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Thesis

Blockchain, good governance and public procurement

Master of Science in Public Administration
International and European Governance

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Preface

When choosing Corruption, Integrity and Transparency as a capstone for my Master of Science in Public Administration at Leiden University I did not expect that I would end up researching and writing an exploratory thesis regarding blockchain, e-government and public procurement processes. I already knew I wanted to write something about e-government, because I find new initiatives in the public sector rather interesting and infrequent. Therefore, I decided to investigate if blockchain technology has the potential to enhance public procurement processes.

The objective of this thesis is to understand blockchain technology as a tool of e-government and to explore the possible effects of the technology within the pubic sector and in particular public procurement processes.

After several months of hard work which at some points I enjoyed more than others, I am happy to have completed this thesis and I hope that anyone who decides to read it will enjoy it. At the same time I know that I could not have done this without the people who supported me throughout the whole process. Therefore, I would like to thank Dr. A.D.N. Kerkhoff who supervised my work throughout the entire thesis cycle. I would also like to thank my family, housemates and friends for supporting me in such a process and always being there for me. Finally yet importantly, I would like to give special thanks to the blockchain experts Martijn Bolt, Olivier Rikken and Brendan Abbott for providing me with such valuable information and insights in regard to blockchain technology as they have experienced it and to my friend Claire Mansfield for proofreading my thesis.

Table of Contents

Table of Figures and Tables

1. Introduction

According to the European Commission more than 250.000 public authorities within the European Union spend an equivalent of €2 trillion or 14% of the Gross Domestic Product (GDP) per year on the purchase of goods, services and supplies in multiple different sectors such as energy, social protection, education services, healthcare and others. In all these procurement processes, public authorities are the main buyers. Public procurement can be used to boost jobs, growth and investments opportunities while it contributes to the creation of a more innovative sustainable economy which is resource efficient and socially inclusive. The essential high quality of public services depends on the contemporary, well-managed, well-governed, effective and efficient public procurement processes. The improvement of public procurement according to the European Commission, can have a tremendous effect on the economy. In particular, an increase of 1% in efficiency can actually save €20 billion per year (European Commission, n.d.).

Unfortunately according to OECD public procurement is one of the areas mostly prone to corruption, with 57% of all foreign bribery cases being procurement corruption (OECD, 2016). That is due to the combination of the volume of transactions, the financial interests at stake and "the complexity of the process, the close interaction between public officials and businesses, and the multitude of stakeholders" (OECD, 2016, p. 6).

In order to protect and enhance public procurement processes, governments can use e-government with which governmental processes and/ or services can be executed and offered online with the use of information technology. E-government is believed to increase transparency, accountability and procedure efficiency within the public sector and governmental processes. The potential advantages that e-government has to offer are directly linked to the architecture of government's systems and networks, as well as the communication structures and participants within them [public officials or other parties such as suppliers, vendors, or third outsourcing partners] (Shim and Eom, 2008; Andersen, 2009; Elbahnasawy, 2014). As the European Commission states, public procurement is undergoing a digital transformation and electronic procurement is deeply linked to e-government. Furthermore the EC states (European Commission, 2017, n.d.):

"The EU supports the process of rethinking public procurement process with digital technologies in mind. This goes beyond simply moving to electronic tools; it rethinks various pre-award and post-award phases. The aim is to make them simpler for businesses to participate in and

for the public sector to manage. It also allows for the integration of data-based approaches at various stages of the procurement process."

A tool that e-government could use in order to establish good governance in public procurement processes, in terms of public values such as accountability, integrity and honesty, innovation and openness to change, and transparency and trust, is blockchain technology and its applications, which would supplement the government systems, not replace them. Blockchain supposedly increases transparency, integrity and accountability, which are considered strongly impactful mechanisms to boost good governance, due to disintermediation, immutability and distribution of power in a network (Bauhr & Grimes, 2014; Sohail & Cavill, 2008). This technology can facilitate public services and create a new dimension of trust, transparency and accountability in the public sector.

Blockchain (as will be discussed in more detail in chapter 2.1) should not be considered a mechanism that would actually replace the existing government systems. Instead, like any other technology, it is simply a tool and not an end-solution in itself. It is a combination of multiple existing but distant technologies, thought to be one of the most innovative and transformative digital technologies that should be considered under the new paradigm of governmental policy making and e-government service delivery. Blockchain technologies make available new mechanisms, which are based on algorithms, in order to establish and manage trust across entities. In consequence, providing algorithmic trust through a network of entities can have significantly lower costs for governments, citizens and businesses.

Blockchain can be utilised as a single shared ledger among multiple interested independent or non parties and simplify the way they maintain and exchange data between them and the complexity of entities maintaining their own data sources in multiple separate systems. One important benefit of the use of blockchain by governments is believed to be the simplification of bureaucracy both in terms of the duration and administration of bureaucratic services and the processes within them, and the reduction of discretionary power and corruption, mainly because of the use of distributed ledgers and smart contracts that can be programmed and are immutable. Furthermore, it can increase automations, transparency, audit-ability and accountability of information within government record keeping registries for the benefits of the citizens. In regard to the public sector, it is expected at the minimum to facilitate and enable several government services and functions, if not at the maximum to revolutionize them. Government services and functions can include amongst others the facilitation of economic transactions including pensions, grants and

other social transfers; the provision of records, data and information; possibilities of e-voting; regulatory oversight of markets; tackling tax fraud and tax evasion; and most importantly in relation to this thesis the provision and monitoring of public spending and the redistribution of public money.

An increasing number of countries are becoming members of open government initiatives and electronic strategies in order to improve their governance and e-governance, increase their transparency regarding the retention and use of data, information, procedures and their efficiency in terms of cost and time. Governments in various countries have already adopted use of blockchain technology. One example is the government of the Netherlands which has already ran blockchain projects for multiple occasions both on a national and on a local level. On a national level, the government of the Netherlands including the Dutch Authority for the Financial Markets (AFM) and the Dutch National Tax Office (Belastingdienst) have run a complete community-based pension administration by using blockchain technology using open source and closed custom code with the Dutch pension provider APG. The aim of the project was the improvement of payments and pensions administration. In addition, on a local level, the Netherlands has established the Stadjerspas which is a service using blockchain technology and infrastructure in order to provide discounted services to low income citizens. The initiative of the Stajerspas smart vouchers run on blockchain technology took place in the municipality of Groningen in 2016. Another example is the German government which in consultation with various blockchain operators regarding the ways that blockchain can contribute to the country's economy in terms of effectiveness and efficiency. Many parties from the automotive industry, pharmaceuticals, energy, public administration and start-up companies are participating in these consultations. Blockchain is also thriving in Australia, where the government has actually removed taxes from transactions and trades occurring on bitcoin. In addition, the government of Dubai plans to transfer all government documents and systems to a blockchain by 2020 - a paperless initiative - aiming at becoming a key player in the field of blockchain and increasing efficiency in all aspects of government (Laurence, 2017).

These examples show us that governments are trying to transform or change and empower themselves to upgrade their processes and meliorate. Transformation, within governments, can take multiple forms including but not limited to the upgrade of an operational process, the establishment of a new process, product or service; a major (positive) shift on government's performance levels (Bannister and Connolly, 2014). In addition, a change of a certain public value or related to it, is also considered transformation for a government. Banister and Conolly stated in regard to transformation that “this may take the form of a new value, it may involve a change in the

importance of an existing value or a step change in the delivery of a value" (p. 119). Therefore, in this thesis we will not be discussing about minor changes, but a degree of change that indicates significant differences in regard to public sector values. In particular, special focus will be given to accountability, effectiveness and efficiency, innovation and openness to change, integrity and honesty, and transparency and trust.

This thesis is a qualitative, descriptive and partly exploratory research which focuses on the added value of blockchain technology as a tool of e-government and its effect on good governance and public values in procurement processes within the public sector as existing research looks at the applications of blockchain mostly within the private sector and specifically in the business and financial sectors, in particular supply chain. That is because in the public sector there have only been pilot projects using blockchain and testing its potential costs and benefits. In addition not a lot of attention has been paid to the challenges that blockchain could bring along or challenges that governments implementing it and/or using it are facing or could face. Therefore, the research question of this paper is:

> *What are the potential benefits and challenges of blockchain technology - as a tool of e-government - to procurement processes in the public sector?*

1.1 Relevance

A system that performs well in terms of productivity, efficiency, and integrity has wide-ranging national benefits. On the other hand, weaknesses in procurement management under deliver social services, increase sovereign risk for foreign investment, and reduce national economic growth (International Monetary Fund, 2010). The urgency of achieving high performance standards in public procurement has been underpinned by the International Monetary Fund (1998), Asia-Pacific Economic Cooperation (1999), and the Organisation for Economic Co-operation and Development (2006), which can be realised only through the establishment of best practice in terms of the application of methods and resources that produce the best social and economic outcomes from public financial resources, within a value framework of good governance. This thesis aims to address this need for well preforming procurement systems, by providing research that has theoretical, social, and empirical relevance to both governments and individual citizens.

In addition, the existing research of e-government is divided into three streams. The first two are Evolution & Development and Adoption & Implementation while the third one is Impact on Stakeholders. Limited research has been conducted on this third stream because of "*the fuzziness and diversity of the intended goals of e-government projects*", although previous studies suggest that electronic government projects are supported by internal agencies. (Srivastava, 2011, p.108 as cited in Krishnan et al., 2013; Krishnan et al., 2013; Nam, 2018; Lupu & Lazar, 2015). This thesis can be theoretically significant as it contributes to the second stream of existing research (Adoption & Implementation), and it focuses on the adoption and implementation of blockchain technology as a tool of e-government for public procurement processes and its impact on public sector values such as accountability, effectiveness and efficiency, innovation and openness to change, integrity and honesty, and transparency and trust.

Moreover, this thesis can be socially relevant three reasons. One of them is because the interrelation between new technologies, governance and public procurement should be studied as ICT becomes more and more a part of societies' tool to use in day-to-day activities and governments have been using it more since the 2000s. Another reason is that citizens as taxpayers are always seeking more transparency and efficiency from governments in regard to the spending of public money, the taxpayers' money, and this paper looks into the possible effects of blockchain technology for improving public procurement processes. As aforementioned, according to the European Commission public authorities within the EU spend around 2 trillion per year for the purchase of goods, services and supplies. This research can help citizens and governments understand the basic characteristics of blockchain confirmed by and linked to real expert views to

see whether blockchain can be of added value to public procurement processes. A third reason is because citizens should be aware of current developments in the area of governance and technology. Through this thesis they can understand the way blockchain technology and public procedures work. A fourth reason is because governments can see the views of experts in regard to the benefits that blockchain technology can offer as well as the challenges that might come along with the technology or faced prior-to or during its implementation.

Last but not least, for this thesis I chose to conduct interviews with blockchain experts who have experience working with blockchain and/or government and/or public procurement procuresses. Therefore, this thesis is empirically and scientifically significant since all the data collected in regard to public procurement processes and blockchain are primary data. Currently, there is limited existing empirical evidence around blockchain technology as a tool of e-government and its potential effects to government procedures and in particular public procurement processes. The exploratory nature of this thesis and the primary data collected provide new information about the current status of blockchain technology, e-government and public procurement processes.

1.2 Outline

In the first part of Chapter 2 which is the Theoretical Framework, 2.1 outlines the main characteristics of blockchain technology. In addition, the different types of blockchain, systems/ networks and the feature of smart contacts are discussed. The second part of chapter 2, 2.2, contains information in regard to e-government and the types of e-government related to public procurement. Following, in 2.3, there is an explanation of public procurement, the traditional public procurement processes and the operationalisation of good governance in public procurement. In addition, a summary and a table in regard to blockchain, e-government and public procurement processes in which the main blockchain technology potential advantages and challenges for good governance and public values in public procurement are provided. In particular, the key benefits of blockchain technology that contribute to improving the public sector's efficiency and enhancing integrity, transparency and accountability are presented. Chapter 3 provides information in regard to the research methodology, research design, data collection and limitations. Next, chapter 4 consists of the empirical analysis of the interviews with experts conducted during the research fieldwork in regard to the effect and relationship between blockchain technology based public procurement and the public values of accountability, efficiency and effectiveness, innovation and openness to change, integrity and honesty, and transparency and trust. In addition a table with the main findings is provided. Finally, Chapter 5 outlines a discussion, the conclusions of this research and recommendations for future research questions to be further explored in regard to blockchain, governments and public procurement.

2. Theoretical Framework

In the following chapter the concepts of the independent variables of blockchain, e-government, and public procurement will be analysed.

2.1 Blockchain

As the name indicates, blockchain is a chain of blocks which contain(s) information. The logic of this technique was first introduced by a group of researchers in 1991, whose original idea was to timestamp digital documents in order to eliminate the possibilities of somebody changing or tempering with the documents, similar to a notary (Haber and Stornetta, 1991).

Blockchain itself though was first introduced when an anonymous author or group of authors called Satoshi Nakamoto published a paper, in which blockchain was presented as the network that enables and allows financial transactions to take place instantly in a direct way instead of using an intermediary as a financial institution (Nakamoto, 2008). In other words, blockchain is the technology allowing two actors [also called *nodes*] within the system to transact in a peer-to-peer (P2P) network, and subsequently save the completed transactions along with the owner(s) of the transacted assets spread throughout the network in a distributed manner, hence timestamped distributed ledger technology (Back et al., 2014).

Distributed Ledger Technology (DLT) is the technology enabling all participants in a decentralised distributed network to share a (i) constantly expanding, (ii) impossible to reverse and/ or change, (iii) chronologically ordered, list of cryptographically signed transactional records (Bashir, 2017). Connected peers in a network can execute a value-exchange transaction between them directly and will be verified consensually with the use of algorithms over the network. A transactional event can be traced back to, at any point in time, by any participant in the network having the right access rights (Ganne, 2018). This will be further discussed in the following chapters. This means that if the transactional event is traced back to, so is/are the actor or actor(s) within the network, who was/were involved in that transactional event at that point in time.

DLTs address the problem of digital information being copied using the internet, also known as the “double spending” problem, by shifting the responsibility of the validation of the actual transfer of the asset to the whole network with the help of precisely designed algorithms (Ganne, 2018). Since all actors within a network have a transactions record copy, and any change of

ownership of the digital assets in the system requires validation from its users, the need for a centralised database will no longer exist.

Although blockchain refers to a specific technology stack, lately it is seen more and more as the shorthand for a wide collection of distributed ledger products (Gartner, 2018). Even though the concepts of blockchain and distributed ledger technologies are sometimes used in an exchangeable manner, at the end of the day they are not the same. The difference between them is clear.

The fact that distributed ledger blockchain technology is storing information and transaction details in consecutively connected blocks within a distributed decentralised network does not automatically mean that the case is the same for other distributed ledger technologies, and that is what makes blockchain so secure and unique. Although there is no clear consensus on one definition regarding distributed ledger technologies and blockchains, the authors of the European Commission's Science for Policy Report, Blockchain for Digital Government, defined them as (p. 8-9):

"**Distributed ledger technology refers to the protocols and supporting infrastructure that allow computers in different locations to propose and validate transactions and update records in a synchronised way across a network**."

"**Blockchain is a type of distributed ledger in which value exchange transactions (…) are sequentially grouped into blocks. Each block is chained to the previous block and immutably recorded across a peer-to-peer network, using cryptographic trust and assurance mechanisms. Depending on the implementation, transactions can include programmable behaviour.**"

Blockchain is a distributed ledger which is entirely open to anyone and has a really interesting attribute. If data (general information or specific transaction information) get recorded in the blockchain, it is really difficult, if not impossible, to change them afterwards. Every single block apart from the data that it contains, carries some specific information as well which are the hash of the block and the hash of the previous block. The data stored in a blockchain depends on the type of blockchain, for which more things will be explained in 2.1.4. A hash can be seen as a digital fingerprint, a digital ID number or a barcode, that is always unique and different for every block (Laurence, 2017). Therefore, the hash can identify a block and all of its contents, as well as the previous block that the former is linked to and the blocks after that if new ones have been created. It

is, in a sense, effectively creating a chain of blocks. There is an example with 3 blocks, green, pink and yellow, following below.

2.1.1 Blockchain hash

When a block is created, the hash of that block is also calculated. If somebody changes something within the block or tempers with the information that the block contains, then the hash of the block would also be changed (Haber and Stornetta, 1991). However, if the hash changes, then the block is no longer the same. Therefore, hashes are extremely useful in the detection of changes and/ or alterations to blocks. This technique of block creation, identification and linkage or connection to one another is what makes blockchain so secure. Following there are three blocks linked to each other forming a blockchain. The three blocks are represented by a different colour.

The green block is the first block which cannot point back to any other block because it is the first one. Therefore, it is called the Genesis block. Following the second block is the pink one and the third one is the yellow. Each of these blocks contains its own hash as well as the hash of the previous block (previous hash). So block #3 points and/or is connected to block #2 and similarly block #2 to block#1.

