not sure if I have clear answers on that, but we can talk through, because mostly what blockchain is about is tracking the movement of assets. It can be used for procurement, but I am not sure its value is as strong when it comes to cure procurement, because there are other technologies that are already doing that. But I am more than happy to explore that topic with you and see what we get to.

Barbora Sulikova: Alright, thank you very much. So, should we get to the questions?

Bob Yelland: Yeah, yes please.

Barbora Sulikova: Alright then. Well, just to start off, *what do you think, is blockchain technology in your opinion able to add value to a supply chain in general terms*?

Bob Yelland: In general think, the value it brings is pulling together lots of fragmented companies with the ability to have transparent view of any transaction. So, blockchain's particular value is when there are many parties involved in one transaction. All of whom need the same status.

Barbora Sulikova: Just to clarify, we are not talking only about financial transactions, but also about any operational transactions, right?

Bob Yelland: True. And in many industries, even buying house, many industries whereby multiple people need the same view at the same time. If it is just two people a buyer and a seller, then I would question whether or not blockchain is the right solution for that. Its value really is when you've got byer, seller, banks, insurance companies too, because all want to see the same information.

Barbora Sulikova: Ehm. But then again when we are talking about global supply chains, the company that is in contact with suppliers is probably handling more than just one vendor, so for them it might be easier to handle all the communication and contact and to automate certain processes, even within the procurement, right?

Bob Yelland: Yes, it comes then to if when you are sourcing your products, you are working with many different companies. If you are working with them all individually on the separate contracts, then blockchain is not necessarily the right technology, because, If I have got 100 suppliers, it is 100 different agreements and there is no value in supplier A seeing the transaction between me and the supplier B, then I am not certain that blockchain necessarily would be the right solution, if that make sense. Where the value is, is when you've got multiple stages, perhaps the process and it could be any process, whereby often it is easy to get confused or to lose information or information can get corrupted, because there are lot of parties to the same transaction. If there are two parties to a transaction, there is less value to blockchain. If nobody else needs to see the details other than two people, there are reasons why you might want to use it. Perhaps for historical purposes to make sure there is a clear record, but in general, the value of blockchain is when you get lots of people all parties to the same transaction.

Barbora Sulikova: Alright, then maybe we can talk about *what kind of blockchain would be the most suitable for supply chains. I mean in terms of reading or writing access. It is permissioned permisionless, would it be private or public?* What would be the most suitable for supply chains?

Bob Yelland: It really comes down to the business confidentiality of the transitions. So, if the transaction is something where you want to keep the quantity private, the price private, even perhaps the agreement between which two suppliers private, so you do not necessarily want that

to be published, then a private permissioned network is the right platform. So, the most of the clients we work with, they ask for private permissioned platform, because they do not want their details of their business transactions to be held on a public ledger. Now, if you point things like paper clips, you know things that do not necessarily need to be kept confidential, then a public blockchain would be fine. Because should that get released into an open world, somebody publishes the fact that you have bought thousand paperclips from the supplier, that is not embarrassing, ok. That does not cost you any problems in terms of reputation, or in terms of disadvantage. So, when it comes down to a transaction, our experience is, most clients that we work with want to keep the agreement private; therefore, they go for a private, permissioned.

Barbora Sulikova: As you have been talking about your clients and your experience, *are companies open to consider implementation of such solution into their day-to-day operations*?

Bob Yelland: Yes, they are. At the moment there is a huge amount of interest, because companies spent a lot of time in dispute resolution. The nature of companies today, is that because they are so dependent upon many other suppliers, in order to deliver their goods to their clients, they are spending all of their time chasing orders, working on what has gone wrong, why prices has changed, reconciling and that is adding a lot of time and costs to their process. So, clients are extremely interested in blockchain. And so are regulators. In industries where the product is regulated, regulators like this, because it gives a real-time visibility of what's been purchased and moved around the world. So yes, there is a lot of interest in the technology, but it is harder to implement than most people realize.

Barbora Sulikova: Of course. There is not really a huge education existent about the technology itself and about understanding how it works.

Bob Yelland: Yes, the lack of skills and also with blockchain you've got to get a support of your network at the beginning. You do not build a blockchain and then tell the people to sign up. You have to build it with your partners.

Barbora Sulikova: Together, in collaboration. Ehm

Bob Yelland: Exactly. So blockchain is all about collaboration, from the very point of design onwards. And that's hard. That's hard to get all those people in the room agreeing on the same standards and agreeing to launch at the same time. So, what we are seeing is that, there is a lot of enthusiasm at the beginning, but I can take 1 to 3 years to build the project, because everybody has to agree.

Barbora Sulikova: So huge complexity is present. Alright, then maybe we can move to less general questions concerning the procurement process. *What do you think, how can procurement function in terms of order management be addressed by blockchain?*

Bob Yelland: I guess in terms of order management it allows there not to be any confusion. So, for me blockchain makes the most sense, when it is across multiple countries. So, if I am ordering something from a supplier in the next city, then we are in the same time zone, we speak the same language. If there is a confusion I can drive over and I can clarify the problem, ok. That's easy to fix. Where would be the issue, is when you are talking about suppliers and making orders at cross-country level, you are talking multiple currencies, multiple languages, different legal systems perhaps and that's where the confusion arises. In terms of blockchain for order management it means that you are both looking at the same records, so it is quite clear exactly what have just been ordered, what quantity is, what quality is, what the price agreed is. And that prevents confusion in the order process.

Barbora Sulikova: So, we are speaking about geographical spread of operations. Then maybe in terms of computational contracting we know that *blockchain is collaborating to a large extent with smart contracts and if these are established on the basis of blockchain, can such blockchain lead towards the automation of the processes and help to streamline the activities between vendor and vendee?*

Bob Yelland: Yes, it can do, particularly if it is something done on regular basis, you know you can create a smart contract to say every month we order another quantity of this, so you can set that up in a smart contract. If you need multiple people to agree, if something needs to be signed of by several people before it is placed then smart contract can manage that process, so you do not have to chase around yourself. So yes, smart contracts can be used particularly for complex orders or repeat orders to simplify this process.

Barbora Sulikova: So, it basically reduces also all the paper-based processes in the delivery related activities.

Bob Yelland: Yes, it certainly can do. Papers are often an issue once you start shipping around because thigs can get lost. But the other issue really has more to do with time saving rather than paper saving. When we speak to people, the paper is a problem, but the bigger issue often is time it takes to get these orders processed.

Barbora Sulikova: Understood. When we were talking about risks that you have mentioned concerning products being not delivered, *can blockchain assist in mitigating risks related to deliveries or are there also some new risks that can emerge*?

Bob Yelland: I would say shipping and delivery is the biggest area for blockchain, also procurement and ordering and reconciliation. The biggest issue is the delivery process, because that's where there are many different companies involved in the shipment of the item. When we worked with one company, it was tracking goods from East Africa to Europe, it typically went

through 30 different companies. 30 different people of organizations, including customs, insurance companies, all of who had to be involved. The biggest value for blockchain, as for both buyer and the seller, is the possibility to see exactly where the product is on its journey. And that gives me some peace of mind, knowing that the product is on its way. And if it is a product that needs to be stored in a correct way like food, then I am also quite confident that concerning the transportation it is stored in a manner that won't cause contamination. So, the biggest value for blockchain, really is in that delivery process. Because that's often where the confusion or the contamination or sometimes a fraud occurs.

Barbora Sulikova: Alright. So basically, *then also the communication between businesses is enhanced* because if there is an issue and the supply of particular good is disrupted, with blockchain all of this this will be communicated easier and the problem can be addressed more effectively.

Bob Yelland: Exactly. It means you are starting with the knowledge of at least what was agreed and where the product was the supply chain, so it makes it far easier to resolve issues, because it should be clear where the breakdown occurred.

Barbora Sulikova: Ok, thank you. Then, maybe we can switch from procurement and product delivery to sourcing function. *Do you think that with blockchain technology companies are stimulated to outsource more of their value adding activities*?

Bob Yelland: That's interesting question. The way blockchain is implemented today is really just taking existing processes, existing products and putting them onto the blockchain. So, this is very much like the internet was, 15 to 20 years ago. The paper catalogues people had, were put on the internet. And it was then when companies started to consider change of the model, of their business model by using the Internet. We are seeing the same with blockchain which is on day 1 people are not changing their business they are merely taking their existing processes, existing products and orders and putting that on the blockchain. But, if that gives them more transparency, more trust with their supply chain then it would allow them to outsource more. Products that in past were more reluctant to purchase, I think it could build some confidence that now maybe they could go over to the next step and outsource much more. (- 25:34)

Barbora Sulikova: That is what I was reading about, that it can have a potential impact on outsourcing.

Bob Yelland: It is not happening today, it is still early, but I can see that happening in 5 or 10 years' time.

Barbora Sulikova: We have mentioned disrupted deliveries; *do you think with blockchain it would be possible for companies to stick with single sourcing of a particular product or sourcing*

from multiple suppliers will be dominant? Because, both have benefits. And with blockchain we said that the communication is handled more easily and everything can be more effective, maybe single sourcing would be more stimulated. What is your opinion on that?