Figure 1: Original Blocks

In case somebody has or had the ability to temper with one block e.g. block #2, then that would cause a change in the hash of the block as well. Consequently, block #3 and all following

Figure 2: Original blocks with attempted change

blocks (if any) would become invalid as they no longer store a valid previous (block) hash. So changing one of the blocks would make all following blocks of the chain invalid.

2.1.2 Consensus Mechanisms in Blockchain

In order to prevent actions such as changing or tempering with the blocks and/or information within them, blockchain has some consensus mechanisms in place. The most famous one is called "Proof-of-Work" or PoW and is used in the case of bitcoin blockchains (Nakamoto, 2008). This consensus mechanism slows down the creation of new blocks and therefore, makes it extremely difficult for somebody to temper with a block. That is because if somebody tempers with one of them, then they would have to recalculate the PoW for all the following blocks as well.

By being distributed, blockchains secure themselves. Instead of using a central entity to manage and have control over the network, blockchains use a peer-to-peer network in which anyone is allowed to join. Any person who joins the network, is also called a node, and gets a full copy of the blockchain which he/she can use to verify whether or not everything is still in order (Nakamoto, 2008). If somebody creates a new block, that new block would be sent to all other nodes on the network. First off, all the nodes have to verify that the block has not been tempered with and then, if everything is correct, all the nodes add the block to their own blockchain.

In this way, consensus is created by and amongst the nodes of the network since they were the ones who confirmed which blocks are valid and invalid. The blocks that have been tempered with will be spotted by nodes on the network. Consequently these blocks will be rejected and

therefore invalid. In a nutshell, only if somebody tempered with all the blocks of a chain, re-do the PoW of all the blocks on that chain and get control over 51% of the P2P network (51% attack), would they have successfully tempered with the blockchain and would the tempered block be accepted by everyone else and therefore added on the blockchain.

A consensus mechanism is, in other words, the governance rules and protocols of distributed networks. In these networks, the consensus mechanism enables the execution, recording and completion of transactions under certain conditions. In that sense, a consensus can be built upon a previous transaction and a previous one and a previous one and so on, forming in that way a sequence of transactions, just like a ledger. In order to understand how a consensus mechanism works and whether the system is trustworthy or not, I will explain how someone using specific network chains can be fooled by using the system. For example, there is a network with 6 individuals in it (A,B,C,D,E, and F). A wants to trick B so that it appears that A has paid B 200euros (in cryptocurrencies). A wants to avoid sharing that specific block with the rest of the network being C,D,E, and F so that they still believe that A still has the 200 euros.

If the pink block in Figure 3 represents node A and the blue block node B, the four black and yellow boxes represent C,D,E and F. The blue and yellow boxes are the ones that have been shared in between A,B,C,D,E, and F and are confirmed by and known to all. In order for A to pull off its trick, A would have to find a valid proof of work before all the others in the network working on their own added blocks and add blocks to the chain with B which could create the following:

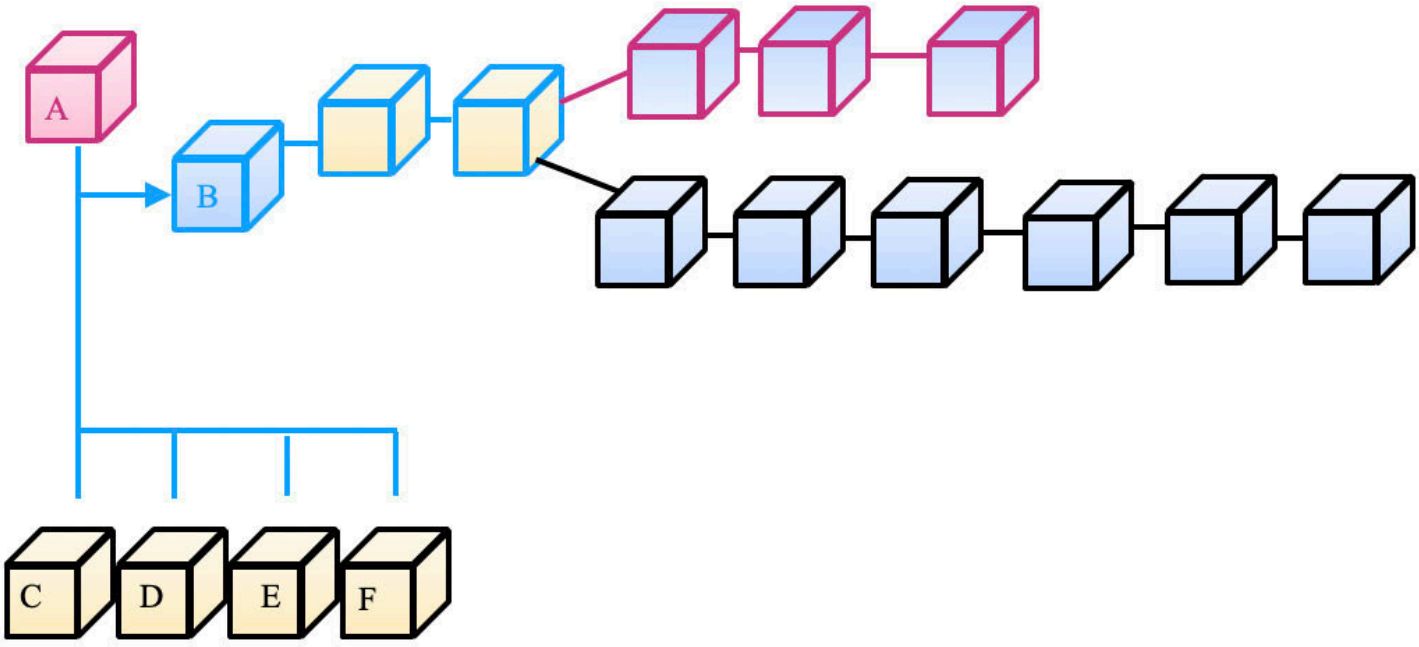

Figure 3: Attempt to deceive someone on a network

Even if A was able to achieve this, this would create a new chain of blocks (the pink and blue) while at the same time B would continue to get blocks that have been broadcasted and shared from C,D,E and F creating another chain (the black and blue). Therefore, while B may continue receiving blocks from A those blocks will be different than the ones he will be receiving from the other chain which he is aware of.

In addition, as mentioned, A would have to re-do the PoW of all the blocks on that chain, which is a lot of work and a difficult process and/ or get control over 51% of the P2P network (51% attack), which is unlikely to happen.Therefore, the blue-black chain will continue on growing faster than the single fraudulent blockchain that A is sharing with B. So after certain time, B will reject the blocks received from A since they will be different than the ones received from the other longer chain which is the one B is familiar with and trusts the network and the consensus mechanisms in-between the multiple nodes (A,B,C,D,E, and F) there.

2.1.3 Electronic (digital) signatures

The problem that existed until the publication of Nakamoto's White Paper in 2008 was that a user could not confirm if the person who made the transaction and actually sent him the value had not sent it elsewhere - double spending. Therefore, it was necessary to have a third party which would control the transactions and which the financial system and all actors within it would trust and depend on. When the first public blockchain was created (Bitcoin), anyone could make a transaction. Therefore, a method to protect privacy had to be found and established on the network.

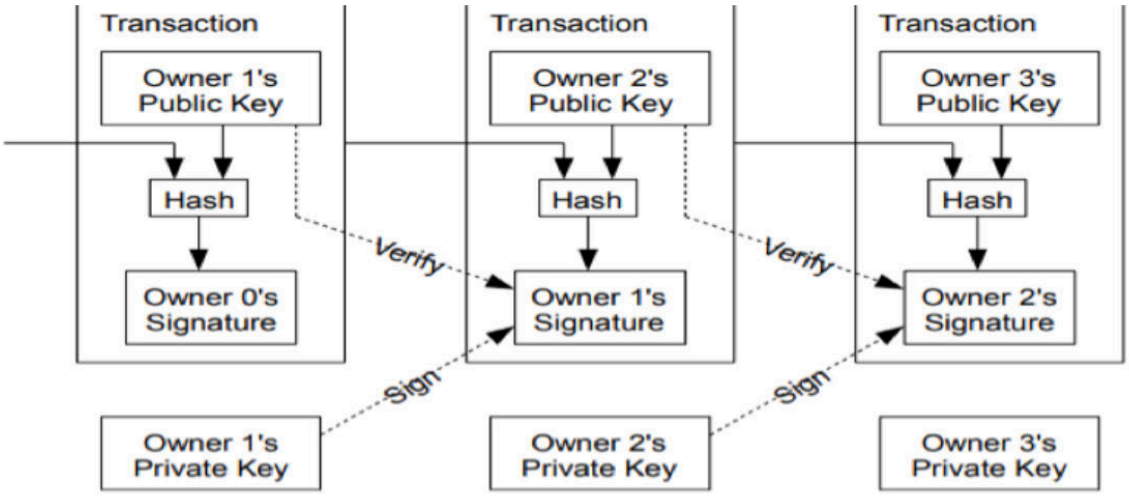

Figure 4: Digital Signatures

The solution to this was digital signatures, with asymmetric cryptographic technology which validated and controlled transactions.

The process of providing digital signatures is divided into two phases: signing and confirmation. Each user is a holder of a pair of keys, a private and a public one. The private one is created when someone initiates a transaction.

As shown in the Figure 4, when and if a transaction is combined with a private key, a signature is created. Essentially, the user holding the private key which he/she only knows, signs the transaction.

Then, the transaction is shared over the network. Access to it by the recipient can be achieved by using the sender's public key. In the blockchains algorithm there is a verification function (*Verification Function*), in which the recipient enters the sender's public key and the transaction data and confirms or rejects that the former is also the private holder. So, the public key confirms the validity of the transaction to other users and through the whole process the transaction is achieved through the contracting parties (Nakamoto, 2008).

2.1.4 Types of blockchain

According to the literature and research regarding blockchain technology, there are multiple types of blockchains with different but sometimes partly overlapping characteristics (Bashir, 2017; Laurence, 2017; Ganne, 2018). These are the Public, Private and Semi-Private.

Public blockchains are ledgers that no-one owns and permission is not required to enter the network, therefore also called permission-less. This means that they are open to the public and anyone who wants can join as a node and participate in the decision-making process. All nodes participating in the permission-less ledger have a copy of the transactions and employ distributed consensus mechanisms in order to reach a decision regarding the current or eventual state of the ledger. This type of blockchain is good for transparent applications since the blockchain secures the system from the trust-less network.

Private blockchains are not open to anyone who wants to join but rather only to a consortium or specific group of people or group of organisations which have decided to share the ledger amongst them. Private blockchains are permissioned and introduce the feature of access-control which provides specific access levels to the participants of the network. In other words, permissioned blockchains have an administrator assigning roles and access-levels to the

participants. This ensures that participants are not included in the validation nor block-creation process and therefore eliminate the possibility of (cyber) attacks towards the blockchain.

One major difference between the public and private blockchain is that in the public blockchain, all nodes are equally important and have the same rights, while in the private blockchain that is not the case as some participants will have limited capabilities in comparison to another participant in the same network (Bashir, 2017).

Furthermore, there is the combination of a public and private blockchain, which makes a hybrid type of blockchain called semi-private blockchain **o**r consortium blockchain (Bashir, 2017). Part of it is public and is open to anyone who wants to participate. The other part of it is private, controlled by a specific group of people or group of organisations. Even though this type of blockchain is permissioned, it is more decentralised than a private one.

A permissioned ledger is a blockchain of which the participants of the network are known and have already trust each other (Bashir, 2017). Since trust is already established between the participants of the network, distributed consensus mechanisms are not needed in this type of ledger. Alternatively, in order to maintain a common version of truth in regard to the state of the records registered in the blockchain, an agreement protocol can be used. Moreover, a permissioned blockchain is not required to be private as it can be a public one with regulated access control.

The fully private and proprietary blockchains deviate from the core idea of decentralisation. Despite this, in specific private settings within an organisation, such as various government departments or different government organisations, data sharing might be required and a level of guarantee regarding the authenticity of those data may have to be provided. Under these circumstances, fully private and proprietary blockchains can be useful.

2.1.5 Types of Systems/Networks

In the past, Information and communication technology (ICT) has traditionally been based on a centralised paradigm. In the centralised network a central authority has full control over the existing database and/or application servers. Currently, with the help of technology anyone is allowed to establish a decentralised system and run it without the risk of single point of failure or one single trusted authority in-between (Bashir, 2017). The system can be run either autonomously or with some human intervention. Whether any human intervention is required or not depends on the type and model of governance that the decentralised application running on the blockchain is or would be using.

Generally, there are the three existing types of systems. These are centralised, the distributed, and the decentralised and were first introduced by Paul Baran, in the context of communication networks, in 1962. The following picture which represents the different systems was initially published in his paper about distributed communication networks.

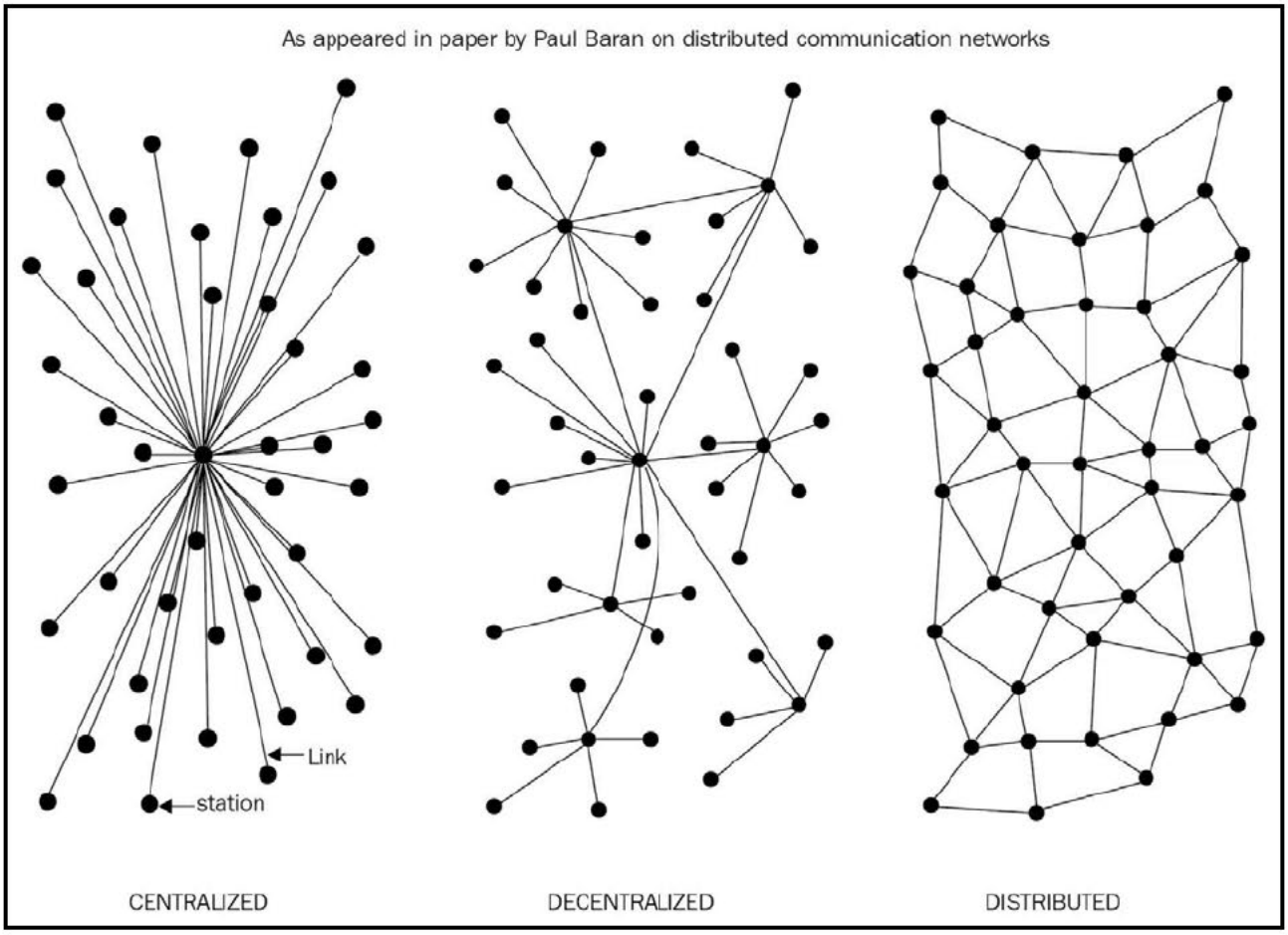

Figure 5: Types of networks (Paul Baran)

Centralized systems are conventional (client-server) IT systems in which a single authority is controlling and being in-charge of all operations on the system (Baran, 1962). In centralised systems, every user is dependent on one single source of service, the central authority. All users are connected to a central network/ server/ entity that stores and controls all the data. Such systems are easy to be established but are particularly vulnerable, as if the core network is damaged, all data is lost.

Distributed systems are ones that keep and computation spread across the network to multiple users with equal access to it and no central authority (Baran, 1962). In the case of blockchain, the nodes that participate in the chain, create a network, are connected and equal to each other, share the same information, perform the same tasks and communication is achieved

without the help of a central node. This process may be more complicated than the traditional one but it is safer as if a node is lost, the system continues to operate. The more nodes, the more secure the network. The fact that the chain is shared with users, distinguishes it from the classic databases, because there is no need for a third party to validate transactions (e.g. a bank).

While in a distributed system a central authority governing the whole system still exists, in the *decentralised* system, it does not. That is the type of network in which everyone is equally important and not dependent in one central authority as the control is distributed among the peer-to-peer network. Decentralised systems are not invulnerable to attacks but are rather safe in comparison to centralised ones. Although distributed systems have a clearly better performance and flexibility, they also have higher costs.

The degree of decentralisation of a network depends on specific requirements and circumstances and varies from semi- to fully- decentralised. From a blockchain perspective, decentralisation can be seen as a mechanism which enables the retrofitting of existing applications and paradigms and/or the creation of new applications for the purpose of giving full control to the users.

Decentralisation has been used in strategy, management, and governance and the basic idea behind it is to distribute control and authority of the organisation over the network to peers instead of one central authority being in full control (Bashir, 2017). That can lead to increased efficiency, reduced burden and involvement of top management, better motivation and faster, more transparent decision making.

2.1.6 Smart contracts: a feature of blockchain

The term smart contract was first used by Nick Szabo, a computer scientist, law scholar and cryptographer, in 1997. Szabo wanted to use a distributed ledger in order to store contracts. However, back then, the technology to support this idea was not available. Many years later, Vitalik Buterin, realised the importance of blockchain beyond financial transactions and created the Ethereum blockchain, which uses smart contracts. Today, smart contracts are just like real-hard copy contracts except from the fact that they are completely digital. The terms and clauses of the contract are represented as thecae of the program, the main spinal cord in other words. In more technical terms, a smart contract is actually a computer program stored inside a Blockchain.

A popular example is the following. If there is a large fundraising or crowdfunding platform, like Kickstart, GoFundMe and other similar corporations, which gives the ability to product teams

to log on the platform, create a project and set a funding goal and start collecting the money from others who believe in and support the idea of the project. In this way, Kickstarter is the third party or the intermediary in-between the two parties, product teams and supporters. Therefore, both the product teams and the supporters have to trust the platform to handle their money correctly. If the funding goal of a project is reached, and therefore is funded successfully, on the one hand the project team of the project expect to receive the money for the project from Kickstarter and on the other hand the supporters (investors, philanthropists, individuals, and so on) expect the money to be sent to the project if it was successfully funded or to receive a refund in case it was unsuccessful. In a similar public procurement environment, one or more departments of a government, vendors and suppliers and other parties might be involved. Public procurement will require financial transactions to occur amongst the government departments procuring the goods and services and the vendors and suppliers providing those goods and services. These vendors and suppliers usually have banks and other financial institutions involved in their financial transactions which they have to trust for the execution of all transactions. Therefore, all parties involved have to trust each other in regard to the money and/or value being transacted.

In the above-mentioned example, both parties have to trust Kickstarter, as a third party, to make a successful transaction between them. This can be avoided with the use of smart contracts; a similar system that does not require Kickstarter, and therefore other third parties to be part of the equation, can be built.

So, if a smart contract was created for this purpose, it could be programmed to hold all the received funds from the supporters until the goal that has been set is reached. Following, the supporters of the project would be able to transfer their money to the smart contract. The smart contracts would have two outcomes based on the funds raised for the project. The one outcome would be that the smart contract automatically transfers money to the project team of the project fund raiser if the goal that has been set has been reached. The other outcome would be that the smart contract automatically transfers money back to the supporters who placed them in the smart contract in the first place, in case the project does not meet its goals.

In addition, since everything is stored on the internet, all procedures are executed instantly, 24 hours a day, 7 days per week. Therefore, many of the processes are simplified and automated (e.g. with smart contracts). The research of Ream, Chu and Schatsky (2016) looked into two smart contract use cases, one for securities trade clearing and settlement and the other one for supply chain and trade finance document handling.

Their research revealed that blockchain based smart contracts could offer multiple benefits to a variety of potential applications. The first one is speed and real life updates due to the fact that smart contracts entail encoded software in order to automate tasks/transactions that would typically be carried out manually by people. The aforementioned transactions, if automated are also less prone to manual errors, so consequently, the second benefit is accuracy. The third benefit is lower execution risk due to the decentralised process of execution that a smart contract would have. The virtual execution of the contract eliminates any risk of manipulation or tempering, non-performance and errors because the execution of the contract is run automatically by the whole network and not only one central authority. The fourth benefit is that due to the fact that a smart contract is based on a blockchain and the blockchain achieves disintermediation, smart contracts, in consequence, eliminate the need for trusted intermediaries and other third parties. Accordingly, the fifth benefit is lower overall cost, since less intermediaries would be needed and the expenses in relation to intermediaries and third parties would also be lessened.

2.2 E-Government

Madison (1822, n.d.) pointed out that knowledge is power and those who possess knowledge have the power to rule. Various definitions of e-government can be found. West (2005, p. 1), for example, defines e-government as "the public sector use of the internet and other digital devices to deliver information and democracy itself". The OECD also defines e-government, namely as "t*he use of information and communications technologies (ICTs), and particularly the Internet, to achieve better government*" (OECD, 2003, p. 11). In addition, it is defined by the World Bank as "*government-owned or operated systems of information and communications technologies (ICTs) that transform relations with citizens, the private sector and/or other government agencies so as to promote citizen empowerment, improve service delivery, strengthen accountability, increase transparency, or improve government efficiency*" (Panzardi et al., 2002, p. 2).

Therefore, for this thesis, e-government will be referred to as the use of ICT by governmental bodies and agencies in order to transform relations with citizens, businesses, government organisations and other non-state actors in a number of ways so as to increase transparency and public accountability which are critical tools for good public procurement processes and for the prevention of bad governance practices such as corrupted or fraudulent acts (Basel Institute on Governance, 2017).

It is worth mentioning that e-government can take many forms. There are some established types or categories of e-government based on who the government interacts with. These are Government-to-Business (G2B), Government-to-Government (G2G), Government-to-Citizen (G2C) and Government-to-Employee (G2E) and there is a brief description for each of the following:

- G2B focuses on cost- and time-reduction, information gathering and storing efficiency and effectiveness between government and businesses;
- G2G focuses on the efficiency of information delivery amongst governments or departments thereof;
- G2C focuses on the communication channels and communication abilities between the government and its citizens (Evans and Yen, 2006); and
- G2E includes everything between a government itself or government units/ departments/agencies/etc. and their employees.

Following, further details are given regarding the two types of e-government, G2B and G2G, that are directly linked with public procurement and public procurement processes.

2.2.1 Government to Business (G2B)

Government to Business (G2B) pays exclusive attention to the cost reduction and gathering and storing information, abilities which enables the governments to buy products, make payments and perform business in a more effective way regarding both time and cost (Evans and Yen, 2006). Moreover, this opportunity can help governments obtain information and data needed to be analysed in order to optimise the decision making processes and other procedures. Electronic applications to provide such government services are amongst others *E-procurement, E-sourcing and E-Invoicing* (Basel Institute on Governance, 2017).

An *Electronic Procurement (E-procurement)* tool can substitute all stages of procurement or purchasing between the public and the private sector, ranging from the first steps of purchasing requests up to their payment and completion (Basel Institute on Governance, 2017). Furthermore, it could enable money transactions and information exchange to be made online.

E-procurement, E-Sourcing can be used as a platform where suppliers make bids online for specific projects or purposes via a single portal. These bids could then be obtained by the government to choose the best supplier. Such a tool can offer governments the advantages of monitoring the process, increasing the competition between suppliers and therefore reducing the costs of prices and services and last but not least gaining insight in sourcing information (Basel Institute on Governance, 2017).

Moreover, an additional tool could be a platform for *Electronic Invoicing* which can enable the electronic movement of invoicing data between partners, suppliers and buyers (Basel Institute on Governance, 2017). Regardless of whether governments are the buyer or the supplier, they will have the ability to check if there are gaps in the public money spending and purchasing. In this way, government will have an effective financial supply chain and a monitored payment system.

2.2.2 Government to Government (G2G)

Government to Government (G2G) focuses on the improvement of the delivery efficiency of information that are being transacted with other governments or within the government itself (Evans and Yen, 2006). In other words, it has to do with the internal efficiency and effectiveness of governments. If procedure steps are reduced within government operations and redundancy and duplication issues are eradicated, governments will be able to communicate more effectively and economically. Duplication issues regard people working on the same issue, project, process and/ or

policy without being aware of the other(s) as well as duplication of information or documents in the communication chain and governmental units and/ or locations.

Furthermore, if information is made available via the same communication stream or online server to multiple governmental bodies, at real time, it makes it easier for information to be cross-checked and thus increases its reliability while benefiting national security streams and crime detection and enhancing efficiency and transparency. This can be made feasible with a similar platform to *E-Communication Platform* which would be available only to public or government officials within governmental agencies or public institutions, in order to communicate and exchange information in an efficient manner. In this way, coordination and cooperation of governmental operations can be promoted amongst state institutions. Likewise, the interchange of automated data will be more accepted and institutions can integrate to an electronically unified government.

2.3 Public Procurement

Public procurement is one of the most vital economic activities of governments (Brammer and Walker, 2012). Generally, public procurement represents on average 13% to 20% of GDP (The World Bank, n.d). Specifically, the volume of public procurement, including both the purchase of goods and services, was estimated to be worth €2 trillion or 13,3% of GDP, in 2017 only for the European Union (European Commission, n.d.) while the global expenditure in procurement was estimated at nearly 9.5 trillion US dollars in 2020 (World Bank, 2020). It is worth mentioning that while governments have a strong incentive to spend public money right according to the United Nations Office on Drugs and Crime, it is possible that 10 to 25 percent of a public contract's overall value are lost due to corruption (The World Bank, n.d.).

According to the European Commission, "public procurement refers to the process by which public authorities, such as government departments or local authorities, purchase work, goods or services from companies" (European Commission, n.d.). Furthermore, the OECD states that "as public procurement accounts for a substantial portion of the taxpayers' money, governments are expected to carry it out efficiently and with high standards of conduct in order to ensure high quality of service delivery and safeguard the public interest" (OECD, n.d.).

Public procurement refers to the acquisition of goods and services offered to governments by the suppliers via a public contract (Kiiver and Kodym, 2014) and it can include services such as education, healthcare, leisure and other social services (Walker and Preuss, 2008). At a high level, procurement is the process by which a government agency publishes a tender for a Purchase Order (PO) of goods or services, in order to function and maximise public welfare, and interested suppliers submit their bids/offers prior to a certain time deadline (McMahon, 2016). Then the offers that have been submitted by prospect suppliers (vendors) are received, examined and categorised based on the award criteria set by the government agency in the initial stages of the procurement cycle. Then the winning offer is announced and all relevant parties are informed of the outcome.

The tender phase of public procurement is one the most important phases and plays a central role within public procurement processes as it links the government specifications for procurement with potential vendors and suppliers (Kiiver and Kodym, 2014). In addition, communication between government employees involved within the procurement processes and potential suppliers is not permitted prior to the publication of the tender in order to make sure that competition between suppliers will be healthy (Kiiver and Kodym, 2014).

This is why internal controls and other relevant measures should be in place in regard to the effectiveness of the public procurement systems at all levels of government. In addition, these should be periodically and consistently evaluated and assessed with respect to the results of the procurement process. According to the OECD (2015, p.11) "Public procurement systems should collect consistent, up-to-date and reliable information and use data on prior procurements, particularly regarding price and overall costs, in structuring new needs assessments, as they provide a valuable source of insight and could guide future procurement decisions."

2.3.1 The typical process of public procurement

The traditional public procurement procedure is a multi-stage and multi-step process (Ferwerda and Deleanu, 2013). In a nutshell it consists of 3 stages: the pre-bidding phase, the bidding phase and the contract management and evaluation phase. In more analytical terms the full procure-to-pay cycle or procurement lifecycle consists of more stages.

The first stage of procurement is a spend analysis. Governments gather data related to spending from the accounts payable, conduct a spending analysis and determine whether they are compliant with their rules or not. In addition, governments assess and identify the existing needs and define the contract specifications.

The second stage is the strategic sourcing part in which the bidding phase also takes place. Throughout this stage, governments identify potential sourcing projects and suppliers. In order to select one, governments can prepare solicitation documents and request requests for proposals [RFPs], requests for information [RFIs] and requests for quotations [RFQs] from potential suppliers in order to evaluate their responses and received offers and send those to the Advisory Committee on Procurement Approval. Then, there is usually a standstill period in order to handle any complaints or other remarks before awarding the contract.

The third stage of the public procurement process (incl. post-bidding phase) is the contracts management stage in which governments negotiate the contract before its execution, manage the contract and relevant catalogs and evaluate the procurement. The contract management and evaluation include setting specific criteria, deliverables and actions to be followed-up and KPI's [Key Performance Indicators] in order to have a threshold to judge upon.

Following the award, execution and management of the contract the supplier will have to be paid by the government in regard to the goods and/ or services provided. Thus the stage following the contracts management stage is the requisition stage. The fifth stage of the procurement lifecycle

is the Purchasing or Procurement stage where Purchase Orders are created, the goods and/ or services are received and the performance of the suppler can be evaluated.

After and as a result of all the previous stages, the last stage of the procurement lifecycle, the payment of the supplier can take place. Of course for the payment to be executed the selected supplier or vendor has to send invoices to the government body and these invoices have to be reconciled by responsible personnel and if everything is in order then the payment can be executed (usually by the Accounts Payable dpt.).

In regard to all stages mentioned above, the people involved in the procurement and related administration thereof have to adhere to government policies, good code of conduct and follow specific hierarchical workflows along the process. In addition, these workflows and authorisations matrixes have to be followed in order to secure the procurement process and everything has to be documented, recorded and saved. The following picture shows all the stages of the procurement lifecycle.

Figure 6: Procurement Lifecycle (SupplyChainGameChanger)

E-procurement is shortly defined by the OECD as "the integration of digital technologies in the replacement or redesign of paper-based procedures throughout the procurement process"

(OECD, 2015, p. 6) while a more analytical E-Government Procurement (e-GP) definition has been given by Shakya (2015) according to whom e-government procurement is:

> "the collaborative use of information and communications technologies by government agencies, the bidding community, regulatory and oversight agencies, other supporting service providers, and civil society in conducting ethical procurement activities in the government procurement process cycle for the procurement of goods, works, and services and the management of contracts, thereby ensuring good governance and value for money in public procurement and contributing to the socioeconomic development of country" (Shakya 2015, 141).

Blockchain can transform the typical procurement procedure in both running the tender process and managing the awarded contract (Ream et al., 2016). The process can be automated based on pre-defined bid-analysis and selection criteria and set deadlines. In order to run the tender process on a blockchain, all interested suppliers would enter their bids into the blockchain which means that the entered offers would be hashed as well. By using blockchain technology the identity of bidders and suppliers can be proven or confirmed prior to accepting bids. Once the deadline of accepting bids is reached, no more suppliers would be able to enter bids onto the blockchain. Then the submitted bids would be evaluated by the smart contracts according to the encoded requirements and criteria that would have been set at the creation of the contract. Based on that a winning bid would be identified by the smart contract according to criteria and requirements that have already been set during the creation of the smart contract. Therefore, no public officials could choose their preferred supplier and no conflict of interests could occur.

Furthermore, by publishing a tender on a blockchain, the fact that all participants and potential bidders/suppliers have the same information and the fact that this procurement or tendering information cannot easily be altered due to the characteristics of the technology are assured. In addition, since all bids would have been entered in blocks and are hashed, everyone on the blockchain network could view and examine the block and the bids within it. This means that all authorised nodes and signers of the contract could examine the data and documents submitted during the bidding phase of the procurement process and ensure transparency and correctness.

In order to manage the awarded contract on a blockchain, the work or service provided would be verified by authorised signers. In case the purchase order concerned goods to be received, then it could additionally be automatically logged using blockchain based logistics. Once all the

conditions of the contract had been met and the smart contract had been successfully “completed”, the payment (transaction) could automatically take place, transferring the money from the public organisation to the chosen supplier who carried out the smart contract.