Bob Yelland: I think what will happen is, because of blockchain, companies will get much better insight into a quality of their suppliers today. So, they will get a better idea about who is delivering on time, who is at the right level of quality, if there is a contamination in the system, which suppliers or which curriers are causing that contamination. So, I think one thing that can happened, is some suppliers will be taken off of the company's list because they would be identified as being problems in the supply chain but today the companies are not aware that they are problems. So, the reason a lot of suppliers and curriers like blockchain is it allows them to demonstrate that they are quality providers, that they are the best people to work with; therefore, it allows them to differentiate themselves. So, I certainly think we will see some suppliers disappearing because companies will realize that they are the ones that were always unreliable. But, at the same time, it also allows a company to bring on board new suppliers who in the past maybe had problems to manage smaller suppliers. This will allow them to manage many more without an increase of cost. So, companies often limit their suppliers because for every supplier that is on board there is a cost of managing that supplier. You have to check their credit history and reliability, etcetera. I think blockchain would make that easier to onboard new suppliers. So bizarrely I think it would result in reduction but I think it would also result in opportunities for smaller companies to become part of a supply chain of a larger company that in the past was not physically possible.

Barbora Sulikova: So basically, *what blockchain has a potential to do is to facilitate the process of supplier selection, am I right*?

Bob Yelland: Exactly, so I was spoking to a few retailers and retailers are very interested in sourcing from family suppliers. But today that is not possible, because you cannot work with thousands and thousands small family businesses. With blockchain you are allowed to do that and to source ethically, to demonstrate that they are really trying to reduce poverty by sourcing directly from very small individuals who are experts in one particular area.

Barbora Sulikova: So basically, what we have been saying is that visibility, control, and related risk management this all can be managed by blockchain. Hypothetically speaking, in the future it can have a huge impact on sourcing itself and supplier selection, as well as procurement.

Bob Yelland: I think so, because I want to know if a supplier has been inspected recently or certified. How do I know that I am not buying from a company that employs slaver?

Barbora Sulikova: And that has later also implications for customers.

Bob Yelland: Exactly, so all the sort of things can be put on a blockchain so now I know, I can have confidence that when I buy from a supplier, knowing that they were inspected 3 months ago and they passed the inspection. So, for me as a buyer it reduces the risk I have in dealing with the most companies.

Barbora Sulikova: *Are there some other aspects of procurement that can be addressed with blockchain, that we have not mentioned yet*?

Bob Yelland: Yes, so the other interesting are payments for instance. So particularly if I am paying for goods, I can have a long delay after receiving goods, it can be 30, 40, even 90 days later and for small companies that can be a disaster. I may pay to a warehouse that shipped to me and the warehouse pays his suppliers and so on. So, it can take a long time before the money transfers from buyer all the way down until the seller gets his final cut. And because the payment goes across the multiple countries, there is currency conversion happening in every country and there is a cost to that as well. So, one thing blockchain could do, is that it could allow you to pay your suppliers directly. Today the money cascades down one level at the time if that make sense. What I could do is I can pay the bill and the bill could be immediately split up and everybody can get paid on the same day. So, 20% can go to the warehouse, 10% can go to the shipping company, 5 % could go to the insurance company and so forth. This can happen in one go, the day the buyer pays.

Barbora Sulikova: *Does it mean that all unnecessary intermediaries in the payment process are eliminated and that can reduce costs and administration*?

Bob Yelland: It is not necessarily eliminating. Often an intermediary might add value to the process. So, if the intermediary does not add any value I would agree. If all they are doing is passing money around, then blockchain would get rid of them. If they are adding value to the process they will remain. The difference is I can now pay all of those people at the same time. I do not have to pass my money down along the chain, which can take months before it gets to the final person, by which time currency rates might have changed and he ends up with a fraction for what he was expecting. Let me give an example, that I saw literary yesterday what was very clever. If you go to the vending machine at the university for instance, and you buy a chocolate bar, then when the vending machine owner comes along, he takes the money from the machine. From that money he would then pay the university some money for rent, because he is paying to have the vending machine on the site, and he also pays the warehouse for the chocolate bar. So, he will pass some money to the warehouse as well. The warehouse then would pas the money to the chocolate manufacturer. So, you have got 4 or 5 people from the moment you purchased that chocolate bar in the machine. Your money is split 5 ways at the time. What could happen with blockchain is, at the minute you buy that chocolate bar all 5 people will receive their share at the

same time. That is what can happen in the supply chain world. The biggest inhibit to international trade is lack of finance. Until I get paid I cannot buy more raw materials to make my next batch of products. So, if I get paid at the same time the sale happens, I can become more productive. That is very interesting aspect of all of this, that it can really speed up the processes.

Barbora Sulikova: Especially across boundaries, ok. Then, couple of general questions at the end. *What are some of the decisive factors for an enterprise to actually consider the use of blockchain for their procurement processes*?

Bob Yelland: I think the key thigs are, you need a multiple people involved in every single transaction. If I am buying just from a one person and I am dealing with him directly, he is the creator of the product, there is very little value in blockchain. So multiple people involved, ideally in multiple countries. I think once you've got those two combinations, I think blockchain starts to be very interesting.

Barbora Sulikova: So, two major preconditions. Probably the last question. *When we are talking about procurement and sourcing activities there are current technologies existent such as enterprise resource planning, supply chain management software, electronic data interchange and so many more. Do you think that blockchain has feasibility to replace all of these and does it actually make sense to replace them?*

Bob Yelland: No. Your ERP systems and all of your internal systems will not change, because most people would not interact with the blockchain directly. What is happening with your ERP systems is once you place an order in the system then it will write it automatically to the blockchain. So, the blockchain is merely a communication method. Let me give you a parallel here. Before e-mail existed, if I wanted to place an order I had to use a telephone, that was the only way. Now, I would enter my order into my ERP system, I would say I am placing this order today, I would then pick up the telephone and then place the order. When email came along, my ERP system did not change, I still placed my order into my ERP system and then send an email to the supplier with the order. So, what you are taking away is the communication. So blockchain will manage the communication between the supplier and make sure there is no confusion over the order that was placed. Your ERP system does not necessarily need to change it would just need to interact directly with the blockchain.

Barbora Sulikova: So then if I as a company decide to implement blockchain. *Would the benefits of blockchain solution offset the costs of operating this technology?*

Bob Yelland: Personally, for me as a blockchain vendor I would certainly hope so. Talking to some supply chain companies, they estimate between 10 and 20 % of their final costs to be due to bureaucracy. So, 10-20% of that final costs of product are just going to bureaucracy. So that is

what they are going to save. That % is very dependable on what the product is, how many people are involved in a supply chain. There are lots of influences on that number. So, I would not be allowed to say that blockchain would save everybody money. Depending on what you are buying, maybe telephone or email is absolutely fine. But in terms of large international purchases with many people involved in that chain than almost definitely they would safe money. No question.

Barbora Sulikova: Alright, I think that is more or less all of the questions that I had in mind at the moment.

Bob Yelland: Excellent. Was that helpful or not?

Barbora Sulikova: Actually, it really helped a lot. Than you very much. Maybe if some questions arise, I can dress them via email if that would be possible?

Bob Yelland: Sure. Not a problem at all. And if you go to IBM the blockchain webpage, you will find some case studies there about supply chain. For blockchain, supply chain is probably the biggest area. For us this makes a lot of sense and I really do think it will transform the way supply chains work, it would reduce a lot of the confusion and the arguments and frustration today that companies feel. People in any companies waste far too much time on the phone, just chasing, chasing, chasing, working on what has gone wrong and typically somebody somewhere got confused, they got misunderstood quantity of the order or whatever and that can cost tens or thousands of pounds. In the UK few months ago, we had problem with Kentucky Fried Chicken. They switched suppliers and the chicken did not turn up and they had to close every single store in the UK for 3 days. So, companies these days re so reliant upon, suppliers arriving on time and on delivered quality that they can go out of business if the mistake is made, so blockchain is very interesting for this area.

Barbora Sulikova: So basically, it is a saving companies from disruption of their operations and day-to-day business.

Bob Yelland: Yes exactly, reputation also, not just money. It can be reputation, brand value. If you portray yourself as an ethical company, then you need to prove that your suppliers are ethical companies.

Barbora Sulikova: And that is probably many times hard especially concerning 2nd and 3rd tire suppliers into whose operations we do not have such a deep look.

Bob Yelland: Exactly. the blockchain cannot solve every problem, but it helps with the transparency.

Barbora Sulikova: Okay. Thank you very much for your time.

Bob Yelland: No problem. Good luck with your dissertation.

Transcript of the Interview 2

Otto Schell

Blockchain specialist, Global Enterprise SAP Business Architect and Head of SAP CCoE, Transformation Advisor at PDA Group, CEO of "The Diplomatic Council Otto Schell Institute for Digital Transformation"

27.06. 2018, 11:00

Time range: 29:49

Otto Schell: Hello Barbora, how are you?

Barbora Sulikova: Good, thank you very much for asking. I would like to thank you for finding a time for me and doing this interview.

Otto Schell: It is important for me too, do not worry.

Barbora Sulikova: Thank you. I hope it is not going to be a problem, I will record the conversation just for the later purpose of transcribing. Is that fine with you?

Otto Schell: That's fine, yes.

Barbora Sulikova: Would you like to ask me something before we start or should we get to the questions?

Otto Schell: No. For me it is just important that I will provide you with the information that I have from my role in automotive industry. So, I answer you with regards to that and maybe some ideas are very broad from the environment of PDA. So, if you use my quotes just make sure that it is not used as Opel directly, but more general in terms of automotive. Or if you use something you also can send me a short note afterwards and ask me if it is ok and I will reply to you very fast.

Barbora Sulikova: Ok, that would be prefect, thank you very much. Alright, just maybe a little introduction. What we are trying to do with Mr Kilian is that we are looking how implementing a blockchain into the supply chain would affect procurement and sourcing functions of the supply chain, ok?

Otto Schell: Yes

Barbora Sulikova: Ok, so maybe we can start already with the first question. *Do you think that the blockchain technology would be widely applicable within the environment of supply chains or it is going to be restricted, for example industry-wise or in terms of operations?*

Otto Schell: In my point of view, it can be widely accepted. Especially, I was yesterday at the supply chain event. People at the moment are trying to find small pilot areas and, in my view, as I have mentioned previously it can be widely spread across different scenarios. When we talk about blockchain, it can be also combined with artificial intelligence. So, the answer is a clear yes.

Barbora Sulikova: You have experience within the the supply chain environment from your work with partners. *Do you think based on your personal experience, would the companies be actually willing to implement blockchain into their day-to-day operations or there is still a scepticism about the solution?*

Otto Schell: It is a mixture of both. Of course, there is at the moment a little concern about blockchain, but this is nearly to the fact that it is somehow new. On the other side it is not really touchable. So, you need to be extracting what you know to where it goes. And certainly, people get more and more understanding as more and more showcases will become existent. Talking about blockchain from more or less financial, artificial perspective, when you ask people what is blockchain, they will tell you Bitcoin. But this is not what we talk about in the process industry. In the process industry blockchain can support financial flows and can take out intermediates. But on the other side, for me blockchain is a kind of internet protocol plus a semantic. It helps me to address some of the concerns I have at the moment with a lot of processes, historical things which are not changeable, immutability. So, there are a lot of things that blockchain concept as such, which will help companies to understand better how you can use it and in which cases you can use it.

Barbora Sulikova: That is true. There is a huge hype about blockchain especially in terms of cryptocurrencies and other potential applications are omitted by general public.

Otto Schell: True, but quite honestly there is no difference with the first ATM machines which were put to the streets. So, when you could get money out of a cash machine a lot of people still used checks, because they did not trust these machines. So, this is something that is normal when you come to face with something new.

Barbora Sulikova: Then maybe, in terms of supply chains, we know that there are different types of blockchains regarding the reading and writing access, public or private; or permisionless vs permissioned, even consortium blockchains. *What do you think would be the most suitable type for managing suppliers and supply chains in general?*

Otto Schell: Mixture of all of them, because it really depends how fast you can go. For example, when you consider a two-company scenario on existing processes and you try to align these with blockchain, it ca be mixture of any scenarios you have mentioned. But if you go really further and

try to avoid all those current processes and you really restructure your entire supply chain, then a different mix will be used. It really depends on different scenarios. From my perspective, trust through Cloud will be based on the mixture with what I have on my own premise, so I think all the options are relevant.

Barbora Sulikova: Ok, so when we are talking about supply chains especially, there is a lot of other current technologies such as Enterprise Resource Planning, Electronic Data Interchange, Management Software. *Do you think that with blockchain, these will disappear or blockchain would have more of a supporting role for these*?

Otto Schell: Also, yesterday I was a part of a discussion where people talked about the blockchain. There are opinions that blockchain supports the current processes. So, the current process means that you request the material, you will get confirmation that the material is coming, you receive the material together with receipt. You sent a receipt confirmation and invoice handling is in place. And all of this goes also through intermediaries, that can be a bank or something else. The idea that I was part of yesterday is that all of these existing processes will add on blockchain. How do we do this? First of all, we need to test blockchain and the capability. On the other side we do not want to disrupt the current processes. So, we do not want to take our business and disrupt, make a complete difference. So that is one scenario. I would like to see a scenario where people do this completely new. So, when you go to the blockchain capabilities, why do you really need intermediates, why do you really need banks. I think it will take time until companies will really go to extreme. I hope to find such initiatives very soon.

Barbora Sulikova: *Ok so basically, when you were talking about intermediaries, there is a lot of time taken especially in terms of contract handling and lot of manual settlement processes in relation to payments for materials or parts procured, which are time consuming and also there are fees related to these. Do you think that this can be addressed by blockchain? Would blockchain actually help to save time and costs related to these settlements?*

Otto Schell: My answer on this is clearly yes. In discussion when it goes to supply chain elements of payments, I strongly believe that when you are talking about the higher scenario of system to system and not people to people, blockchain environment and artificial intelligence at the moment is something that will support this kind of ideas, because then you do not need really payment terms. AI will calculate what is best for both sides and then will give a trigger on it.

Barbora Sulikova: So, when we are talking about the payment terms for example, there is also a huge hype about smart contracts related to blockchain. *Do you think that smart contracts can lead a way towards automation and help to streamline processes between vendor and vendee?*

Otto Schell: Yes, clear yes. Because again what we are trying to do is to translate our old world by using new technologies. So, take everything out, process break or data flow break, etc. Everywhere where you have to interrupt with an intermediary will be taken out.

Barbora Sulikova: Leading towards higher efficiency.

Otto Schell: Yes, but some people are thinking in this direction but not many of them are acting on this direction.

Barbora Sulikova: So, it is not really on the way yet.

Otto Schell: Yes, and lot of people are trying to find excuses why not to do it.

Barbora Sulikova: *Then again in terms of procurement function, more specifically in terms of order management, can this be addressed by blockchain?*

Otto Schell: This goes in hand with smart contracts on one side, on the other side, when you consider a world where we are in competition with sensorics, the answer is clear yes.

Barbora Sulikova: So basically, it can also help to reduce bottlenecks that are related to the supplier orders and extending the inventory unnecessarily, right? This can be cleared out and clear amounts required for the companies' operations can be procured from the partners?

Otto Schell: I would put it differently, it would be more transparency and more insights to allow to act. In a world where we would use AI to detect, AI could use blockchain to detect aspects much better than what we have now applied on the processes. Because processes are many times broken. But this is very futuristic for some people right now.

Barbora Sulikova: *Then, procurement is related to supplier deliveries and many times there is a risk related to these deliveries, for example supplier is not delivering what he promised to or not managing to deliver on time or at all due to some disruption. Can these risks be mitigated by blockchain?*

Otto Schell: I would again put it differently. Under the assumptions that you have blockchain based on tools like AI to validate would you ask the same question?

Barbora Sulikova: I mean, yes most probably, because as you have mentioned AI and blockchain goes together and they are most efficient when it is a combination of these two tools.

Otto Schell: Yes, because in your question you are trying to relate old processes to a new technology, there should be a mixture, it is fuzzy, but if you really think this through, the answer is a clear yes.

Barbora Sulikova: So, depends what kind of configurations we have in the network.

Otto Schell: Correct.

Barbora Sulikova: Alright. Then maybe we can move to sourcing function of the procurement. Companies usually decide whether they want to have a single supplier for one item or they are going to opt for multiple sourcing for the same item. Because blockchain offers more transparency, maybe the company would opt for one single supplier so the handling is easier, but at the same time maybe thanks to the transparency multiple suppliers will be given opportunity to be partners of that particular company. *Do you think that blockchain will somehow affect either single sourcing or will push more for multiple sourcing?*

Otto Schell: I do not think this is really a blockchain issue. Purchasing will change from one-to-one relationship to an end-to end relationship. This is already ongoing if you see some of the cloud solutions such as Ariba or Cooper, or in your private life using Alibaba or Amazon. You really do not care who is providing. Of course, you look at the stars but at the end you give a requirement and you will get the item back. So, procurement related processes will change in the future to network related processes. Where can blockchain add is more or less at the end-to-end scenario. For example, I you procure a digital asset and the asset is equipped with blockchain from beginning, you know about the condition of the asset, you now where it is, you know where it changes hands and all of these kinds of things. It will add to end-to-end procurement aspect, making sure that quality assurance is in place, making sure that all attributes of the journey can be captured. This certainly at the moment is very difficult, especially due to the fact that as I have mentioned processes are broken. One party is responsible for this, another for this, sometimes you do not even know conditions on the finance side. So yes, blockchain is then more or less a kind of supporting activity, because it is immutable, you have the consensus behind the contract. So yes, it is more supporting than driving decisions.

Barbora Sulikova: That was quite important insight for me. *Then, when we were talking about that basically blockchain provides more of a supporting role for sourcing function, do you think somehow blockchain can facilitate the process of supplier selection?*

Otto Schell: I am not sure whether it will kind of foster a supplier selection, but it will be helpful upon delivery. If you have a smart contract in place you have a better overview of the purchase of the asset or it can be also a human resource and under the condition that you have the processes completely under control. I think it is more supporting the quality issues. But blockchain as such from the concept point of view does not tell you what is right or wrong, that is more or less the question of experience, global capabilities, there are other areas that I believe more AI would help more than blockchain. But it is always a combination yeah? If you get a good follow up of processes and these kind of things, you have much better view of what is going on in your environment. If you get also more insight into your environment it would be much easier to get

things done. In other words, the way we describe purchasing and supply chain will also change I the future. Again, so smart contracts are more about the rules instead of decision criteria. On the other side, having with blockchain the records of transaction you understand who is in your network, you have a safe environment, you can follow up the business logic and also consensus, these are all supporting environments and with this support you are able to make better decisions.