2.3.2 Operationalisation of good governance in public procurement

Public value theory has been a focus point within public administration research as there is a lack of clarity regarding the correct manner to measure the extent to which organisations are generating public value. Faulkner and Kaufman conducted a literature review, in 2018, on public value measurement in order to identify and evaluate the available measures. A number of public value dimensions were identified during the study including but not limited to:

- public satisfaction;
- economic value - generating economic activity/ employment;
- service delivery (including take-up, satisfaction, information, choice, importance, fairness, cost);
- outcome achievements;
- efficiency for the organisation and efficiency for users;
- democracy and political values such as openness transparency and participation;
- financial performance - revenues, expenditure value for money, efficiency;
- non-financial performance - efficiency, customer satisfaction, service quality, social value from the user perspective, tangible economic value from administration perspective, intangible economic value from the administration perspective;
- accountability;
- trust and legitimacy as well as trust in public institutions; and
- protecting citizen’s rights.

As mentioned in 2.3, "public procurement accounts for a substantial portion of the taxpayers’ money” and according to the OECD (n.d.) "Governments are expected to carry it out efficiently and with high standards of conduct in order to ensure high quality of service delivery and safeguard the public interest”. According to the Council of Europe there are several principles in regard to good governance or in other words “the responsible conduct of public affairs and management of public resources” (Council of Europe, n.d.). Furthermore, the OECD has published a recommendation of the council on public procurement in which the OECD recognises that the

enhancement of good governance and integrity within public procurement adds value to the efficient management of public resources and consequently taxpayers' money (OECD, 2015).

Nonetheless, good governance is difficult to measure and particularly in regard to a technology and public procurement. That is because the potential benefits of blockchain technology are plenty, however, as with all technologies, and especially the new or emerging ones, there are some challenges or weaknesses in blockchain that need to be addressed. Blockchain is still an immature technology that has not been extensively tested in the public sector. More and more, governments are taking initiative and launching projects based on blockchain technology but many things have yet to be seen and many obstacles yet to be faced. In addition, the original "free" idea of blockchain is not always legally implemented. Once the central authority is abolished and everyone can interact with it, (negative) side effects can occur.

In this thesis the operationalisation of good governance will be assisted by the combination of the above information, principles and recommendations in order to make use of five different (pairs) of public values described in the table following below (Table 1) and linked amongst good governance, blockchain and public procurement. These are:

- Accountability;
- Efficiency and Effectiveness;
- Innovation and Openness to change;
- Integrity and Honesty; and
- Transparency and Trust.

Accountability

In terms of good governance it is expected that all public officials participating in decision-making processes should take responsibility for their decisions and their outcomes. In addition, sanctions and effective remedies should be in place in case of maladministration. Accordingly, within public procurement oversight and control measures should be applied throughout all phases of the procurement cycle in order to increase accountability. Furthermore, all internal and external controls and audits should be sufficiently integrated, coordinated and resourced. For this purpose, clear lines regarding monitoring and oversight of all public procurement phases and activities should be set.

In respect to monitoring and evaluation along the whole public procurement cycle, tender phase, and upon completion of the contract, evaluation assessments and audits can be easily

conducted as due to the nature of blockchain technology the audit trails will be clear, accessible and traceable. Moreover, the communication of decisions would also be logged on the blockchain, therefore responsible public officials and/or relevant suppliers and other stakeholders can be held accountable and would be easy to spot. Since blockchain is a distributed ledger technology and information is stored in blocks in the network, it makes it easy to trace back to transactions and make them fully disclosed even in complicated ecosystems (traceability).

Furthermore, blockchain offers immutability and once data has been recorded on a blockchain, it is almost impossible to be changed. Additionally, the new data entries are recorded and linked with the previous ones and their data (append-only way of recording). In this way, any transaction throughout the network can be traced and the responsible people can be held accountable. Unfortunately, due to the immutable nature of these technologies, problems can arise. In case a change needs to be made or any errors have to be corrected, this would actually be impossible.

Efficiency and Effectiveness

In regard to good governance in terms of efficiency and effectiveness, the available resources should be used in the best way possible and the results should meet the set or agreed objectives and goals [e.g. goals that were set from the government in regard to public procurement, contracts and suppliers]. In addition, performance management systems should enable the evaluation and enhancement of the efficiency and effectiveness of government services. Audits should be conducted on a regular basis in order to assess and improve, if and when needed, the performance and available procedures. Therefore, public procurement cycle should be efficient and satisfy both the needs of government and the general public. In order to do so, governments should develop and use tools for the improvement of procurement procedures and reduction of duplication issues. Consequently, greater value for money would be achieved.

Blockchain technology would make it possible for agreements and deals to be made faster and cheaper because of two reasons. The first is the fact that blockchain does not require a time-consuming verification, reconciliation and clearance process. The second is that a shared ledger which contains a single version of specific agreed upon data can exist between specific entities [e.g. government(s) or multiple departments of a government and/or multiple suppliers. Since central authorities and other third intermediary parties [e.g. banks and/or other financial institutions] are not needed for a transaction to take place, costs related to third parties and intermediaries of the

transaction are eliminated. Last but not least, a blockchain public procurement process can increase efficiency in public organisations because of the self-executing nature of smart contracts as long as the input information/requirements in them is correct.

Innovation and Openness to Change

In respect to good governance in regard to innovation and openness to change, governments and public officials should be open to new and efficient solutions for existing and/or upcoming problems as well as for the improvement of current processes and procedures. Governments and public officials should be willing to work with a technology such as blockchain to conduct their procurement activities and adopt an ecosystem approach and a new way of working within a network.

Blockchain's technology combination of append-only recording, distributed ledger and consensus mechanism can possibly cause disintermediation which eliminates any intermediaries or middle-men from the transaction and/ or nullifies any intermediary/middle-man related transaction cost. Although this mostly affects public blockchains, one of the most important challenges that has to be faced in regard to blockchain technology is its lack of technical scalability, especially when the transactions increase more and more. Some solutions for the problem of the scalability have been proposed and most of them revolve around protocol-level enhancements such as storage optimisation and/or re-design of the bock (Zheng et al., 2018; Eyal et al.,2016; Bruce, 2014).

In addition, decentralisation can be seen as a challenge due to its incompatibility with the existing institutional structures and architectures of governments (Bashir, 2017). It is alleged that for the implementation of blockchain technology to be impactful and fully harness its potential in the public sector, governments shall reconsider and maybe even re-design their processes and government structures in order to fully adapt to blockchain technology.

Integrity and Honesty

In terms of good governance for integrity and honesty, governments and local authorities should comply with the law, judicial decisions as well as relevant rules and regulations adopted along the course of time (Rule of law). In addition, the public good should be prioritised against individual interests. Accordingly, effective measures to prevent and tackle all forms of corruption should be in

place and conflicts of interests should be declared in a timely manner in order for the people involved to be excluded from any relevant decision-making process.

Integrity in regard to public procurement refers to “the use of funds, resources, assets and authority, according to the intended official purposes and in a manner that is well informed, aligned with the public interest, and aligned with broader principles of good governance” (OECD, 2015, p. 6). Therefore, the integrity of the public procurement system and cycle, and the honesty of the people involved within procurement activities, should be preserved and ensured by standards and guidelines. Additionally, internal controls and compliance measures should be in place and adequate monitoring should be conducted. Anti-corruption measures should be implemented such as “no corruption” warranties in regard to the stakeholders, providing assurance that potential suppliers have not and will not attempt or engage in any corruption regarding the contract.

Blockchain technology with the use of cryptography provides high security and integrity in transactions. As already mentioned since blockchain is a distributed ledger technology and information is stored in blocks in the network, it makes it easy to trace back to transactions and make them fully disclosed even in complicated ecosystems (traceability). Furthermore, blockchain offers immutability and once data has been recorded on a blockchain and/or with a smart contract, it is almost impossible to be changed. Additionally, the new data entries are recorded and linked with the previous ones and their data (append-only way of recording). In this way, the data integrity on the distributed ledger is highly secured.

Unfortunately, on a theoretical level there are doubts about the recognition of smart contracts as legal contracts with independently binding content. Cryptocurrencies, which are mainly used for value transactions on blockchains, are not recognised as legal tender by governments. Although they are accepted as money in some countries, they are still far from being widely accepted as a normal currency. Last but not least, copyright issues for public blockchains arise as they store sensitive data and transactions.

Transparency and Trust

Good governance in terms of transparency and trust means that governments should establish decision-making process according to rules and regulations and enforce the decisions taken accordingly. Furthermore, Financial management, estimation of resources, revenues and reserves as well as the use of exceptional revenue should be carried out with prudence and consideration. Budget plans should be prepared taking into consideration the public’s opinion. In addition

information on decisions taken and their implementation as well as the results of those should be provided and/or made available to the public in order to enable it to follow and contribute to the work of governments in an efficient and effective manner or act as an extra line security.

Good governance in terms of public procurement means that the public procurement system should be adequate, timely and transparent throughout all phases of the procurement cycle in order to promote a just and fair treatment of any potential suppliers. Moreover, the visibility of the public funds flow should be ensured from the start until the end of the procurement cycle. In particular, free access to public procurement information should be allowed via an online portal for all internal and external stakeholders as well as the public, on a domestic and a foreign level.

Since blockchains are shared within the network and anyone can see their content, this makes the whole system as transparent as it can possibly be and therefore, trust can be established. An unfortunate consequence of that is the issue of privacy. Given the P2P architecture and as long as transactions and data are publicly visible and permanently recorded, users' privacy cannot be guaranteed. Recent studies in regard to transactions (specifically made using Bitcoin) suggest that IP addresses can be linked to users' nicknames, revealing their identities. Hence an additional challenge can be lack of trust in the technology itself as blockchain is a rather complex technology if average users [e.g. public officials/government employees, supplier/vendor employees] do not have a basic understanding of it, it is rather difficult for them to trust its capabilities.

Nonetheless, blockchain technology can add value to the procurement process since less people will be involved and therefore less interactions amongst people regarding the process, this means that there will also be less opportunities for human input, errors, delays and fraud opportunities to occur. In general, blockchain technology and related applications can mitigate risks in the public procurement cycle due to the two main pillars of trust of this technology, identity and reputation, and the help of specific verification and consensus mechanisms. The second pillar of trust, reputation, is just the outcome of past transactions. Since all transactions are logged and stored on a blockchain, the logs are secure, clear and transparent, and they can be assessed by anyone on the blockchain. Therefore, it would be easier for public organisations to assess and evaluate the reputation of possible suppliers within a specific network. Last but not least, blockchain can reduce the risk of cooperating with non-trustworthy suppliers/bidders severely and increase the competition and participation in public tenders.

Table 1 Public Value - Operationalisation of Good Governance

Public value (Operationalisation of Good Governance)	Good Governance	Public Procurement	Blockchain	Challenges
Accountability	a. Public officials take responsibility over decision making and outcomes. b. Sanctions and effective remedies for maladministration.	a. Oversight and control measures over procurement. b. Internal/External controls. c. Audits. d. Clear lines reg. monitoring and oversight of overall procurement.	a. Traceability. b. Immutability. c. Append-only way of recording. d. Highly secured data integrity.	a. Immutability - due to which crucial or needed changes are really difficult if not impossible.
Efficiency and Effectiveness	a. Resources should be used in the most optimum way. b. Results equal set or agreed goals and objectives. c. Audits and performance management systems should be in place for the enhancement of government services and procedures.	a. Efficient public procurement cycle. b. Satisfying the needs of government and the general public. c. Tools for the improvement of procurement procedures and reduction of duplication issues.	a. Faster and cheaper deals and agreements. b. Elimination of third party and intermediary costs of the transaction.	a. Human error / wrong input.
Innovation and Openness to change	a. Governments and public officials should be open to new and efficient solutions to problems and the improvement of processes and procedures.	a. Public procurement process based on blockchain technology.	a. Disintermediation.	a. Scalability and Decentralisation.

Public value (Operationalisation of Good Governance)	Good Governance	Public Procurement	Blockchain	Challenges
Integrity and honesty	a. Compliance with the law, judicial decisions, rules and regulations. b. Public good prioritised against individual interests. c. Effective anti-corruption measures to prevent. d. Timely declaration of conflicts of interests to protect decision making processes.	a. Integrity of the public procurement system and cycle. b. Internal controls, compliance measures and adequate monitoring. c. Implemented anti-corruption measures.	a. Cryptography provides security and integrity in transactions.	a. Doubts about the recognition of smart contracts as legal contracts. b. Copyright issues for public blockchains due to sensitive data and transactions. c. Cryptocurrencies are not recognised as legal tender by governments.
Transparency and Trust	a. Decision-making processes and enforcement of decisions should be according to rules and regulations. b. Financial management should be carried out with prudence and consideration. c. Budget plans should take into consideration the public's opinion. d. Publicly available information.	a. Adequate, timely and transparent public procurement system and public procurement cycle. b. Visibility of the public funds flow should be ensured from the start until the end of the procurement cycle. c. Free access to public procurement information should be allowed via an online portal.	a. Maximised transparency.	a. Lack of trust in the technology itself. b. Privacy.

3. Methodology: Research Design and Data Collection

3.1 Research Type

I chose to conduct a qualitative, descriptive and partly exploratory research as there is not extensive research available on blockchain technology and its potential for procurement processes within the public sector. In this thesis I will not be discussing about minor changes, but a degree of change that indicates significant differences in regard to public sector values. In particular, special focus will be given to accountability, effectiveness and efficiency, innovation and openness to change, integrity and honesty, and transparency and trust.

Up to date, there has not been a lot of academic literature on public procurement and blockchain and there has not been a lot of public procurement projects executed with the use of blockchain technology, hence a quantitative research approach specifically for public procurement and blockchain would not be easy, if not impossible. The exploratory nature of this research will not only shed light on the potential added value(s) of blockchain technology for public procurement, since primary data will be collected, but will also raise new questions and doubts which will hopefully lead to further research within the field for both qualitative and quantitative research.

3.2 Research Design

I examined if blockchain adds value to good governance in terms of public values being met within public procurement. In particular, the public values that were in focus were (i) Accountability; (ii) Efficiency and Effectiveness; (iii) Innovation and Openness to Change; (iv) Integrity and Honesty and (v) Transparency and Trust and how they are linked amongst governance, procurement and blockchain in sub-chapter 2.3.2.

I measured this by performing interviews and asking experts their opinion and views on blockchain and public procurement. As blockchain technology is not so wide-spread, there are not a lot of people that have worked hands-on with blockchain technology, so it was challenging to find people with combined theoretical and practical experience. I believe LinkedIn is a good source to find people with "hands-on" work experience on something particular as it is a business and employment-oriented social networking service. Therefore, I conducted a key word search on LinkedIn (words used included: blockchain; procurement; public procurement; government; governance; procurement; government procurement) in order to find experts on blockchain, governance and/ or public procurement and created a sample of potential interviewees to contact. After screening their profiles on LinkedIn to check their skills and experience, the candidates with the most experience (or combination) of blockchain, governance and public procurement were selected from the sample as suitable potential interviewees. A I contacted them via LinkedIn and/or e-mail and introduced myself, my research and the reason I was reaching out to them with a request for an interview.

As forementioned the interviewees were selected based on their knowledge as mentioned above, their availability and acceptance for an interview. One of the interviewees was introduced to me from a different candidate that I initially reached out to but did not have sufficient knowledge of the subject. The three experts interviewed were Martijn Bolt, Olivier Rikken and Brendan Abbott. All three have different work experience and background experience with blockchain.

- Martijn Bolt [located in the Netherlands] [redacted]. Martijn has worked with governmental agencies, multinationals and entrepreneurs, figuring out how to make improvements in organisational terms or in governance terms using blockchain's network approach.
- Olivier Rikken [located in the Netherlands], CEO of Ledger Leopard and Blockchain, Smart Contract, DAO (Decentralised Autonomous Organisation) & Governance

Expert, has extensive experience with blockchain, governance and public procurement processes but not in combination.

- Brendan Abbott [located in the United States of America] is a Senior Manager at Deloitte where he works at the government and public services blockchain practice. Brendan has been working on emerging technologies for 22 years and has worked on blockchain for around 5 years. In particular, Brendan has worked with governments in the US. He has mainly worked with federal governments in order to evaluate and implement blockchain and has a lot of experience working with governments and seeing the benefits that they can gain from blockchain as well as the challenges that they will have with it.

3.3 Research Method

The aim of this exploratory research is to gain understanding of and possibly verify whether blockchain is a suitable tool of e-government for proper public procurement, and whether blockchain can add value to public procurement. Since there is not a lot of secondary qualitative data regarding blockchain and public procurement available, in regard to the research method I chose to conduct interviews in real world setting [field research] with experts who have the theoretical and technical knowledge as well as work experience within blockchain, governance and/ or public procurement and any combination thereof.