Barbora Sulikova: So, just to clarify, basically the blockchain in terms of sourcing and procurement does not affect directly the decisions within these functions but creates more ideal environment for operations.

Otto Schell: Great, I would say so, es.

Barbora Sulikova: Ok, *then is there something else that comes to your mind, how blockchain can make procurement and sourcing more effective or efficient that we did not mention so far*?

Otto Schell: For me it is very important that we rethink our current processes. We are used to work in one-to-one relationships, so called chains, and we are going to the networks. It means in everything what we are doing, we should really think about what is the right thig from the future perspective. So, what is for next generation. Next generation would be that we apply blockchain into our processes, over next generation would be what we have discussed at the beginning that we immediately start with blockchain since the beginning. So that is the one thing that I think is very important that there is a plan behind. Secondly, I think all the technologies will play together. There will be scenarios where blockchain will be very important in the supply chain with its major capabilities just from a process flow perspective; on the other side, it will be also important from the order perspective. As said why do you need to order something and the pay invoice, if you go directly in the extended ledger technologies. So, I think there will be change in the future in behaviour.

Barbora Sulikova: What I would like to ask next is, *what are the decisive factors for an enterprise to even consider implementing blockchain into their procurement and sourcing functions, or in general into the supply chain? How do companies decide that yes this is the right solution for us*?

Otto Schell: My advice would always be to do a kind of process mining and to do a kind of overview of process automatization. Process mining means that there are tools in place over different landscapes, not only ERP landscape, and check how processes are used. There is a lot of discussion that we need this and we have to take over to the new world. If you really mine the process you will find out that is it really used by the people? So, it is very important that you get a good visibility where you can implement the change. In terms of automatization, a lot of repetitive work like invoice matching or checking whether receipts are really done can be

atomized with robotics in the first steps and then you can be more focused on what are other issues. So together, mining and robotics give an overview of the current environment and every time a process is broken we know exactly when due to the transparency and then blockchain will help. Immutable history cannot be changed. I think if people understand these kind of things, this kind of logic behind, then they will understand what the benefit of blockchain is.

Barbora Sulikova: Thank you. I think that is probably all that I had in mind and wanted to ask. Would you like to add something additional?

Otto Schell: I am very open. If you want to get any clarification through some questions afterwards, no problem, just get in touch.

Barbora Sulikova: That would be perfect, thank you very much. I might use that opportunity.

Otto Schell: So, I do for example a lecture in Germany, to give students an understanding about blockchain and these kinds of things, and here quite honestly is the same if you go to students or of you go to CEOs for all of them it is all new. the blockchain for supply chain is one of the high considered areas. Also, if you consider material supply, with blockchain you are exactly aware of what the amounts for production are and what to request from a supplier so you do not need to pay additional costs for storing inventory of supplied products which are part of a finished final product, neither we need to pay for storage locations.

Barbora Sulikova: Ok, thank you very much. Then I will not take more of your time.

Otto Schell: Take care.

Transcript of the Interview 3

Mathieu Bruneton

Deloitte Consultant Technology Integration & Enterprise Application, Co-author of White Paper Publication "Using Blockchain & Internet-of-Things in supply chain traceability"

26.06. 2018, 17:00

Time range: 25:51

Barbora Sulikova: Good Afternoon Mr. Bruneton

Mathieu Bruneton: Hello Barbora, how are you?

Barbora Sulikova: Great, thank you. First of all, I would like to thank you for agreeing with me on this interview.

Mathieu Bruneton: Sure, always happy to discuss these kinds of topics.

Barbora Sulikova: Just to make sure, the interview will be recorder just for the later purposes of transcribing, I hope it will not be a problem.

Mathieu Bruneton: No, that is fine.

Barbora Sulikova: So, should we get directly to the questions?

Mathieu Bruneton: Yeah, sure, we can.

Barbora Sulikova: Alright, just to clarify, what I am trying to do together with my supervisor is analyzing how implementing blockchain into a supply chain will affect sourcing and procurement functions of supply chain. Alright so let's get to the first question.

Mathieu Bruneton: Yeah sure.

Barbora Sulikova: *Do you think blockchain in terms of supply chain is restricted somehow e.g. industry-wise or it can be applicable in any industry, in any operations, etc.?*

Mathieu Bruneton: Well I think blockchain is definitely for me more than a concept than really an industry-centric. First blockchain was concentrated around financial services obviously, payments, payment processing, and transactions, but today I think it is a concept that can be applied to any industry. We can think about a supply chain as you are looking at it, or also health care industry. So, I think any industry can benefit from the blockchain concept.

Barbora Sulikova: As we know there are many types of blockchain solution, ranging from public to private, from permissioned to permisionless. *What do you think would be the most suitable type for companies to apply into their supply chain operations?*

Mathieu Bruneton: I think for supply chain it would be definitely a private blockchain, permissioned.

Barbora Sulikova: *Based on your contact with clients, are companies open and willing to implement the solution into their day-to-day SC operations or more skepticism prevails so far about the solution?*

Mathieu Bruneton: I think, according to our experience, it all depends on the size of the company. If we are talking about a big logistics partner, they are going to be looking at it more realistically. Whereas when you consider a local supplier, they are going to be much more resistant to actually adopt the technology, because it is a huge investment.

Barbora Sulikova: *And how does it actually work if I as a big company decide to implement blockchain into my SC. Do I need to get all of the suppliers agree on that and agree also on the implementation policy?*

Mathieu Bruneton: Yes definitely, I mean there is a whole transformation and that needs to happen on the level of entire operations. It does not only mean, ok we are adopting blockchain. It also means changing IT infrastructure and architecture of the company. So yeah, it is obviously a strategy phase, a design phase, implementation phase. So, it is a huge investment which small companies are most of the times not ready to handle.

Barbora Sulikova: And if we are talking about investment, *would actually the benefits of blockchain solution offset the costs of operating this technology?*

Mathieu Bruneton: The technology is not yet mature enough, but it is an investment for the future definitely. I think, once the system is in the place and then the benefits are undoubtedly balancing the costs of the solution. But as I said it is a huge investment at the beginning, and will take time, like 5 years, till it would be fully applicable.

Barbora Sulikova: Alright. Then we can move to the separate procurement function, more precisely the transactional function. *What would you say in terms of order management, how this will be affected by blockchain?*

Mathieu Bruneton: I think blockchain, to be honest, cannot work alone. For the blockchain to be really efficient, blockchain cannot live without IoT, as you could see also in our article. I think the real asset here is the combination with IoT services. So, mainly the IoT service would provide a trigger depending on different messages, for instance in health care industry it can be one set of medicine that is out of temperature or something like that. I think this combined with the trust that blockchain provides, that is when blockchain would really work at its full power.

Barbora Sulikova: Then if we are talking about transactions and payment services in terms of SC, there is a lot of times that intermediaries are necessary in contract handling, the processes are usually manually settled; therefore, they are time-consuming and many fees are related to the transactional processes in general. *So, how could blockchain help to address these particular issues? Would it help to save time and cost in terms of transactions*?

Mathieu Bruneton: Definitely it would save time and cost. First it is going to bypass a lot of intermediaries, all the brokers you see on the SC.

Barbora Sulikova: *Does it mean also that these intermediaries would be eliminated from the transactional process or the transaction will be more streamlined?*

Mathieu Bruneton: I think, they will not be eliminated as such, but it will definitely be streamlined and also way more trust will be established. It is like the financial business; more trust decreases the cost obviously. That is simple as that.

Barbora Sulikova: *the blockchain is strongly associated with smart contracts. Can these in supply chain lead a way towards automation and streamline the processes between vendor and vendee?*

Mathieu Bruneton: I think interesting questions, it would require both vendor and vendee to communicate and also the process of transaction will be much more efficiently handled on the trusted network. So, I think definitely yes.

Barbora Sulikova: How smart contracts work is that basically, they can trigger the payment and asses everything within the contract automatically between the partners right?

Mathieu Bruneton: Yes.

Barbora Sulikova: Alright. Procurement is also related to delivery of purchased assets. *Can blockchain assist in mitigating risks related to deliveries?* For example, quality aspects, or supplier not being able to deliver on time, etc.

Mathieu Bruneton: I think yes. But then again, I do not think, blockchain will be able to do that alone. Here IoT device or human interaction might be necessary to log in to the blockchain and once provided by a trusted stakeholder or trusted verified IoT device than the authenticity of the data will be guaranteed. Thus, trusted information will be shared among the stakeholders on the blockchain.

Barbora Sulikova: *the blockchain has a potential to increase transparency in a supply chain. How this transparency will affect sourcing function and basically selection of suppliers from which the company might enter into business with?*

Mathieu Bruneton: Well that is again the part of mitigating the risk. The businesses should be very selective on their suppliers. The company would be able to look at the operations with the particular supplier over the past years, and then asses them. One of the main attributes of the blockchain is that it is auditable and it can be also a tool to select suppliers. Allowing vendees to actually check how has the supplier been doing for the last let's say ten years, what were the problems, issues with the products, and then compare it with other members of the blockchain. At the end make a screening of the suppliers that you want to use.

Barbora Sulikova: *But how does this work if we have a new product and we are looking for a completely new supplier partner and we do not have any data from past experience. How can that be addressed by blockchain, can the potential vendor provide information and upload his performance on the blockchain for the vendee to see?* So, the vendee can actually assess the potential partner.

Mathieu Bruneton: Good question. I think it all depends on which blockchain are we talking about. If it is a private one it would be difficult to asses using the blockchain, because the new partner is not necessarily present on the blockchain. So, it really depends on which blockchain we are choosing. If it is a public blockchain than obviously any new partner can join and then the blockchain will be able to help. If it is a private one for existing partners, then I guess not.

Barbora Sulikova: Then again, when we are talking about the sourcing function, *companies can choose whether they will source one particular product from one supplier or they are going to opt for multiple sourcing partners. Will this decision be affected by blockchain?* For example, because of more transparency into the supplier's business the company would go with a single sourcing partner, or it would stimulate more smaller vendors to join the company just because the company can have a greater overview and control.

Mathieu Bruneton: Well, that can be both I think, because if you consider that you have a senior supplier, obviously a very high-risk situation if you do not have any other supplier that would mitigate the risk. The blockchain will basically also help you to identified whether there has been any fraud or break in your supply. the blockchain will help you to immediately identify where it is coming from and eliminate the potential threat or this particular supplier.

Barbora Sulikova: *So basically, if there is a problem in company's operations and there is for instance a bottleneck, we would know exactly where in the chain the problem is occurring and maybe with which supplier it is related right?*

Mathieu Bruneton: Yes, that is pretty much like that.

Barbora Sulikova: *Do some other important aspects come to your mind, how blockchain can be beneficial in procurement or sourcing?*

Mathieu Bruneton: Well the things we talked about are pretty much it. Obviously, a risk management, fraud detection. It is a very helpful tool because it is allowing producers to detect immediately where fraud or any defects on supply chain have been present. I think those are the main benefits of the blockchain.

Barbora Sulikova: *What are actually the decisive factors for an enterprise to even consider implementing blockchain for procurement or sourcing?*

Mathieu Bruneton: Well that is the return on investment. I think they have to be very thorough with the analysis before implementing it, to really assess which will be the benefits. Is it going to benefit financially but also operationally? Assess the positive impact it has on the company. That is one of the decisive factors. But also, in terms of risk mitigation. So, these two should be the key performance indicators.

Barbora Sulikova: Alright, then the last question. *There are currently quite few technologies existent in SC such as ERP, EDI, or management software. Are these going to disappear with the implementation of blockchain or blockchain will just play a supporting role?*

Mathieu Bruneton: I do not think they are going to disappear. I think those technologies and companies are very much aware about the blockchain trend and they are hopefully assessing what their benefit is in that transformation. I do not think they will disappear, I think they will remain and blockchain and these will support each other. the blockchain trend would be more used as leverage for company's strategy.

Barbora Sulikova: Ok, thank you very much. That were probably all of the questions that I had in mind. If there is something that you would like to add, please feel free.

Mathieu Bruneton: No, apart from wishing you a good luck with your thesis, that is pretty much it.

Barbora Sulikova: Thank you very much. Have a nice day.

Transcript of the Interview 4

Roger Crook

Chief Strategy Officer at Shipchain (Logistics platform based on blockchain), strategist in FinTech, LogisticsTech and Logistics including blockchain/cryptocurrencies, CEO Capital Springboard, Board & ICO Advisor,

03.07. 2018, 09:00

Time range: 26:02

Barbora Sulikova: Hello, Good morning. Thank you very much for agreeing to have this call with me.

Roger Crook: You're welcome. I hope I can be of help.

Barbora Sulikova: Do you have some questions before we start or should I get to mine so I do not take a lot of your time?

Roger Crook: Maybe just give me two minutes of what exactly you are doing, and then you go to your questions.

Barbora Sulikova: I am writing my Master thesis at the moment. What we are trying to do with my supervisor is examining how implementing blockchain solution into a supply chain will affect specifically the functions of procurement and sourcing. Now we ca start with the questions. I will firstly ask couple of general questions concerning blockchain in SC and then dive deeper int the procurement.

Roger Crook: Ok.

Barbora Sulikova: *Would you say that the technology would be widely applicable within supply chains or do you think there is some kind of restriction, for instance industry-wise or operation-wise?*

Roger Crook: I think that blockchain generally can be applied to any supply chain. I am sure there are examples when it would not be the best solution, but in general I do not see restrictions.

Barbora Sulikova: You are also a strategic advisor at Shipchain. *Based on your personal experience, are companies actually open to consider implementation of such solution into their day-to-day* operations or there is still a scepticism related to blockchain as such?

Roger Crook: I think, there is a lot of companies that are exploring it and a lot of companies that are thinking about it. So, I would categories the companies into those which are doing a sort of deep investigation and objective of implementing something within the next 12 months or two

years. There are companies who are trying to apply the concept, but not many and there are few companies that are using the solution. But I mean if you look at a bigger picture and the total umber of companies, this is in sort of less than 1% of companies that are really doing very much with it right now. There are many more people who do not know what to do or have no interest because they do not believe it or do not even know what it is. I mean there is some people, right at the bottom of the pile, who do not even know what the blockchain is.

Barbora Sulikova: Or think about it in terms of bitcoin or cryptocurrencies.

Roger Crook: Exactly. Some people who think it will go away. So, there is not many companies at it, not yet. But I think it will change. It is changing quite fast from my experience. I mean, I have been involved with blockchain for the past 18 months and it has changed dramatically during this time.

Barbora Sulikova: There are different types of blockchain in terms of reading ad writing access, private vs public, permisionless vs permissioned. *What do you think would be the most suitable type for supply chains?*

Roger Crook: My personal opinion is that best would be public. I am not precisely expert on blockchain as such, I am expert on supply chain. Private chains are private to the company; therefore, they are not inclusive of other companies and in my experience, private chain would cut out the opportunity in the benefit of blockchain for SC. You have got a lot of suppliers, a lot of companies you are interacting with, lots of customers, then public chain would be much more beneficial.

Barbora Sulikova: But then if we are talking about public chains, if we have organization sourcing one particular product from different suppliers, the competing vendors probably do not want other competitors to see details of their business operations. Because then information is open to be reviewed by any vendor.

Roger Crook: Yes, you are right.

Barbora Sulikova: *So maybe different configurations of the ledgers, e.g. a public one for a customer to see the journey of the product and maybe opt for more restricted configuration with suppliers*?

Roger Crook: Yes, I would have thought so. I guess that is completely correct. Parts of the supply chain need to be public, other parts need to be private. Companies are not going to want to give up their competitive advantage; therefore, they are definitely going to keep some aspects at the private chain, product information or IP information, etc. But other information they would want

to share with customers or even all suppliers so they would need a public chain. So, there needs to be different layers.

Barbora Sulikova: *From top of your mind, what would you say is the best benefit of blockchain for sourcing or procurement in particular.*

Roger Crook: I think the records of every transaction, that you have every interaction in the supply chain, one. Secondly, it reduces duplication, reduces data input, so it is cost effective. It probably speeds up the supply chain and reduces cost for the customer and the company. Furthermore, it creates a one-time record.

Barbora Sulikova: One of the most important aspects is that blockchain would ad complete transparency to a supply chain and business dealings with suppliers. *How do you think blockchain can affect a strategic decision of single sourcing versus multiple sourcing?* Because on one hand if there is transparency, then we know everything about that single source, we know how the goods are moving, whether the deliveries are timely or not, so, it would be sufficient to manage this one supplier. But then, on the other hand, exactly thanks to the transparency, maybe the doors are going to open and companies will source from multiple smaller suppliers. What is your opinion on that?

Roger Crook: Well, I think it will change the way supply chains operate, along the lines of what you are saying, because of the fact that today most of the SCs are multi-sourced and products are multi-sourced. But I think in the future there will be even more multisourcing if suppliers are willing to participate in the chain. Also, some suppliers will be cut out as they will not be willing to be part of the chain. So, there is an advantage for new companies to enter the supply chain and there is a disadvantage for some companies that are not technically capable of taking the benefits of blockchain. But it happens all the time in supply chain. Take the Apple's SC, they change their suppliers on a regular basis. Just because their technology changes they need to look for partners somewhere else, to source for the new components. So yes, it might make multisourcing easier and could it increase the number of suppliers, especially talking across multiple countries. In my experience, today a lot of sourcing is done in a way that companies suppliers focus on few origin countries for manufacturing and some of them actually fail badly because of supply chain disruption by only having one country of sourcing. I can think of an example a disk drive manufacturer for Hewlett Packard and Dell computers was manufacturing disks in Thailand and then there were major floods that we heard about 5-6 years ago. As a result, their factories got flooded and they did not have a backup and they were not manufacturing in any other location. So, as a result that supplier really brought down HP supply chain. So,

Barbora Sulikova: *So then basically, blockchain can assist in mitigating risks related to deliveries.*

Roger Crook: Absolutely. It can mitigate a risk to supply chain disruption.