I chose to follow a semi-structured interview format as it is flexible to conduct for such a new technological issue in combination with the exploratory character of the thesis and because apart from the knowledge of experts I also wanted to hear their personal thoughts and views based on their diverse experience and expertise. Semi-structured interviews are generally appropriate for gaining insight in the experiences, understandings and opinions of a particular group of people, in this case blockchain, governance and/ or procurement experts. The detailed answers of experts could potentially provide high internal validity in regard to the information received, however, I am not testing a cause-and-effect relationship between blockchain and public procurement. In addition, the interviewees were selected based on their knowledge as mentioned above (non-probability sampling technique), their availability and acceptance for an interview. Such a non-probability sampling technique is suitable for exploratory and qualitative research since my aim is not to test specific causal relationships and hypotheses, but to gain an initial understanding of a small or under-researched subject regarding blockchain and public procurement and contribute to the scientific research around blockchain, e-government and public procurement.

This non-probability sampling technique improves the external validity of the thesis although the results of these interviews, due to the small number of interviews and the subject that is being analysed cannot be generalised for the effects of blockchain in different fields/sectors. Nonetheless the results and conclusions in regard to the advantages technically provided by blockchain and the potential challenges to be faced in regard to the implementation of blockchain can be generalised. But in order for students, academics, scientists, researchers and others to realise the effects that blockchain can have on a specific process other than public procurement then they should also research the relationship between blockchain and the specific process that is of interest in itself (e.g. blockchain and its use for voting is being extensively researched or blockchain in supply chain).

I used a question reference guide, but since it is a semi-structured interview format and the questions were openly asked and freely answered, there was a possibility of different follow up questions during the interviews. Table 2 illustrates the 11 questions that were used as a reference guide.

Table 2 Question Reference Guide

No.	Question
1	What is your experience with Blockchain and/ or Public Procurement? (Any governance and/or procurement related projects)
2	What are your thoughts about blockchain based public procurement?
3	What is your opinion about smart contracts and their potential to improve public procurement processes in action?
4	Do you think that blockchain based public procurement would be more efficient that a traditional procurement process?
5	Is blockchain according to your opinion a technology that is suitable for proper public procurement?
6	Would you prefer a public or permissioned blockchain for public procurement processes [and why]?
7	What are the biggest advantages-disadvantages that blockchain can offer to public procurement processes according to your opinion?
8	Do you think that blockchain based public procurement would make the employees and suppliers involved (feel) more accountable due to the hashing of the transactions?
9	Do you believe that decentralisation can be of added value in public procurement processes?
10	What do you believe would be the economic impact of using blockchain technology in public procurement?
11	What do you think are the biggest challenges that blockchain based public procurement will face in order to be implemented and established?

3.4 Data Collection

Due to the unusual circumstances because of COVID-19, all interviews were conducted over the phone via a call or Skype. The interviews were recorded with the consent of the respondents and upon the completion of each interview, I put the interview transcript on paper and shared it with the interviewee in order to check the accuracy of the transcript and ensure that information had not been not been misinterpreted or misheard during the interview [*Respondent Validation*]. Appendix I on page 62 contains an interview log and the interview transcripts of the interviews conducted.

3.5 Limitations

There are some limitations with regard to this research that have to be addressed. Due to the exploratory character of this thesis and the small sample of respondents, there is a risk that the results cannot be accurately interpreted for a generalised population. In addition, since I am conducting qualitative interviews and providing primary qualitative data which cannot be mathematically measured nor analysed, there is a risk of the interpretation of such information being judgemental and biased rather than objective and unbiased. In addition due to the fact that all qualitative studies are unique they are difficult to replicate.

Another limitation that has to be addressed is that the people who were interviewed for this thesis are working with blockchain and believe in it as a technology. Therefore, there is a potential risk of biased opinions. As they are believers in it the technology they might miss a critical view or point of critique in regard to the technology.

The disadvantage of conducting semi-structured interviews is that a semi-structured interview is less reliable than a structured one and it is nearly impossible to repeat the exact same interview with different respondents. Although structured interviews are useful when you know what type of information is needed (Sekaran and Bougie, 2016), they did not fit in this case.

In the upcoming chapter the analysis of the interviews conducted with the three interviewees mentioned above in regard to the accountability, efficiency and effectiveness, innovation and openness to change, integrity and honesty, and transparency and trust is outlined.

4. Analysis

In this chapter the interviews conducted are categorised, analysed and presented in the five following “public value” subchapters (accountability, efficiency and effectiveness, innovation and openness to change, integrity and honesty, and transparency and trust) and the potential advantages and challenges of blockchain technology in public procurement processes in regard to the aforementioned values is discussed.

4.1 Accountability

According to blockchain experts, transparency as discussed in 4.5 and the fact that anyone can prove who handed-in what or who made a certain decision at a certain point in time, the creation of an audit trail and considering that anything happening on the network can be verified by government organisation(s) can increase the feeling of accountability within public procurement processes. In Brendan Abbott's belief "it is the transparency (that blockchain provides) that provides accountability" and not the hashing of transaction per say while according to Olivier Rikken "The fact that you can undoubtedly prove that somebody handed-in or made a certain decision(s) etc. can increase the feeling of accountability".

In regard to procurement processes with multiple steps within the process and/or a number of different organisations involved in the process, blockchain can provide a secure way for governments and individuals within them to conduct their procurement from cradle to grave, including RFPs (requests for proposals), supplier selection and maintenance, project initiation, managing the contract and providing the audit trail for the whole procurement process.

An advantage that blockchain can offer to public procurement processes in regard to accountability is that anything happening on the network can be verified by the government organisation running the procurement process. As Martijn Bolt stated, "the advantage of the P2P is that you can verify everything that is happening" and "You don't need to trust a supplier or an organisation or individual, as a company or a government organisation you can audit and verify everything until the last piece". An additional advantage that blockchain can offer in regard to accountability within public procurement is the creation of an audit trail with which any relevant audit can be easily conducted and the people involved can be held accountable. In regard to procurement processes using blockchain technology, Brendan Abbott stated, "if anyone comes back and needs to audit if this procurement was done appropriately and following the correct rules, they would be able to have that audit". Moreover, he explained the benefits of blockchain initiatives in public procurement around trusted suppliers and stated, "… having, kind of, the blockchain being able to create appropriately available information about suppliers, services, ratings - in the US we have these things called CPARS (Contractor Performance Assessment Reporting System)… where they are essentially grades for service providers and contractors. Having that available to the appropriate focus in the procurement ecosystem gives you much better information much faster". He added, " We have a lot of requests for information rights so like the freedom of information act

and things like that, where certain information needs to be made public. And having that trusted audit of who promised what and when is super valuable as well".

However, the advantage of anything happening on the network being able to be verified comes along with a disadvantage which is the responsibility of the verification. The creation of an audit trail which can hold people accountable for their actions can also have unexpected negative side effect(s) one of which is "making people freeze" because of being afraid to take actions that could entail making a mistake that would undoubtably be recorded and easy to be traced back. In regard to the former, Martijn Bolt specifically mentioned "this also comes with an enormous responsibility. So you should only endeavour in this P2P network technology if you are up for the task and the task will be that you take responsibility and make sure that you are not tricked into something or make sure that you cannot introduce bad governance or bad security measures, for example". In regard to the latter Olivier Rikken stated, "A negative side is that it can result in a certain freeze of people who will be bound to or really scared to make mistakes because every mistake is undoubtedly recorded. It is a double edge sword. People are afraid to make mistakes. If a mistake is not record people are "easier" to act than when every decision is recorded. So it could have unexpected side effects".

Therefore, governments should try out this technology only if they are ready and willing to be responsible and accountable for verifying everything themselves and ensuring accuracy, good governance and no malicious or suspicious governance or security measures. That would lead governments to function on their own and not use other third parties or organisations for any activities and their responsibility thereof.

Sadly, this can be a formidable challenge as well. According to Martijn Bolt "this is the problem with implementation today because especially governmental organisations are not ready for that task". On the contrary, Martijn Bolt stated that companies and organisations nowadays are "used to hire organisations to do the work for them and then they re-introduce the same problem that they are trying to solve, for example vendor lock-in". Martijn explained that "Vendor lock-in is a big problem within governmental institutions because their entire procurement is based on a few IT providers and if you maintain that process where you try to outsource responsibility as a governmental institution then you might end up with the same problems and blockchain will not make it better".

On the contrary, according to Martijn Bolt the addition of blockchain would make things more complex and expensive. He stated, "The whole idea of a P2P network is to participate in that

network as a peer and if you give up that aspect you probably don’t need a P2P network and if you don’t need a P2P network you don’t need blockchain”.

4.2 Efficiency and Effectiveness

According to experts, blockchain technology based public procurement would be more efficient than the traditional procurement process in a number of ways. In particular, Martijn Bolt stated we "would not have all this legal red tape anymore". He also stated that "in the long term we're getting rid of extensive bureaucratic processes and lengthy (paper) contracts by replacing them slowly with an ecosystem approach that uses a common - unstoppable - business logic that guarantees execution, payment and enforcement through automated contract terms in an upfront compliant manner". Also, in more technical terms he stated that governments "would only have a well set-up computer architecture and a computer system… that does basically semi-fully automated procurement and every transaction is a pre-used transaction so if something goes wrong the risk is never bigger than one transaction". According to Martijn Bolt, in that way all the vendor lock-ins that are existing, especially in the public sector, can be resolved and his general advice to municipalities and government institutions is to "switch to open source and do not agree with contracts where vendors provide closed software services" as that would lead to operational processes becoming part of vendor lock-ins in the long term.

Martijn supported that this can be resolved and in particular he mentioned, "You can open that up using blockchain by automating parts of these processes and using maybe neutral positioned smart contracts in the network where you and all the participants of the ecosystem work together and collaborate instead of having this traditional server or this traditional buyer seller relationship. Then it becomes an ecosystem-based approach to getting services and then you basically work more together and have more guarantee towards the future that you will not end up with this vendor just charging you money for less and less service". In other words, blockchain and neutrally positioned smart contracts can be used to automate parts of procurement processes in networks where all nodes/ participants of the network collaborate instead of having a traditional seller-buyer relationship.

In addition, blockchain expert Olivier Rikken believes that blockchain adds greater value to the operational side of procurement rather than the contractual both in cost and time efficiency. His justification in regard to the cost efficiency part was "… we spend less time on administration and handling conflict etc. so… in the end-to-end supply chain or supplier chain we would have a certain decrease in cost. So the economic effect would redundantly be lower cost in complex environments" while his justification in regard to the time efficiency part was "it will also have the effect speeding up processes because unnecessary waiting will be much more visible in processes

and in itself which if you consider times equals money, then it is a cost-saver as well." Olivier supported that "…if you use blockchain to guard the progress of the process of procurement you can have benefits with regards to speeding up the process in itself and because then you basically have an external workflow management system if you guard the progress through smart contracts… that could make the process more efficient" but mentioned that it completely depends on the set-up as well. Furthermore, he pointed out, "if you have a procurement system where basically the people performing the actions are not part of the government but are suppliers or sub-suppliers, and that happens a lot actually, then it can help in reducing administrative burden throughout the chain". Therefore, blockchain can help reduce the burden of administrative processes throughout the procurement lifecycle, especially in situations where the people who are involved in the procurement process are not part of the government for which the procurement is being conducted for but are maybe employees of the suppliers or sub-suppliers.

On top of that, blockchain can have a positive impact on efficiency in terms of capability according to blockchain expert Brendan Abbott who said "From the capability side I think blockchain provides a lot of potential. There are a lot of potential projects where they are trying to identify trust in suppliers, so there are blockchain networks where people are indicating potential suppliers to work with, and they could be used in procurement." If an improved (supplier) qualified list and better information available at real time are to be used, the efficiency of public procurement processes can be greatly improved.

It is worth mentioning that blockchain expert Olivier Rikken stated that although disintermediation is a good thing or can lead to good things, "it is not always the best thing, sometimes you want to have an intermediary in between for certain reasons" and according to him the procurement process "will always be a highly centralised process" but decentralisation has the potential to benefit the process. In particular "it has potential to make the process more efficient with better quality results… if you have a better qualified list and better information that is available at real time, that can help provide some great efficiencies." Accordingly, disintermediation has the potential to "make processes in a certain supply chain more efficient and maybe you can take out the link in the whole ecosystem, that would be great, because that leads to less paperwork and less red tape etc.". In the same manner, Brendan Abbott mentioned that governments can use blockchain "in situations where you want to have a shared ledger of vendors-suppliers and experiences that you want to be able to quickly look for other examples of where the work has been done before". He states that "In other cases, it's going to be heavier than you need" and he mentioned that one of the things they always tell people is "if another technology works you should

do that instead of blockchain because blockchain brings some other baggage along with it". He explained that there are other technologies, applications and/or solutions our there which are not distributed ledgers/blockchain based technologies but can provide the same solutions especially for situations in which the use of blockchain technology as a solution comes from within a single organisation (e.g. Hashgraph or **Amazon Ledger Database**). In detail he stated, " So a single government organisation may want to still have immutability, audit-ability, transparency but it does not include other organisations. There are a lot of technologies out there, non distributed ledgers technology that are similar and can play that role. They are kind of internal or single organisation solution(s) that still provide the audit-ability, immutability, transparency".

4.3 Innovation and Openness to change

Blockchain benefits such as transparency and immutability can be met only if organisations that want to try out and adopt this technology, completely convert their ways and methods of working in different ones from cradle to grave. The innovation and change that blockchain can offer makes sense only if organisations radically change their traditional hierarchy, their standard operating processes and ways of doing things. More specifically, Martijn Bolt stated that "… the characteristics that blockchain technically provides (transparency and immutability) only make sense if organisations that adopt this technology change their ways of doing things". He explained that all the projects that he has seen up until now "miss the point". More specifically he mentioned in regard to the procurement projects that he has seen, which according to him are not a lot, that they "are focusing on a detail of blockchain ecosystems. So, one of the details being transparency, one other detail being immutable ledger technology." According to him, this " …is not the main gist that blockchain provides." He explains, "these characteristics only make sense if you adopt the way organisations or individuals cooperate using blockchain networks" and "that is a networked type of collaboration and not a hierarchal type of collaboration".

According to experts, blockchain based technology, is in itself, a completely different approach towards innovation, governing and managing governments, different government departments, bodies and agencies and/ or companies. With blockchain technology the traditional hierarchical structure of a government is not there anymore. On the contrary, due to the nature of blockchain technology there is an ecosystem or network approach established, according to which everyone cooperates and works together towards a common aim or goal. All three experts expressed that the implementation of blockchain and in particular to convince everyone to work in such a way will be one of the biggest challenges. In addition, they supported that a blockchain process is completely different from the existing [traditional] processes as we know them today and that is why it is difficult to compare blockchain processes with the traditional ones as there are no similarities in-between them.

As already mentioned, blockchain expert Martijn Bolt stated, "these characteristics only make sense if you adopt the way organisations or individuals cooperate using blockchain networks. That is a networked type of collaboration and not a hierarchal type of collaboration", "…it is fundamentally not a company structure anymore when you are working from an ecosystem structure instead of a hierarchical. It is a mix of small organisations and people, doing a task together with a common goal but it is much more flexible and fluid in structure compared to a

company than a governmental organisations". In addition, he supported that "joining an open source is usually an international endeavour, not the standard hierarchical standard of a multinational for example, but it is a group of people trying to do something that they all agreed on doing or whether they have a common interest in achieving some sort of goal, and it is usually a group of people that forms an ecosystem and not an individual or board running a company. So today it is still difficult to compare that with existing procurement processes because there are no similarities". Moreover, Martijn supported that the reason why blockchains came into existence in the first place is because "it is a different governance structure, it is a different way of doing things without a hierarchical institution in the middle". He explained further by referring to the history of blockchain and said, "The only reason that blockchain is there is that the people who invented BitCoin did not want to rely on a central trusted third party so they got rid of the central banks and not because the technology of a Bitcoin is better that the banking technology. On the contrary, paying with the banking system is internationally much easier and better, but you can pay now with the Bitcoin infrastructure, in spite of having a trusted third party. You don't need a trusted third party. And that is fundamentally not a technical solution because the technical solution of Bitcoin is worse than the technical solution of banking but the difference is that the technical solution of bitcoin no longer needs a trusted third party. And that is not a technological innovation, that is a governance innovation. What X, Y, Z. etc. companies are trying to sell is not a governance improvement but a technological improvement and this is where they are lying. The only reason to use blockchain is when a value chain needs a governance improvement and not a technical solution".