Barbora Sulikova: then if we were talking about for example Apple changing suppliers or maybe onboarding suppliers for new product types, *do you think that blockchain can help with supplier selection?*

Roger Crook: I think so, because whatever tender process is going on between product manufacturer and supplier or any buyer and supplier then tender process with public blockchain could be recorded on the chain. There will be less time and easier visibility in the process. Secondly, I thin companies will only target suppliers that has the capability to accept the use of blockchain. So yes, definitely. It will make it more transparent.

Barbora Sulikova: Then I think we can move to the transactional function of procurement. *Do you think order management ca be addressed in terms of blockchain?* By order management I mean setting orders of material/ products, handling the payments and invoices and deliveries.

Roger Crook: I do think it can help, yes. I mean ultimately blockchain should be able to handle all process from order through the collection of cash and make it one seamless process with transactions on the chain and recording of each step. So, I think it will speed up that process, it will speed up payment; therefore, cashflow will improve in companies.

Barbora Sulikova: So, all the manual settlement processes in terms of contract handling that are time consuming and come with fees related to for example bank' handling are going to be reduced.

Roger Crook: Yes, I would have thought so, absolutely.

Barbora Sulikova: There is also a *huge hype related to blockchain about smart contracts. Do you think in terms of SC they can lead a way towards automation and streamline processes between vendor and vendee?*

Roger Crook: Well I would hope so, but to be quite honest I am not sure how that would work.

Barbora Sulikova: Then, currently in supply chains there is a lot of existing technologies present such as ERP, VMI, electronic data interchange. *Do you think that blockchain would transform the supply chains and eliminate these technologies or it would be just a supporting role for everything that is already existent in the enterprise?*

Roger Crook: Well I think it comes down to the cost of implementation, because for example electronic data interchange is relatively inexpensive to implement. When you go back 20 years EDI was newish and therefore, quite expensive to implement. But for me EDI is a bit like blockchain today. Presumably blockchain will be expensive at the beginning to implement, not because of the blockchain technology but because of all the changes that company has to do with already existent technologies and processes. And therefore, I think at the beginning blockchain

will be used at the point of the pyramid for exclusive quality deals and EDI and other systems will continue to be used. So, to some extent they will be used in parallel and then ultimately EDI will disappear as blockchain will become more accepted, easier to implement, and more known. My experience with EDI is that you have one company at the beginning and the receiving company saying I do not know what that is, I do not have the capability. So, if you do not have two parties that can actually talk the same language, then it does not happen because one party says I do not know and I do not have time to find out, I am not interested so we carry n using whatever it was we were using till now. So, now I think the same will happen with blockchain. The learning curve for technology within different companies.

Barbora Sulikova: So, for ERP system it is the same right? If there is a company with already established systems than maybe all the information recorded on ERP will be automatically submitted to blockchain, but it would be hard to replace the system completely.

Roger Crook: Yes, that is right.

Barbora Sulikova: Ok, then probably the last question. *What do you think are decisive factors for an enterprise to consider implementing blockchain for their procurement or sourcing function?*

Roger Crook: Well I definitely think the international aspect is important, the size of the company is also a factor. The most progressive companies are medium and large companies who want to use blockchain as a competitive advantage, to be ahead of their competitors. So that they can go to their customers and use it. Secondly, I think that customers will drive it in some industries. So, I think some industry sectors will drive it more than others. So, the customer might come in a three years' time and say we are not going to be doing business with you, unless you get blockchain. I have seen that happen. And I think that will happen with suppliers as well. Suppliers will have to in some cases adopt blockchain because they do want to do business with big companies and they will definitely have to adopt the capability.

Barbora Sulikova: And maybe it is also in their own interest if they want to prove their credibility.

Roger Crook: Exactly. And some will just do it because they truly believe in it.

Barbora Sulikova: Ok, I run out of the questions that I had in mind. If you would like to add something, please feel free.

Roger Crook: No, I think that is all.

Barbora Sulikova: Ok then. Again, thank you very much for your time and have a nice day.

Roger Crook: You too. By.

Transcript of the Interview 5

Vyacheslav Kubaev

Engagement manager at McKinsey & Company, Blockchain Specialist and Business Process Improvement Expert

02.07. 2018, 10:30

Time range: 37:36

Barbora Sulikova: Hello, Barbora Sulikova speaking.

Vyacheslav Kubaev: Hello Barbora, Vyacheslav here.

Barbora Sulikova: Thank you very much for finding a time for me, I know you are having a busy day.

Vyacheslav Kubaev: I would like to apologize for all the rescheduling.

Barbora Sulikova: Do not worry, we found the time at the end.

Vyacheslav Kubaev: If you could give me some short specifics of what you are researching firstly and then I am yours.

Barbora Sulikova: What I am trying to research with my supervisor is if we implement blockchain solution into supply chain, how this will affect procurement and sourcing functions of supply chain. So, we are not looking at the supply chain in general, but more on the specific functions material purchasing.

Vyacheslav Kubaev: Alright, that is clear.

Barbora Sulikova: So, if you do not have any further questions, maybe I can start with mine?

Vyacheslav Kubaev: I can give you my initial thoughts, also based on reflections from similar discussion we had with clients in Russia, specifically related to blockchain and procurement.

Barbora Sulikova: Ok, that would be perfect.

Vyacheslav Kubaev: First of all, it is sometimes hard to have the blockchain discussion because we normally intend that we refer to the Bitcoin as initial blockchain technology and particular this has its strategic switch which basically limits the business use of the technology. As an example, the anonymity, which will be disclosed as soon as you one time identify the person, imagine I am a company and I am paying you in Bitcoin, then you know it is a payment from my side. Outside the blockchain you get this information, you know it is a payment for a particular contract. The specifics of the blockchain implementation for Bitcoin immediately imply that you will see the

full payment history of myself, but not only the payment history, but also a payment future. Cause now you have a clear picture that I use the system with a particular person and you can straight forward some particular ideas of the wallet in that system.

Another physics of the Bitcoin is that it really limits the one-to-one implementation of the technology in real life. So, you will need to change this specific if you will apply blockchain in business environment. As an example, if we are talking about procurement, the ledger which will be opened for all third parties in the procurement process. If we are talking about competitors, blockchain would contain some very sensitive information.

Barbora Sulikova: So, *basically when we are talking about the type of blockchain then most suitable for supply chains would be most probably private permissioned right?*

Vyacheslav Kubaev: Yes, different services of blockchain, not exactly bitcoin. And most likely not even Ethereum. Also, for Ethereum, you will need a condition for the smart contract confidentiality and the opportunity to explore. But if you will talk about it practically, most likely some another newly developed version of blockchain which will have suitable functions for the business environment would be better. I recall one of the discussions we had with oil and gas company and their procurement guy was trying to figure out whether blockchain could be a useful thing for them. First initial though is, ok blockchain creates trust in a system, in a network. We have some stuff when we need to trade quality of the spare parts for the oil fields, we need to trace the history of the equipment if it is manufactured by different vendors, so supplied by different network of distribution. We need to trace the origin of the equipment and make sure it will be what the later contract required. So, then blockchain can provide the feature of traceability. That is a good part of blockchain. But the bad part is, now if we set up a full transparency it opens up a very dangerous situation. In particular situation of this particular company, do we really want other vendors to get the information about the volume you purchase from their competitors? Maybe it is ok, but usually information can be used as a leverage in the negotiation, for instance in negotiating discounts. And this is the information that would be visible in the network and you do not want to disclose it to other vendors from who you procure.

See, it is something you need to deal with. You need to make the ledger visible only for selected participants. Or you do some restrictions of particular aspects of the ledger, let's say I can see the mounts and volume procured but only if I am a buyer, or only if I am a particular supplier. Some particular aspects of bitcoin implementation, they need to be changed if you would like to switch to a practical business life. So that is the first idea.

The second thing is that basically you will need a lot of testing and implementation. It is I would say operational thing. If you will refer to the history of the crypto assets and different cryptocurrencies you will see that IBM coin is the only one which was not hacked. There is very

few of them. Even Ethereum, well established cryptocurrency was hacked. If after a couple of years of using blockchain for procurement, you find out it was hacked and you paid money to a person who used the vulnerability in the system, you need to overcome some legal barriers to change the history in the blockchain. So, blockchain is very good up to the point it can be hacked, so until the point when you get an error in the system. If the system was broken there is no mechanism that can get you to normal, initial operations. You might consider whether you want to have it on day-to-day business.

There is a third consideration I would like to give you and then we can discuss questions from you. When you think about blockchain for a particular business case, you should consider three filters, three criteria. So, a good problem to be solved with blockchain is a problem when you need to create connection between large network of participants who do not have full trust in each other, when you need to shield the transaction via exchange and when your data of operation is so sensitive that you are obliged to have a distribution storage to be protected from physical destruction then you have an opportunity to recover data. These are the three criteria and the point is only when all three of them are in place then blockchain is a good technology. If only one is the problem that you are solving, if let's say you just need to create trust between parties then there are other historically more adopted and advanced technologies like electronic signature etc. which will help you to solve that. So, if you apply those three measures and you see that those three are not required simultaneously maybe blockchain is not the right solution and other more traditional technologies should be applied. If all three are required, then blockchain is a perfect solution.

That was from my purely theoretical standpoint. Now we can go into your specific questions.

Barbora Sulikova: Thank you. You were talking about different configurations in terms of blockchain and that it needs to be addressed and set differently depending on the kinds of operations of the enterprise, the kind of contact the organization has with other participants in the network. So, *how would blockchain in terms of supply chain affect strategic decisions of single sourcing or multiple sourcing?* Because more transparency might lead companies to stick only with one vendor as they will know all about its operations and state of the supplied goods, but on the other hand it can stimulate sourcing from multiple suppliers exactly thank to better visibility; and therefore, better organization. So how this will be affected by blockchain?

Vyacheslav Kubaev: Yes, you are right. There is a trade-off between the initial idea of the full transparency, everybody knows everything about each other, it creates trust, it creates stability of the system. But then you come up with a practical example; so, you will need to do some tradeoffs basically. And if you refer to some practical examples of using blockchain to derivatives trading for instance in Russia, it was a bank example of course, they ended up creating a very complex

blockchain set-up consisting of three ledgers, if I recall correctly. Different levels of visibility to participants. So, you need to somehow work around the trade-offs, but of course you do not want to lose the initial idea. Let's say you have a system between two parties and they authorize themselves with electronic signature than what is the difference between blockchain and standard database based on signature access. Literally no difference. You have to work your way around. You can have a combination of different ledgers for different purposes and some trades with basic technology that you use of instance for authorization. Another practical example I was discussing with a Central Bank of Russia about the national cryptocurrency. There when you are talking about the currency in a practical bitcoin application, everybody could be a person creating, issuing a new currency, using the standard terminology of regular currency. Then for a Central Bank it is not an ideal situation. You cannot allow everybody in the country to issue money or numerous reasons. Because you would like to control the inflation, or other stuff. So, then you would like to say ok, it will be a blockchain system but the miners will be pre-selected individuals of the Central Bank or regular banks. Then it is a dilemma whether it is a real blockchain or it is some sort of technology that is close to blockchain as it is no longer open to minors to join and to validate the transaction.

Barbora Sulikova: So, based on what you said, it really depends on how we decide to configure the connection between the company and vendors in their operations. Some might have access to all the information, and for some the access might be restricted. *So then with blockchain is it possible to help companies with both single sourcing and multiple sourcing? Just depends on the kind of ledger we decide to opt for.*

Vyacheslav Kubaev: Yes. Even though what I said, I still think blockchain has a great potential for procurement and supply of the parts. Particular example on the market, Walmart and IBM the blockchain created a configuration of the ledger for traceability. And there you see that all three filters I have mentioned are relevant there. You have huge network of suppliers between who trust needs to be established and Walmart's quality lies in its supply chain. And it is ok to create transparency for company's operations and reduction of the costs, and also to justify prices. I had similar discussion about diamonds mining industry in South Africa. It is another example where not for economical reason but for the reason of the originality of the good you would like to establish a clear mechanism to prove the origin. Then there is a lot of discussion going on in electricity and there, procurement is closely linked with the supply. In Russia we have currently centralized electricity and heating system, so centralized power plants and centralized distribution system. You have a decentralized consumption of the electricity. When you have a decentralized generation closer to the consumption point, you do not need so many assets in the distribution part, so many households become producers not only consumers of the good. And they have opportunity to resell certain amount of electricity they generate themselves. And this is another

example, where blockchain could be very very powerful. Generated energy can be sold in the network and household will get paid for a particular number of kilowatt procured especially from that household and not particular generator. So, see, these are all identical problems.

Barbora Sulikova: Then maybe also related to the aspect of transparency, *can blockchain assist in the process of supplier selection for an organization?*

Vyacheslav Kubaev: Yes.

Barbora Sulikova: *But how does it work if we have a completely new item to be sourced and we do not have the information about potential suppliers resulting from the past trade with them from our already established blockchain*. Can this be again addressed by different configurations and opening a new ledger for potential supplier bidders?

Vyacheslav Kubaev: Yes sure, that is an idea. It is very hard to discuss blockchain applicability in general because then when you have real life, you need to take your particular company, your particular problems you are trying to solve, find all the features of blockchain that need to be changed or adjusted, think, work around, experiment. Based on pilots you have you will find even more bottle necks.

Barbora Sulikova: *Then in terms of transactional function of procurement, how the order management can be addressed by blockchain? Can it be facilitated in some way?*

Vyacheslav Kubaev: Pardon?

Barbora Sulikova: For example, *if we think about smart contracts, can these lead a way toward automation and streamline the processes between vendor and vendee?*

Vyacheslav Kubaev: By order management you mean issuing invoices, and then delivery and payment?

Barbora Sulikova: Exactly

Vyacheslav Kubaev: Yes, I would say that smart contracts should be a separate area of attention, because smart contract is a very flexible tool because you can write whatever you would like to there. So, what you need to consider there is that it will be self-executed by saying yes if payment will be allowed if no then no. So again, potential is great, is huge the only prerequisite for the smart contract is that the base of the smart contract is derived from some electronic data. So, if you are doing let's say a contract on a transfer of ownership of some particular property then the register of that title of ownership should be in the blockchain as well. Because otherwise there is no data source. That's why when you are trying to apply blockchain to some traditional areas, you have to also think about which databases need to be mirrored, copied, or somehow replicated in the blockchain, so your smart contract eventually works properly.

Barbora Sulikova: So, basically especially when we are talking about supply chain there are already existent technologies existent such as enterprise resource planning, vendor managed inventory, or electronic data interchange. *So, based on what you said, blockchain would have a supporting role for these to automate the processes, instead of replacing the existing technologies, right?*

Vyacheslav Kubaev: Yes, I would say so. It is a great mechanism for a new type of contract relations. Let's say before that I need to write a very long legal clause that states e.g. currency exchange rate you change by that level then you renegotiate prices, if the quality of the product you've been supplied will be lower then again, we can opt for discount for that X units of item. Right now, it is a great opportunity to agree with third parties on blockchain mechanism, right now is a great opportunity to do it automatically. You just agree what is the source of exchange rate for your blockchain, it could be central bank open interfaces with exchange data. For quality discounts, you can say that up certain items supplied, quality control will be executed by a third-party X and you both trust to that third party, and that third party will make a second entrance stating that the quality meets what is required, then 20 % discount can be granted. As an example, just thinking out loud.

Barbora Sulikova: So then when we are talking about contract handling, there is also a lot of intermediaries involved and a lot of manual settlement processes of banks and payment service providers and these are usually time consuming and fees are related to these. *Can blockchain help to address these issues or would assist in saving time and cost?*

Vyacheslav Kubaev: In future yes. Right now, when I am trying to recall some practical examples related to blockchain, we do have to deal with some legal limitations. Saying that there is a legal force only if agency X and bank Y approves the transaction. This immediately leads to legally recognized field and can lead to tax penalties, etc. So, you basically mirror, you create a blockchain reflection of an X, so legal environment in a business rather than replacing them completely. But that is the question of time I would say. Because as soon as we will prove to everybody that particular blockchain application is stable, is viable, then it is the question of changing the legislation. It works the same way as electronic document interchange. Historically it was not deemed to success by anybody, getting electronic invoice, you cannot do the deduction based on that, etcetera. But then slowly and gradually we have seen a number of experiments with the technology starting I think from European countries. They changed the legislation, then other countries followed the same way. Now, In Russia, I think you can do this purely non-hardcopy. So, here I think the story might be very similar. So now, we are in the phase of experiments and trying to figure out ho to best implement the technology, whether it is stable, risky, not risky, the

benefits you can get out of this elimination, how the company can speed up their process. There are some completely new functions that you can get out of the blockchain.

Barbora Sulikova: So basically, it will take a lot of time to become widely applicable and the companies right now might be a little sceptical about the solution and also because it requires a lot of thought in terms of legal issues and configurations and so forth.

Vyacheslav Kubaev: Exactly. Because right now, you cannot completely switch to blockchain. You will create a duplicate of standard process, because you are obliged by legislation.

Barbora I need to run to the next meeting in two minutes. Maybe we can have last question.

Barbora Sulikova: Yes of course. You can answer very quickly. When we talk about procurement, there are certain risks related to delivery. *Can blockchain mitigate these risks related to disruption of supply?*

Vyacheslav Kubaev: Again, to be practical. We discussed the oil client here it was one of the points. When you talk about procurement, you would like to control quantity of the goods supplied, then quality and then that your supplier is on time. So, these are the three requirements. If something is wrong with either of those criteria, then you would like to have an opportunity to penalize your supplier. And of course, here we come back to smart contracts. It is important especially if we are talking about large volume contracts where the delay result in a huge loss for a company. Imagine a critical part for your finished good is delayed by a month, and it happens in real life. Then you have a one month later delay for that particular plans, you have other penalties, and then you loose one month of the production plans. And of course, if you have such situation you can mitigate it by penalizing your vendors, by controlling the supply chain. If you get better transparency across supply chain, it also helps you to control delivery dates, because if your find out about the delay in the early stages, not just let's say delivery is on 1st of June and I did not get it. But let's say couple of months ago you already see that it was not issued for production by a vendor you already can discuss that issue.

Barbora Sulikova: Ok, thank you very much then, it was really helpful. I am not going to be holding you more as you have a busy day. Thank you very much again.