Furthermore, according to Olivier Rikken the implementation of such a blockchain based approach can be a challenge as people tend to think as individuals. He mentioned "Any good blockchain implementation is convincing the whole ecosystem that the implementation is for the better of the whole ecosystem and not per se for the individual company (as such). And that is where we run into the problem that we tend to think as pure individuals all the time. So we always think and also on a company level, what's in it for me instead of what's in it for supply chain. So if it means that a certain link in a supply chain has to incur a little higher cost while the rest of the supply chain can have much lower cost then your solution is not going to survive because the individuals will say this is not beneficial for me so we are not going to do it. It is an ecosystem - and that is always the hardest one to do. That is one of the biggest challenges you are going to run into." Brendan Abbott agreed to that by referring to the members of the network and in particular stating, "the key there is that as with any of these implementations you have to show the value of "what's in it for them" otherwise there is no need for them to contribute." Moreover, he stated that "it is more

of the getting everyone on the same page on why they want to work together on this platform and it could totally be because it is a government mandate but getting everybody to see the value and what's in it for them to participate… is the hard part".

Furthermore, I was informed that multiple ongoing governmental blockchain projects, some of which within procurement, at the moment are not focusing on blockchain technology as a whole but only on some aspects of blockchain technology or on certain details or specific characteristics of the blockchain ecosystems and that is not sound. It is not secure for governmental institutions to use blockchain as a production solution for procurement. It is not rational nor efficient to take certain aspects of blockchain technology and try to incorporate them in the traditional ways of working, neither incorporate them within traditional governance structures such as having legal contracts and invoice structures according to the traditional way of working or according to the current standard operating processes. The technology should be tried out as a whole and not in parts and that is where projects miss the point and become worthless after having already spent an enormous amount of money on those projects. Especially Martijn Bolt stated that "All the projects right now are missing the point. The projects I have seen, and it is not a lot, in procurement, are focusing on a detail of blockchain ecosystems. So, one of the details being transparency, one other detail being immutable ledger technology. That is not the main gist that blockchain provides. And these characteristics only make sense if you adopt the way organisations or individuals cooperate using blockchain networks. That is a networked type of collaboration and not a hierarchal type of collaboration. For example, if you re-introduce a traditional invoice and contract structure with legal terms, the blockchain does not make sense anymore." He emphasised that what most of these projects are trying to do is "… to take some aspects of blockchain technology and try to mix and match that in a sense with traditional governance structures, e.g. having legal contracts and invoice structures and they miss the point totally and the project becomes basically useless".

According to experts that is because, especially in governmental organisations, bodies or agencies, governmental employees do not have sufficient knowledge of the technology to implement it the right way neither enough capacity to change entirely their way of working and adopt blockchain technology as a whole. Martijn Bolt stated that "especially in government related organisations… they just don't have enough "know-how" to do it right and not the capacity to change so much to adopt this entirely new way of working". Additionally, in regard to public organisations within the European Union he mentioned that they have challenges that are still standing since the 70s or 80s such as but not limited to legacy infrastructure or extremely old architecture. Martijn Bolt supported that if blockchain technology was to be added on these

systems, it would not make things easier for these organisations but would actually enlarge these challenges that they are facing. He stated, “adding a blockchain to that will not solve any problems but it will make the challenges only bigger”. It would not only make things more complex for these public organisations but more expensive as well as it is a relatively new technology, not mature enough yet, and highly innovative. Therefore, according to Martijn governments adopting blockchain technology for public procurement would have to accept that “… it is expensive because it is highly innovative. Therefore, it is going to run into all kinds of problems. It is not mature yet as a technology”.

According to experts, since blockchain’s main feature is the P2P network and all nodes would have to agree and work together, if governments want to have control over and throughout their procurement procedures such as a tender application, they should ensure that they can influence the governance system of the infrastructure in order for a change to occur (e.g. the majority of the nodes or suppliers and government agencies and/or employees involved). That is why governments should be very careful in regard to the type of blockchains they are going to use. For that reason, special consideration should be given to governmental projects considering using permissionless blockchains. In this regard, all three experts agreed for multiple reasons that government projects, at least in regard to procurement, should be using or ran onto permissioned blockchains in order for governments to have some control over their processes.

In regard to permissioned blockchains, Martijn Bolt stated that it is “not something that has been proven to be a sound business case, not for the organisations buying this” and “ permissioned blockchain… has nothing to do with the P2P characteristics of blockchain in the first place. You should really re-assess if you need that.” Moreover he supported that “the whole idea of blockchain is creating a P2P system and what permissioned blockchains do is that they re-introduce a central authority or trusted third party and that the whole reason of choosing a blockchain in the first place is inoculated. So there will probably never be a sound business case for companies to buy permissioned blockchains because there is no added value.”

In regard to having control over the procedures Olivier Rikken explained, “if you want to have some control over your application in this case, a tender application, you need to be very sure that you can influence the governance system of the infrastructure and also be sure that what you build in the application itself isn’t completely set in stone in the blockchain in itself because then you don’t have any influence if you want to change something through the process. So you have to be very careful with using permissionless blockchains”. He supported this by stating, “in a permissioned set up that is much easier to build up in such a way because then you are in control of

the nodes and thus in control of the governance of the infrastructure and changing the rules in the infrastructure is completely in your hands." In regard to the type of system and network he highlighted "… I wouldn't say that you use a permissionless blockchain for this, you will always be in the area of the permissioned blockchain. If you build it on a permissionless blockchain then your procurement process, the governance of the infrastructure where you build up is completely in the hands of everybody that has to agree upon it and I don't think that any government will ever allow that the governance of the infrastructure and thus also the smart contract code in itself, because that is embedded into infrastructure, will be in the hands of people they don't control." Although Olivier stated that he is a big blockchain permissionless fan himself, he said "given the kind of information you might want to store and the lack of governance control you have in a permissionless set-up, given that it is a public procurement process and taking also into account the stakeholders who are behind it - I would go for permissioned". Moreover he supported "… I don't see any technical/ performance reasons why you should want to use a permissionless blockchain in this one, because the amount of transactions is not really important in these kind of processes but I think in the end from a governance perspective you want to be in a permissioned set-up.".

Finally yet importantly, Brendan Abbott shared that "most of the parties that we see in the government in the US are permissioned blockchains, they are not the public ones". In particular, he stated, "they are all using permissioned versions of their protocols because there are still a lot of trust considerations and security considerations".

Last but not least, it is worth mentioning that the willingness of governments and highly positioned government employees to undertake blockchain technology and change their ways of working may not be that high. That is because, according to one of the experts, some people like in-transparency and even thrive off of it as they are not going to be held accountable for any of their actions. The fact that people, some more than others, do not want to be held accountable for their actions is an additional challenge in itself. Olivier Rikken stated, "do not underestimate how much people like in-transparency. A lot of people thrive by in-transparency. Transparency is a great good, but a lot of people do not like transparencies. Because it means, they are going to be hold accountable for their actions… and people don't want to be held accountable for their actions. That is a challenge in itself".

4.4 Integrity and Honesty

All experts agreed that blockchain can help governments create a single source of truth regarding public procurement processes especially when multiple administrations and/or governmental bodies and/ or suppliers are involved registering all kinds of different information. Martijn Bolt explained that the advantage due to the P2P network is that “you can verify everything that is happening. You don’t need to trust a supplier or an organisation or individual, as a company or a governmental organisation you can audit and verify everything until the last piece.” On the same note Brendan Abbott stated that from the capability side blockchain offers a lot of potential. In particular, he explained “There are a lot of potential projects where they are trying to identify trust in suppliers, so there are blockchain networks where people are indicating potential suppliers to work with, they could be used in procurement”. He explained that one of the ways blockchain is being used is for trusted supplier networks and another is for the procurement process and stated, “Frequently there are a lot of different touch points and potentially different organisations included in it and blockchain is providing a secure way for people to go all the way from requesting a proposal, through actual selection process, project initiation, all the way through kind of project close-out and it’s providing the audit trail all the way along the process. So if anyone comes back and needs to audit if this procurement was done appropriately and following the correct rules, they would be able to have that audit. So that is another good way that is being used.”

Olivier Rikken stated, "If it is for a process optimisation within one company and for example a tender is always a process within one company basically, then in itself blockchain - smart contracts don’t have that much added value. So I would say only if you have, again, a multi stakeholder or multi actor environment where multiple parties need to agree on certain logic, then smart contracts have added value otherwise they don’t.”

Blockchains on the basis of their type are either owned by no-one or by everyone. According to experts the latter is where blockchain can truly be of added value and create a level of trust between the parties involved signifying that the agreement made between the parties, in this case governments procuring goods or services, will be executed and none of the parties involved (in particular when there are multiple vendors) will attempt to change or modify the code of the blockchain to their benefit. Olivier Rikken supported that “if you want to do straighter processing or automated processing between various companies, then you can use smart contracts very well because you don’t have to trust the other company that they keep track of the software right and vice versa because you put the smart contract in between on the blockchain, then depending on the

kind of blockchain, its owned by nobody or basically by everybody and then it can really add to creating a level of trust between the companies that the agreement that they have agreed upon will be executed and none of the other parties can actually change the code to their benefit basically. So there we see added value of using smart contracts for business logic between in itself, where you use the ledger, the blockchain in itself, for entering of data to make sure that data stays authentic and nobody alters the data in itself."

Blockchain adds value and offers a solution in regard to all these data and different information that would need to be reconciled to assure that they are indeed true and the actions regarding public procurement processes have been properly performed. One example of creation of a single source of truth by using blockchain technology within government processes was in regard to the healthcare sector and was provided by Olivier Rikken. Healthcare is considered to be lower-level governmental process which is provided by a third party supplier but paid for by the government, and in particular the different municipalities. The ongoing debates regarding healthcare were concerning how many hours had actually been worked by the people, if those hours were actually allowed under certain contracts, and whether or not there were subcontractors, etc.

Blockchain was a solution to that. To be exact, blockchain expert Olivier Rikken explained, "… the healthcare is provided by a third party supplier but is paid for by the government being the municipalities and what you have right now is a lot of discussions on how many hours were they actually spent; were these hours allowed under the contract; did you have a subcontractor; was this subcontractor allowed to spend these amounts… and this is where blockchain helps in realising a transparency and creating a single source of truth that you don't have three, or four or five administrations administrating all the different hours where you would have to start reconsolidating afterwards to see if the amount of hours that they actually claimed to have performed were actually true and be signed off for. And it can help them in the end in speeding up financial processes that want to work in forms, which the client signs off of this, that is where blockchain comes in handy".

Nonetheless, in order for governments involved in procurement processes with multiple vendors and/or administrations to use blockchain in an appropriate manner, the design of such a system should be the centre of attention. According to blockchain expert Brendan Abbott, some information needs to be made available to the public in compliance with information rights such as the freedom of information act etc. Olivier Rikken supports that the design of such a system "… needs to be done very carefully and thoroughly, because…due to the transparency of blockchain in itself, company sensitive information and maybe even privacy sensitive information can be out there in a manner you don't want to use it" and that this "is one of the concerns you always have to

have when designing such a system. It is not impossible; you can easily design it in a way so it is usable but you really have to think it upfront". In other words, the system should be designed with an extremely careful and thorough method, as due to the nature of blockchain technology and the transparency that it offers, there is the risk of government sensitive information, privacy sensitive information or even personal data leaking and/or being used and that is certainly something that governments would not want. The use of information in an honest and ethical way, in terms of morality and integrity, is one of the biggest concerns of governments. Thus, in order for blockchain technology to be of added value to governments, the design and architecture of the system and type of network has to be really thought through upfront.

Accordingly blockchain expert Brendan Abbott mentioned "You have to be really smart about how you are implementing something to make sure you are not putting publicly identifiable information on the chain where it is going to be there forever if it immutable whereas GDPR says you have the right to be forgotten. So you don't want to save that on a chain if you can't go back and delete it later if somebody executes their right to be forgotten". Therefore greater attention should be paid to the implementation of such a system. It should be implemented in an extremely precise and courteous manner in the interest of safeguarding publicly identifiable information within procurement process as a result of the immutable characteristics and benefits of the technology in itself, the right of all individuals to be forgotten as stated within the General Data Protection Regulation, at least in the European Union and other similar requests for information rights such as the Freedom of Information Act according to which certain information has to be made available to the public by governments and public authorities and members of the public have the right to request information from public authorities. In particular, Brendan Abbott explained how privacy can be a challenge for blockchain technology to be properly implemented and highlighted the challenge of "how do you handle personal identifiable information or making sure that you are in compliance with GDPR or US privacy laws." Last but not least, he stated that he believes that in spite of the technical challenges that exist in regard to the adoption and implementation of blockchain technology, he thinks the governance and process of blockchain are "being more of a challenge".

4.5 Transparency and Trust

Transparency was already mentioned in the analysis of the previous expectations and all experts agreed that transparency is established due to blockchain technology in itself. Consequently, transparency within governments is established for procurement processes if blockchain based technology is used for public procurement processes but that comes along with some challenges as well. In particular, Martijn Bolt said that transparency (and immutability) are characteristics that blockchain technically provides while Olivier Rikken stated that blockchain can add transparency, by storing hashes on a blockchain you can prove the authenticity of documents etc. not in the process but in itself.

In addition, Brendan Abbott when asked whether blockchain is a suitable technology for proper public procurement responded "Absolutely, especially because of public procurement(s), in governments, there is always need for additional transparency." He supported that "Citizens want to see where their tax dollars are going and ensure that is being done in the most open and secure way. So from that perspective I think there is tremendous potential". The response of Olivier Rikken to the same question was, "if you want to use it to create transparency throughout the chain, yes absolutely. I think it is a proper technology to use for it" but at the same time he stated that we always have to be sceptical about it and raise questions, such as is it the only technology you want to use; is it the most straightforward technology to use for public procurement or is another technology more suitable? He expressly stated, "You shouldn't go blindly on blockchain technology as the most suitable technology to support these processes. If it is purely out of efficiency reasons, if it's for reasons of immutability, handed in documents in combination with progress monitoring through the smart contracts etc. etc., then it could be the most logical technology, but you should always be critical towards this technology stack in itself to start with".

Moreover, Olivier Rikken said that according to his opinion if we look at what is the added value of blockchain in the procurement process other than adding transparency, there are other means easier to implement than to use blockchain and that might also be the reason that there is not a lot of literature around it. He explained that the way blockchain is being used in regard to initiatives within the governmental environment nowadays is "more based around things like self-sovereign-identity or creating transparency with a unique form of privacy safe-keeping throughout processes". Accordingly, Martijn Bolt expressed that according to him all the projects he has seen up until now are missing the point because in procurement they "are focusing on a detail of

blockchain ecosystems… one of the details being transparency, one other detail being immutable ledger technology" and stretched that "That is not the main gist that blockchain provides".

Another way blockchain is being used according to Olivier Rikken is in administrative processes including multiple actors in the chain and this is where transparency can be a challenge in terms of data/ information usage and leakage. He specifically stated, "due to the transparency of blockchain in itself, company sensitive information and maybe even privacy sensitive information can be out there in a manner you don't want to use it" and referred to the example regarding healthcare and the different municipalities.

According to Olivier, blockchain and smart contacts might not be of much added value for the tendering and pre-tendering phase because many parties (suppliers) would have to send everything to one other party being the government and that is a straightforward, one to one relationship with only one party receiving information from many individual ones. Therefore, the only possible added value of blockchain within the tendering and pre-tendering phase is the transparency created. Specifically for the pre-tendering phase, he stated that he does not see added value because there is no multi-stakeholder system, rather there is a potential supplier or multiple potential suppliers and one client being the government. Furthermore, he explained that the only thing blockchain can be used for in the tendering and pre-tendering phase is "to add additional transparency to make sure that the government does not perform any malicious actions or there is some kind of fraud in the background" and "If it is for a process optimisation within one company and for example a tender is always a process within one company basically, then in itself blockchain - smart contracts don't have that much added value". Just as importantly, Martijn Bolt stated, "at this moment and time what a blockchain does is too different from how organisations operate, so optimisation is hard".

Contrastingly, in situations where multiple parties are involved in public procurement processes and trust between those parties has to be established, blockchain technology can be of great added value. According to Brendan Abbott, blockchain can be used for the procurement process when "there are a lot of different touch points and potentially different organisations included in it and blockchain is providing a secure way for people to go all the way from requesting a proposal, through actual selection process, project initiation, all the way through kind of project close-out and it's providing the audit trail all the way along the process". In accordance to that Olivier Rikken stated, "only if you have… a multi stakeholder or multi actor environment where multiple parties need to agree on certain logic, then smart contracts have added value otherwise they don't" and "in the operational part, so the execution of the process, there I see added value

because then you would normally have multiple administrations where you have the reconciliations etc. and this is where you can really add value by eliminating that throughout the supply chain". At a different point during the interview but along the same line of thought he mentioned, "if you cannot trust the government system in itself to begin with, then it can really help into creating transparency in the process and making sure that the process steps are automated through the smart contracts, but depending on the country where you're in and e.g. the Netherlands which is the best country in the world on the front index basis along with Sweden, Norway, etc. then you really have to ask yourself - does adding blockchain or a trust layer of blockchain add value to the process - are there multiple actors in the handling of the process, and in this case I would say there is only one actor involved - being the government - it is not a multi actor problem."