Transcript of the Interview 6

Paul Brody

Principal & Global Innovation Blockchain Leader, Ernst & Young,

"Paul is responsible for driving EY's initiatives and investments in blockchain, playing a dual role as global innovation blockchain leader as well the Americas strategy leader for the technology sector. He has extensive experience in the areas of IoT, supply chain, and operations and business strategy" (Brody, 2017, p.8).

05.07. 2018, 16:00

Time range: 16:02

Paul Brody: Paul Brody

Barbora Sulikova: Good afternoon, Barbora Sulikova speaking.

Paul Brody: Hi, I was just going to connect to a conference call, but this is actually much better to talk via phone. So, what can I tell you that would be useful?

Barbora Sulikova: Just general introduction, I am trying to research how implementing blockchain into the supply chain would specifically affect procurement function, both in terms of sourcing and I terms of transactional function of procurement. Do you have any questions before we start?

Paul Brody: I think you can just go right in.

Barbora Sulikova: Ok, then let's start with some general questions about blockchain in supply chain. Many types of blockchain is existent in terms of reading and writing access, ranging from private to public, from permisionless to permissioned. *What do you think would be the most suitable type for supply chains?*

Paul Brody: Our argument at EY is that if you are not using public network, it does not really…, it won't scale. We believe that permisionless public network is essential to be doing transactions securely and privately.

Barbora Sulikova: For supply chain as well?

Paul Brody: Yes.

Barbora Sulikova: But then if we are talking for instance about the vendor and vendee relationship, wouldn't have all the competing suppliers operating with the same organization access to the competitor's information with that particular organization?

Paul Brody: No. So, using Zero Knowledge Proofs you can actually have entirely secure private transactions over the public infrastructure. It is a really new technology, we are in early stages of defining this, but we certainly believe that technically speaking it is the only way to do it. Otherwise, what you end up with are lots of overlapping private blockchains. And private blockchains they never get sort of network effect. If you are on Walmart's blockchain how are you going to get in touch with that blockchain and get everyone on blockchain as well, that is not a very appealing solution.

Barbora Sulikova: That was basically my information do far, that the best would be to opt for different ledgers with differing types of configurations and never heard about the Zero knowledge Proof technology. Very interesting insight. Then, *based on your personal experience, are companies open and willing to consider implementation of blockchain into their day-to-day operations or there is still scepticism about the solution?*

Paul Brody: Everyone is talking about it, but nobody is doing it yet. No, I would not say nobody, but relatively few. So, almost everybody is seriously considering it; however, the biggest issues right now are simply that companies are not organised enough to take advantage of the technology yet. And this Zero Knowledge Proof technology isn't mature yet, it doesn't work really well. We have a prototype running in our lab and right now it does not scale well. So, it is going to take a year or two before it scales up and then it is going to take time for companies to adopt it. So, everyone says they are interested, but the reality is that, it is going to be some adoption process as we get going.

Barbora Sulikova: Makes sense. Currently there is a lot of existent technologies present such as Enterprise Resource Planning, Vendor Managed Inventory, Electronic data Interchange and another management software. *Do you think that blockchain will somehow replace all of these or will just play a supporting role for the organisational processes?*

Paul Brody: It has to replace them. I mean we have so many overlapping redundant, you know, supply chain solutions. I mean, the whole purpose of blockchain, if you think about tokenizing inventory, if I have inventory tokens and I exchange them to you for money tokens right, and I tell you where they are and thee status of them, I should have replaced the purchase order, EDI messages, shipment tracking. All of these things should be replaced. And if I not replace then I am not really sure what it is I am doing.

Barbora Sulikova: Understood. So, then basically it is safe to say that *blockchain can also help to address order management, right?*

Paul Brody: Absolutely. I mean I anticipate that public blockchain will become the primary mechanism for business-to-business contracting going forward. It will take 5 or 10 years but ultimately public blockchains will be how companies transact with each other.

Barbora Sulikova: So, it really is going to be a competitive advantage for those who are pioneering the solution.

Paul Brody: Yes.

Barbora Sulikova: There is a huge hype related to blockchain about smart contracts as well. *Are these going to lead a way towards complete automation and streamline the processes between vendor and vendee?*

Paul Brody: I expect a very high level of automation, not a complete automation.

Barbora Sulikova: Because, for example every time order or invoice is received that needs to be a confirmation, many times of the paper and inserted into the system afterwards. And there is also a lot of intermediaries involved in the transactional process and payment settlement and this is generally very time-consuming process and associated with fees generated especially by the intermediaries. *Do you think that with blockchain the time and cost related to these activities can be reduced?*

Paul Brody: Dramatically by like more than 90 %. The big part of this is that for the first time ever with blockchain and supply chain management we have the stability in kinds of same technical architecture, in terms of operational aspects which is what is the state of my inventory, where is it, when I am getting it and the financial aspect which is what are the terms and conditions, what are the payment rules, who is getting paid, when is he getting paid, and finally payments itself.

Barbora Sulikova: *But is this already legally addressed, all of the payment processes via blockchain?*

Paul Brody: No. I would say I would not be able to yet be quietly confident that those transactions are fully legal. But from EY perspective, I think we can get there. That is what we are doing. A lot of our research, technical research, regulatory work, concept design is going to work to that end. So, we already are a major auditor of blockchain. We audit blockchain, we do software design. So, ultimately, we will be able to tell our clients, it is safe and legal for you to transact online through the blockchain infrastructure.

Barbora Sulikova: Then, procurement is also related to deliveries. *These are many times linked to risk caused by the disruptions in the network. Do you think that with blockchain these risks can be mitigated?*

Paul Brody: You have to be realistic about your expectations to a blockchain. the blockchains are a software, and they can do a great deal for sharing information, but they are not you know, if you are manufacturing a system and do not record data, blockchain cannot make it magically exist. the blockchains are not going to make tracking, tracks more reliable. So, I do not want to overset expectations. It is a software and you know, it is extremely useful for enabling collaboration, and sharing information, and integrating payments and delivery. I worry that claims out there are getting too far ahead of what is really possible.

Barbora Sulikova: What I was referring to is more the visibility that you get to suppliers' network nod suppliers operations and basically then you can see for example whether the order has been processed and initiated for production and the supplier will be able to deliver on time.

Paul Brody: I think that would be much better under a blockchain model. In particular companies already have data that gives them insight to what is called one tier down in the supply chain. The companies know what their suppliers are doing. What they have no idea is, they do not know what their suppliers' suppliers' suppliers are doing. And that is usually where the problem starts, right. By the time your tier 1 supplier called you and tells you there is a problem, it is already too late. So, I think that blockchains contribution itself is in handling issues that are 3 or 4 tiers down the network.

Barbora Sulikova: Ok. Then, purely hypothetically, if we are talking about the fact that blockchain is supposed to add transparency to the supply chains, *will this technology somehow affect strategic decision of sourcing particular item from single supplier or multiple suppliers?* Because, if you think about it, the transparency will give us a better overview of that one particular supplier and if something is going to happen and delivery will be postponed we will have the information well in advance and buffer from our resources. But maybe exactly thank to this transparency, more of the suppliers will get the opportunity as they would be easier to be handled with blockchain. What do you think?

Paul Brody: I actually have the same conclusion that you do which is that it is very likely that over time blockchain will make payments and selection of vendors so much simpler that It should lead to intense competition. I do not know how quickly that will happen, but I think eventually it could lead to vastly more kind of intense competition between these different companies.

Barbora Sulikova: I was actually thinking how blockchain would actually help companies to select new suppliers but now if we are talking about public blockchain that make sense. Because I was always thinking about blockchain for supply chain being private exactly due to the fact that all the information is shared.

Paul Brody: Yeah, but what is public, with two clicks of the button I can prove to you that I have sold to bunch of other companies.

Barbora Sulikova: Probably the last question, *are there some other important aspects that come to your mind of blockchain's benefit for procurement or sourcing?* Specifically, that we did not talk about.

Paul Brody: Yes. I would say the main one is, companies are not very good at executing the agreements that they sign. So, they are very good at things like negotiating volume and purchase agreements, but they are terrible to actually keeping track of how much volume they purchase. With a blockchain if you issue all of your purchase orders on the blockchain and you have your smart contracts there with a definition of all of the purchases that you have made and the definition of your contract with the supplier, then you should always get the volume discount which is something very few companies get today. Today one of the games that goes on is that buyers and sellers are arguing with multiple variables. And one of the variables that often comes into the play is how good the other party is in keeping their word. So, if we have a volume purchase agreement, I can offer you a very big generous discount if I do not really believe you are capable of keeping track of your volume and claiming that discount.

Barbora Sulikova: *What do you think are decisive factors for an enterprise to actually consider implementing blockchain into their network?* Because for example if we are a large company but dealing only with local suppliers it probably does not really makes sense, so probably cross-border aspect is required.

Paul Brody: My personal instinct is that any company that engages in substantial procurement activity is going to use blockchain. I think that is kind of a given. That is going to happen. I do not know that there is a better or worse or sort of kind of bad choice or good choice. If you have a business-to-business contract that deeds on more than one tier of supplier, the it is not a question if you will adopt a blockchain, it is only a question of when.

Barbora Sulikova: Understood. Ok, that was all from my side. I will not take more of your time.

Paul Brody: My pleasure to be helpful, good luck with your research.

Barbora Sulikova: Thank you very much for your time. By

Paul Brody: By, by.