Normally the solicitation and the purchase requisition process - confirming that goods or services were received in good order - are steps of the traditional procurement processes of governments for the purpose of establishing trust between the government and the "other" third parties. According to Martijn Bolt that is a fundamental difference with networks and supported that the solicitation process and the purchase requisition process are no longer needed. He stated, "You can just use the technology to analyse if it is trustworthy or not. But the process of doing those tests is still there but it is in no way comparable with the existing audit-processes that we know in procurement processes today". By using blockchain technology, the steps of solicitation and purchase requisition process are actually not needed anymore and therefore can be excluded from public procurement processes since governments can use the technology itself to analyse the trustworthiness of the third parties. According to Martijn Bolt, governments "… can analyse what the business logic on the blockchain does" and "are free to join in on that by basically using that smart contract or not using it and looking for another smart contract". He expressed, "That is fundamentally different from the traditional acquisition or purchase requisition process we see in procurement today". Finally, another way that blockchain technology adds value to trust within public procurement processes is by identifying trust in suppliers. According to Brendan Abbott, blockchain provides a lot of potential from the capability side and he shared, "There are a lot of potential projects where they are trying to identify trust in suppliers, so there are blockchain networks where people are indicating potential suppliers to work with, they could be used in procurement".

The following table offers the main findings of the analysis regarding the public values of accountability, efficiency and effectiveness, innovation and openness to change, integrity and honesty, transparency and trust.

Table 3 Main Findings

Accountability	• Creation of an audit trail in regard to process and procedures including decision making - holding relevant people accountable. • Possibility to prove who handed-in what and when. • Anything happening in the network can be verified by governments running the procurement process. • Responsibility of verification - governments will have to verify everything and be responsible and accountable for it and this is not how governments appear to function today. • Demotivation and "freezing" of employees due to fear of taking action and making mistakes that could be recorded.
Efficiency and Effectiveness	• Elimination of legal red tape. • Elimination of extensive bureaucratic processes and lengthy (paper) contracts in the long term. • Reduction of paperwork and administrative burden. • Automated transactions - intermediaries and other trusted third parties are not needed anymore. • Possible solution for vendor lock-ins if governments switch to open source environments. • Blockchain and smart contracts can automate parts of public procurement processes. • Blockchain adds greater value to the operational side of procurement rather than the contractual both in cost and time efficiency. • Indication of potential trusted suppliers list(s) and other relevant information (such as examples of previous work) being available at real time. • If governments aim for a solution within a single organisation then there are other non distributed ledger technologies that can offer that solution.

Innovation and Openness to change	• The benefits of blockchain technology can be met only if governments and organisations completely change their ways and methods of working including hierarchy, standard operating processes, etc. • Projects have been focusing on specific aspects and details of blockchain or have not been thought through upfront which leads them to be unsuccessful. • With the implementation of blockchain there will be a different non-hierarchical structure in governments. It will be an eco-system or network approach. • Persuading everyone to work in such an eco-system or network way and showing what is the value or benefit for them will be challenge. • Blockchain does not appear to provide a technical solution but a governance solution/innovation. • Governments appear to have insufficient capacity and knowledge of the technology in order to implement it correctly and/or transform and change their ways of working. • Governments and public organisations in the EU have legacy infrastructure or extremely old architecture which will be additional challenges. • Blockchain is highly innovative and costly. • Blockchain is a rather immature technology - it can run into new problems. • Permissioned blockchains should be preferred from governments in regard to public procurement processes so that they can have control over their processes. • If permissioned blockchains would re-introduce a central authority then the need for blockchain should be re-considered as it might not be of added value. • Governments and public officials might not be willing to try out the technology nor change their ways of working and operating.

Integrity and Honesty	• Blockchain can create a single source of information in situation where multiple administration are involved. • No need of third parties and other trusted suppliers. • Blockchain can add value or offer solutions in regard to data and reconciliation of different information from multiple parties. • Certain information has to be made publicly available due to laws and regulations therefore the design and architecture of a blockchain technology based public procurement process has to be thought throughout upfront. • Attention has to be paid at the implementation of blockchain technology due to the risk of government sensitive information and/or data being used or leaked. • Different laws and regulations such as the General Data Protection Regulation or the Freedom of Information Act have to be taken into consideration depending on the location and operation(s) of each government.
Transparency and Trust	• Transparency can be established due to blockchain technology in itself. • Although blockchain appears to be a suitable technology for public procurement processes in terms of transparency governments should consider if there are other alternative technologies that are also easier to be implemented than blockchain technology. • Blockchain does not appear to be of great added value in the tendering and pre-tendering phase apart from creating transparency since it is only one party receiving all the information being the government. • Blockchain can add value by creating trust and transparency in processes and networks in which multiple actors are involved. • Blockchain could eliminate the solicitation and the purchase requisition process which are steps of the traditional procurement processes of governments for the purpose of establishing trust between the government and the “other” third parties.

5. Conclusion

Having discussed the elements of blockchain, e-government, public procurement and the relationship between them [chapter 2], the research design and method [chapter 3], and the analysis of the interviews conducted during the research fieldwork this chapter describes the findings of this research. Subchapter 5.1 offers a discussion in regard to blockchain and public procurement. Following subchapter 5.2 contains information regarding recommendations & future research. Last but not least subchapter 5.3 outlines the main conclusions of this thesis.

5.1 Discussion

According to experts, the P2P network approach is one of the main aspects of blockchain technology and one of the basic ideas behind it is for the creation of decentralisation. If governments are to use permissioned blockchains then a central authority or trusted third party is once again re-introduced and that debunks all the primary reasons to use blockchain. Governments are trying to use blockchain as an operational solution when it is in fact a governance solution. In other words, blockchain offers a completely different governance structure for governmental processes in general, including public procurement processes. Moreover, blockchain offers a different governance structure for governments themselves and is a completely different way of operating as a whole without a main "hierarchical" central authority.

Many companies and governmental projects exploring blockchain technology have been abruptly halted when they realise that in order to receive blockchain's technology benefits the organisations using it would have to fundamentally change their power structure and governance. That is something that usually highly positioned people within governments are not ready to do and neither willing to. They are not willing to work with a network-ecosystem collaborative approach or an open source environment and that is the most common challenge seen with the implementation of blockchain technology.

In particular on public procurement, an additional challenge for the implementation of blockchain is that this network approach can be a direct threat to existing and prospect suppliers. That is because public procurement vendors and suppliers will lobby and run strong marketing campaigns to maintain the current traditional public procurement processes as there is a lot of money involved in public procurement processes for them. Vendors will try to maintain the traditional governance structures without blockchain technology for as long as they can in order to have the conventional relationship of buyer-seller and obsolete invoice relationship as long as they can.

Blockchain technology can have greater added value in cases where multiple stakeholders are involved. Blockchain's main feature is the creation of transparency. In respect to public procurement processes, experts expressed their belief that if there are other means which are easier to be implemented than blockchain for a government then the alternative means should be used. That is because as already mentioned governments do not have enough capacity nor know-how to carry out public procurement processes from cradle to grave and because blockchain is a relatively

new technology that will cost governments a high amount of money in order to be appropriately implemented.

Blockchain technology accompanied by smart contracts appears to be not the foremost technology to be used in the pre-tender phase as it is not a multi-stakeholder situation. There would be one potential supplier or multiple potential suppliers and one other party (client) being the government. On the contrary, blockchain technology appears to be a proper technology to be used in the operational part of public procurement processes which is the actual execution of public procurement. That is because there are multiple stakeholders involved within the execution of public procurement processes, e.g. multiple administrations administering products and/or services provided and received, for which governments would have to have checks, controls and reconciliation processes in place in regard to the products, services and information. These are actions that blockchain can actually eliminate and add value throughout the whole public procurement process.

However, the implementation of blockchain at all stages is one of the biggest challenges accompanied by governments' innovation and openness to change. That is because there is a general lack of trust in the technology itself since it is a relatively new, highly innovative but not significantly explored especially within governments and as already mentioned, governments, especially within the European Union have technical challenges in regard to systems and architecture still standing since the 80s. These would be difficult to be resolved in order to implement blockchain as well. The whole structure would have to be re-built from scratch and that is something that governments might not be willing to do.

Additionally, if governments decide to take their chances with blockchain, the next challenge of the implementation process that they are going to face, apart from the implementation in it itself, will be to convince all people involved, including suppliers and vendors in the case of public procurement, that operating public procurement processes on blockchain is the best option for all of them, the whole network or ecosystem and not just for the government itself. That will be a strong challenge to overcome due to the fact that people predominantly have the tendency to think as pure individuals and not as teams, so everyone would question "what is the profit" for them and not for the whole network including the government and the suppliers [as Olivier Rikken explained if a certain link throughout the process would have to incur higher costs than the rest, but all the others links or cost of the whole process would be significantly lower, that certain "higher cost" link might not be approved by the individuals because it will not be worth it for them]. The value of blockchain should be realised on a catholic level and not an individual one. According to Martijn

Bolt, at this moment in time there are only a few organisations that are tiny start-ups (private sector) which are able to understand the concept of blockchain technology as a whole and are able to build the appropriate infrastructure within their organisations in order to have this type of flexibility and conduct their procurement processes by using blockchain based public technology. Most other organisations and especially governments and other public institutions are not ready to run their processes on such a technology.

Therefore, the-non technology challenges will be the most difficult ones to be exceeded by governments. If governments decide and are going to adopt blockchain technology they should be able to recognise, calculate and accept or mitigate the risks that the technology brings along. Finally yet importantly, governments should accept that blockchain technology is not a mature technology yet, as it has only been around for about 10 years and consequently different problems, new questions and unknown challenges at this stage may appear.

5.2 Recommendations & future research

The findings of this study imply that a blockchain can potentially add value and be positively associated with public procurement processes in terms of accountability, transparency and trust, efficiency and effectiveness, and integrity and honesty due to the nature and characteristics of the technology itself. Nonetheless, as far as it concerns the innovation and openness to change of governments, there are a lot of obstacles, challenges and questions that are still outstanding and require further understanding. Therefore, future research could focus on how willing governments and public servants are to undertake blockchain technology within the public procurement processes; who will be fully responsible for the process; and on how governments are going to run blockchain public procurement processes and govern them; how would processes be updated in case needed.

In addition, most of the people working or experimenting with blockchain as well as writing about blockchain are usually people with high technological skills and understanding of technologies in general, aka tech-savvy people. These people know and understand a lot of things in relation to blockchain technology and that is why most articles, papers and scientific reports published focus mostly on the technical aspects of blockchain technology and not the operational nor implementation ones. Moreover, governments have not implemented that many (procurement) blockchain projects and do not have sufficient know-how in regard to blockchain. Therefore, further research could focus on the current status and readiness of governments to undertake public blockchain in terms of a skilled workforce with sufficient blockchain expertise and funds available for blockchain projects and/or the willingness of governments to initiate “full scope” blockchain projects and try their chances and opportunities with the technology in order to properly implement it within the public sector and in particular, public procurement processes? Further research regarding the willingness of governments to change and endeavour blockchain will be of great added value since the technology is available.

5.3 Conclusion

To conclude, blockchain technology can potentially add value and be positively associated with public procurement processes in terms of accountability, transparency and trust, efficiency and effectiveness and integrity and honesty due to the nature and characteristics of the technology itself. However, governments appear to be trying to use blockchain as an operational solution when it is a governance solution and that is not sound. It offers a different governance structure for governments themselves and a completely different way of operating as a whole without a main "hierarchical" central authority. Although according to the experts, blockchain technology and smart contracts are not of much added value in the pre-tender phase of public procurement processes, they can be of great added value for the post-tender (operational) phase of the contract, in which multiple stakeholders are involved especially in regard to transparency. Despite that, experts supported that if the main goal of governments is transparency and there are other means easier to implement in order to achieve this then governments should not choose blockchain as it can be an expensive and difficult solution to implement. Many projects have been seen to fail because they have not been thought through and studied upfront. Therefore governments should research and realise what they want to achieve prior to initiating the project and study the relation with blockchain in order to gain an overview and compare the cost and benefit of blockchain with other alternatives.

The implementation of blockchain can face significant challenges, including but not limited to the following. If blockchain is under consideration to be used as a tool of e-government, the willingness of governments and public officials to adopt blockchain technology for public procurement processes might be a challenge for reasons such as transparency and accountability. Even if governments and public servants are willing to implement blockchain procurement processes, another challenge that arises is how the blockchain and the processes will be managed. Additionally, vendors, suppliers and external stakeholders may be threatened by the implementation of blockchain based public procurement processes and can raise additional challenges and obstacles for its implementation. One of the biggest challenges that experts agreed upon is that it will be difficult to convince all the individuals that working in such a network (ecosystem approach) that it is better for the whole and for them individually and make them realise the potential benefits.

Furthermore, governments will face additional challenges in regard to the implementation of blockchain since they do not have sufficient capacity, know-how or compatible IT architecture, design and systems. Therefore, if governments decide to adopt blockchain technology they should recognise and accept the risks that come along with it including the fact that it is not a mature

technology. It has only existed and been studied for around 10 years and, due to the fact that it is highly innovative, it will probably be an expensive solution as well. Other factors such as different laws and regulations in regard to information and data protection should also be taken into consideration, especially in regard to integrity and honesty and transparency and trust. In addition, many difficulties could potentially be faced in regard to the acquisition of blockchain and how governments will get blockchain networks for their public procurement processes. Regardless of those factors, if governments decide to try out blockchain technology for their processes they should implement permissioned blockchains in order to have higher security and more control over the network.

In conclusion, although there are a lot of potential benefits that can be offered by blockchain technology for public procurement processes, the knowledge regarding the way of operating a blockchain in practice from a governance perspective is still limited and a lot of challenges in regard to the use of blockchain are still standing. Governments have little or no knowledge regarding blockchain, therefore, it does not appear to be the best technology to be used yet. Further knowledge in regard to blockchain technology in practice for government processes has to be acquired before projects start being deployed and that is something that will take time, especially within the government world.

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Appendix I - Interview Log

Interviewee	Date
Martjin Bolt	21/09/2020
Olivier Rikken	22/09/2020
Brendan Abott	01/10/2020

1. Interview - Martijn Bolt

Q1: What is your experience with Blockchain and/or public procurement (any governance and/or procurement related projects)?

[redacted] I have a history in implementation and change management. Prior to my work as a blockchain specialist I was working on the implementation of CEIO governance within organisations. Basically, change management within organisation implementing information management, implementing information architecture, information management systems and in more broadly the strategic position of IT in organisations.

When I came across blockchain I just got heavily interested in how we could revolutionise, basically, how organisations work, and how value-chains could operate. So at that time, when I was working and writing my thesis as a student, I drastically changed my life and became a freelancer.

I work with governmental agencies, multinationals, entrepreneurs, all kinds of organisations and individuals, basically figuring out to how are we going to improve what we have in organisational terms or in governance terms using this network approach.

Q1.1: so is it a kind of optimisation?

At this moment and time what a blockchain does is too different from how organisation(s) operate, so optimisation is hard. It is usually a "spin-off" of a company or it is a new team within an organisation that tries to first understand how this ecosystem approach works and then when the ecosystem approach is in the heads of relevant people, you can try to start projects doing it in this way, a radical different way in approaching innovation in the first place and also approaching managing companies.

Because it is fundamentally not a company structure anymore when you are working from an ecosystem structure instead of a hierarchical. It is a mix of small organisations and people, doing a task together with a common goal but it is much more flexible and fluid in structure compared to a company than a governmental organisations.

I have not worked on projects procurement related. I work with someone who is heavily invested in circular facility management so we have been thinking about and analysing how facility management and the procurement within that could function with blockchain, but I have not implemented a procurement strategy using blockchain technology.

Besides, the fact that I work with open source blockchain projects and basically procurement in those networks is different from procurement we know today within organisations, it is fundamentally different. Joining an open source is usually an international endeavour, not the standard hierarchical standard of a multinational for example, but it is a group of people trying to do something that they all agreed on doing or whether they have a common interest in achieving some sort of goal, and it is usually a group of people that forms an ecosystem and not an individual or board running a company. So today it is still difficult to compare that with existing procurement processes because there are no similarities.

Q2: What are your thoughts about blockchain based public procurement?

You cannot buy blockchain. That is the problem. You can install that software and download to your organisation and use it, and then you become a part of a network but you can't buy a blockchain. It doesn't work like that. Of course there are companies trying to sell you blockchain(s) but that is not products.

Q3: So blockchain and its characteristics would not have added value to public procurement processes?

In the short term no but in the long-term yes for the simple reason that the characteristics that blockchain technically provides (transparency and immutability) only make sense if organisations that adopt this technology change their ways of doing things.

All the projects right now are missing the point. The projects I have seen, and it is not a lot, in procurement, are focusing on a detail of blockchain ecosystems. So, one of the details being transparency, one other detail being immutable ledger technology. That is not the main gist that blockchain provides. And these characteristics only make sense if you adopt the way organisations or individuals cooperate using blockchain networks. That is a networked type of collaboration and not a hierarchal type of collaboration.

For example, if you re-introduce a traditional invoice and contract structure with legal terms, the blockchain does not make sense anymore. And that is what most of these projects are trying to do. They are trying to take some aspects of blockchain technology and try to mix and match that in a sense with traditional governance structures, e.g. having legal contracts and invoice structures and they miss the point totally and the project becomes basically useless. This is still the level of knowledge I see with most projects, especially in government related organisations because they just don't have enough "know-how" to do it right and not the capacity to change so much to adopt this entirely new way of working. That is my personal analysis of how the market base operates.

Q4: What is your opinion about smart contracts and their potential to improve public procurement processes in action?

The first blockchain, Bitcoin, introduced smart contracts. Now we have many blockchains offering different types of smart contracts and there you see the same thing again. You see companies offering smart contracts. If a company claims and tries to sell you the internet, they cannot do that. They can sell you access to the internet or web-presence on the internet but they cannot sell you the internet. It should be a free resource.

In my mind a smart contract provides some piece of business logic that is automated. It can be any type of business logic, a procurement process, or a part of a procurement process but it can also be some other process, any business logic can be programmed into a smart contract, now or in the future.

But if a company tries to sell a government institution that business logic, they don't need a blockchain anymore so usually these projects have nothing to do with blockchain anymore apart from the name blockchain being used for the sales and marketing. I see that a lot.

> **Q4.1: Anything as a business logic can be automated or programmed in a smart contract?**
>
> The model is different. Normally in a procurement process you have some contract phase where a contract between a supplier and an organisation is signed and after that the services or the product(s) are delivered and then the invoice starts basically. That is what I know about procurement. That is the traditional vendor-client relationship. That is a fundamental difference with networks. In networks you don't need all these. You don't need a contract.

You can analyse what the business logic on the blockchain does and you are free to join in on that by basically using that smart contract or not using it and looking for another smart contract. So smart contracts - the business logic that provides some automated service - is just here, it is online, you can verify is, audit it, analyse it and if it does something that you like you can start using it together with other participants in the network. That is fundamentally different from the traditional acquisition or purchase requisition process we see in procurement today.

So that phase needs to be redesigned entirely because you are not looking for a vendor or a party that can do some work, you are trying to find a party that is represented through this technology that provides a specific service that you need and there is no trust involved. So the solicitation process and the purchase requisition process are there traditionally to gain trust in regard to the other party. That is no longer needed. You can just use the technology to analyse if it is trustworthy or not. But the process of doing those tests is still there but it is in no way comparable with the existing audit-processes that we know in procurement processes today.

And then, once you have a functioning use of a business logic that is used on a blockchain or a smart contract then you don't get into this invoice relationship but you just have pay per use mechanisms. When you use 1 millisecond of computing power in that smart contract process you may end up paying 0.001 cent for that. That is completely different with the contracts we see today.

Q5: Do you think that blockchain based public procurement (if achieved) would be more efficient than a traditional procurement process?

Yes, because you would not have all this legal red tape anymore. You would only have a well set-up computer architecture and a computer system in your organisation that does basically semi-fully automated procurement and every transaction is a pre-used transaction so if something goes wrong the risk is never bigger than one transaction. And all these vendors lock-ins we see today especially in the public sector can be resolved. Vendor lock-in is a huge problem nowadays. We are going to solve these with P2P technology but it will require these organisations to understand and adopt to the P2P model and that is going to take some time.

Q6: Is blockchain according to your opinion a technology that is suitable for proper public procurement?

Not at this moment because the organisational processes do not match up with this pay per use operational process. Companies are not used to pay on a pay per use basis, companies are not used to have computers for example reassess the entire procurement process in 5 seconds and buy the same business logic over these networks every 10 seconds from a different distributer. This is not how companies work. This is not how risk managers within organisations understand how to provide guarantees to shareholders. This is entirely off of the way organisations are being run today. But in the future of course organisations are picking this up and then on a pay per use basis these processes can be incredibly efficient and consumer oriented, but it is going to take time (20-30 years).

At this moment, only a few organisations that are tiny start-ups in the Silicon Valley for example are able to understand these concepts and are actually able to build the infrastructure within their organisation to have this type of flexibility and do the buying and selling of services and products in this manner but most organisations are not ready yet.

Especially public organisations, for example in the EU, they have still challenges that stand from the 70s - they have legacy infrastructure, extremely old architecture and adding a blockchain to that will not solve any problems but it will make the challenges only bigger.

Q7: Would you prefer a public or permissioned blockchain for public procurement processes and why?

A permissioned blockchain is not something that has been proven to be a sound business case, not for the organisations buying this. Of course a permissioned blockchain is a very sound business case for organisations such as IBM, Deloitte or Accenture but they are also making money out of this, selling databases that they call blockchain.

A permissioned blockchain, in my mind, has nothing to do with the P2P characteristics of blockchain in the first place. You should really re-assess if you need that. If e.g. Accenture is going to take the risk and you are going to pay for it why not build a database that Accenture maintains? You don’t need a blockchain for that.

The whole idea of blockchain is creating a P2P system and what permissioned blockchains do is that they re-introduce a central authority or trusted third party and that the whole reason of choosing a blockchain in the first place is inoculated. So there will probably never be a sound business case for companies to buy permissioned blockchains because there is no added value.

Q8: What are the biggest advantages and disadvantages that blockchain technology can offer to public procurement processes?

In the long term we're getting rid of extensive bureaucratic processes and lengthy (paper) contracts by replacing them slowly with an ecosystem approach that uses a common - unstoppable - business logic that guarantees execution, payment and enforcement through automated contract terms in an upfront compliant manner.

Q9: Do you think that blockchain based public procurement would make the employees and suppliers involved "feel" more accountable [e.g. due to the hashing of transactions]?

Not at all. This is a major problem in the implementation of blockchain with public organisations. So the advantage of the P2P is that you can verify everything that is happening. You don't need to trust a supplier or an organisation or individual, as a company or a government organisation you can audit and verify everything until the last piece.

The disadvantage is that this also comes with an enormous responsibility. So you should only endeavour in this P2P network technology if you are up for the task and the task will be that you take responsibility and make sure that you are not tricked into something or make sure that you cannot introduce bad governance or bad security measures for example. And this is the problem with implementation today because especially governmental organisation are not ready for that task.

They are used to hire organisations to do the work for them and then they re-introduce the same problem that they are trying to solve, for example vendor lock-in. Vendor lock-in is a big problem within governmental institutions because their entire procurement is based on a few IT providers and if you maintain that process where you try to outsource responsibility as a governmental institution then you might end up with the same problems and blockchain will not make it better.

On the contrary, it will make things more complex and expensive. The whole idea of a P2P network is to participate in that network as a peer and if you give up that aspect you probably don't need a P2P network and if you don't need a P2P network you don't need blockchain.

Q9.1: it would make things more complex and expensive although somebody could expect to make it simpler?

Not at this stage. It is very new, the blockchain space is inventing itself and it is an experiment in many directions. What governmental institutions now try to do is use it as a production solution for their procurement (in thesis). That is not a sound way of operating. If you are adopting blockchain technology, you have to accept that it is expensive because it is highly innovative. Therefore, it is going to run into all kinds of problems. It is not mature yet as a technology.

If for example, a company sells you a database for 10 times the price, that is basically fraud. But since nobody understands these staff it is not considered as fraud, yet. They would be pretending that you are buying something new as a governmental organisation but in fact you are just buying the same vendor lock-in and the same governance problems. Because the only solution that blockchain provides is a governance solution, it is not a technical solution.

The focus is mostly on the technical aspects because people writing about blockchain are usually tech-savvy people and they know a lot about technology. That is a problem in the space because all the texts and all the white papers and all the scientific reports they don't discuss-describe the fundamental aspects of blockchain, they describe the technical aspects. They are then misinterpreted because the broader picture is missed but the broad picture, this is why blockchains came into existence in the first place; the broad picture is that it is a different governance structure, it is a different way of doing things without a hierarchical institution in the middle.

The only reason that blockchain is there is that the people who invented BitCoin did not want to rely on a central trusted third party, so they got rid of the central banks and not because the technology of a Bitcoin is better that the banking technology. On the contrary, paying with the banking system is internationally much easier and better, but you can pay

now with the Bitcoin infrastructure, in spite of having a trusted third party. You don't need a trusted third party. And that is fundamentally not a technical solution because the technical solution of Bitcoin is worse than the technical solution of banking but the difference is that the technical solution of bitcoin no longer needs a trusted third party. And that is not a technological innovation, that is a governance innovation. What X, Y, Z. etc. companies are trying to sell is not a governance improvement but a technological improvement and this is where they are lying. The only reason to use blockchain is when a value chain needs a governance improvement and not a technical solution.

Q10: Do you think decentralisation can be of added value to public procurement?

We don't know. In procurement I haven't seen many projects that really use this alternative governance model that blockchain provides as a solution to something, but I have worked with a municipality here in the Netherlands for a little longer than half a year and one of the problems that they had was this vendor lock-in. They had this IT company, Centric, and basically all their communication of their IT infrastructure went thought the Centric server and this lead this heavy vendor lock-in situation.

They were thinking about chaining Centric for a different suppler and we discussed this problem. And the problem there is that it doesn't matter what supplier you end up choosing as a governmental organisations (in this case it was the municipality). In the short term the vendor will provide perfect service for a great price but in the long term as your organisation becomes more and more reliant upon this vendor they will have all the incentives to charge you more for less service. And that is a fundamental problem with traditional procurement value chains, the architecture of the market in the first place. And you can circumvent that very easily by introducing open source technology in the first place, so those vendors can no longer close their intellectual property rights and make you dependent on their software, so, my advice to municipalities and governments institutions in general will be to basically switch to open source and do not agree with contracts where vendors provide closed software services.

Once you are there, you have opened up the first part but then the operational processes remain part of your vendor lock-in in the long term. You can open that up using blockchain by automating parts of these processes and using maybe neutral positioned smart contracts in the network where you and all the participants of the ecosystem work together and collaborate instead of having this

traditional server or this traditional buyer seller relationship. Then it becomes an ecosystem-based approach to getting services and then you basically work more together and have more guarantee towards the future that you will not end up with this vendor just charging you money for less and less service.

That is my personal view and we don't know how this will evolve because vendors, have usually a business model that is not based on the work they do but is based on how many times they can send an invoice for the same work. So now, that is slowly changing but it is going to take time.

Q11: What do you believe would be the economic impact of using blockchain technology in public procurement processes?

Q12: What do you think are the biggest challenges that blockchain technology based public procurement could or would face in order to be implemented and established?

In general what you see is that a lot of money is being spent on these so called blockchain projects and companies that pay a lot to money for this end up having nothing in the end because they realise that it requires their organisation to fundamentally change their hierarchy or their governance structure and mostly the people on top are not ready to do that, so the projects ends up being useless.

So, that is the general problem with the implementation of blockchain I see everywhere because blockchain projects cannot be approached like traditional projects because you need, really, to work in a network and an open source environment to be able to get the benefits of blockchain. But specifically in procurement space, I think the biggest challenge is that these implementations of this collaborative approach are a direct threat to vendors.

Think about IBM, Accenture, organisations that can send 1.000 invoices for one line of coat, if they have a 1.000 clients, they can send 1 invoice 1000 times if they update some of the software. So there is an enormous incentive for organisations like IBM for example to prevent neutral permission-less networks such as blockchains to flourish in the short term, for the simple reason that it is going to cost them a loss of money. So especially in procurement, they will do all their best to mislead for example government organisations that buy their services into buying these proprietary solutions as long as possible in the same way the Microsoft prevented people from

buying Linux. They were very successful for a long time until now. Now it looks like most computers on the internet are Linux machines.

Therefore, we can expect similar behaviour in the blockchain space because if the blockchain disrupts a business model of e.g. IBM or if a blockchain disrupts a platform such as Airbnb or something like that, what these large companies will do is try to make the trustworthiness of blockchain in general more debated or maybe they start smear campaigns against bitcoin. You see that a lot. Especially in procurement, because that is where the money is made for vendors basically, they will have a big lobby and they will have heavy marketing campaigns to make sure the business models that fit the old governance structure that does not include blockchain, so that they will maintain this situation as long as they can. Calling databases blockchains to make sure they can have this old-fashioned invoice relationship as long as possible.

2. Interview - Olivier Rikken

Q1: What is your experience with Blockchain and/or public procurement (any governance and/or procurement related projects)?

I do have a lot of experience with governance and government procurement processes, and a lot of experience with blockchain as well but never in a combination of the two.

PhD on the governance of decentralised autonomous organisations on public permissionless blockchains.

Q2: What are your thoughts about blockchain based public procurement?

Blockchain can add transparency, by storing hashes on a blockchain you can prove the authenticity of documents etc. not in the process but in itself if you look at what is the added value of blockchain in the procurement process other than adding transparency, there are other means easier to implement than to use blockchain. That is my personal opinion. That might also be the reason that there is not a lot of literature around it.

But what you see within the initiatives within the governmental environment are more based around things like self-sovereign-identity or creating transparency with a unique form of privacy safe-keeping throughout processes. And this is how we see blockchain being used and also in administrative processes where you have multiple actors in the chain (industry chain).

So with regard to procurement, it will always be a highly centralised process where people will receive an RC, or an RP, or other, and they sign up for it and they hand in staff and then they get the job (yes or no). But in regard to the operational side of procurement, so if it not so much the first contractual part where the deal is done but more in the operational point of view then it might become interesting. That is because what we see is that if you have a procurement system where basically the people performing the actions are not part of the government but are suppliers or sub-suppliers, and that happens a lot actually, then it can help in reducing administrative burden throughout the chain.

So what we see there is that, for example for the municipality healthcare, which is a lower level governmental process, there you see that the healthcare is provided by a third party supplier but is

paid for by the government being the municipalities and what you have right now is a lot of discussions on how many hours were they actually spent; were these hours allowed under the contract; did you have a subcontractor; was this subcontractor allowed to spend these amounts… and this is where blockchain helps in realising a transparency and creating a single source of truth that you don't have three, or four or five administrations administrating all the different hours where you would have to start reconsolidating afterwards to see if the amount of hours that they actually claimed to have performed were actually true and be signed off for. And it can help them in the end in speeding up financial processes that want to work in forms, which the client signs off of this, that is where blockchain comes in handy.

So if you are looking for benefits in the operational part of the structural process, once the contract is set off and start going into the operational phase of the contract, basically the execution of the contract, then I see added value. If it is just for the contract negotiations on the front-end, so the pre-procurement and RP and RC, etc. then yes you might use blockchain for some parts but I think other technological elements are better.

Q2.2: So you wouldn't use it for the tendering and pre-tendering phase?

No, for the tendering and pre-tendering phase you just don't have any added value because you send in everything to a third party being the government and the only thing you could use it for is to add additional transparency to make sure that the government does not perform any malicious actions or there is some kind of fraud in the background. Especially for the Dutch market, I am not saying it is impossible, but then it depends on which country you want to implement it.

Because if you cannot trust the government system in itself to begin with, then it can really help into creating transparency in the process and making sure that the process steps are automated through the smart contracts, but depending on the country where you're in and e.g. the Netherlands which is the best country in the world on the front index basis along with Sweden, Norway, etc. then you really have to ask yourself "does adding blockchain or a trust layer of Blockchain add value to the process - are there multiple actors in the handling of the process, and in this case I would say there is only one actor involved - being the government - it is not a multi actor problem.

In the pre-tender phase I do not see the added value because we are not talking a multi-stakeholder system other than you have the potential supplier or multiple potential suppliers and one client being the government.

But in the operational part, so the execution of the process, there I see added value because then you would normally have multiple administrations where you have the reconciliations etc. and this is where you can really add value by eliminating that throughout the supply chain.

Q3: What is your opinion about smart contracts and their potential to improve public procurement processes in action?

The best way to explain it - smart contract - is an account where you decentralise logic. So for inter-company and process automation, this is something really good. You can use smart contracts if you want to do straighter processing or automated processing between various companies, then you can use smart contracts very well because you don't have to trust the other company that they keep track of the software right and vice versa because you put the smart contract in between on the blockchain and the blockchain, then depending on the kind of blockchain, its owned by nobody or basically by everybody and then it can really add to creating a level of trust between the companies that the agreement that they have agreed upon will be executed and none of the other parties can actually change the code to their benefit basically. So there we see added value of using smart contracts for business logic between in itself, where you use the ledger, the blockchain in itself, for entering of data to make sure that data stays authentic and nobody alters the data in itself.

If it is for a process optimisation within one company and for example a tender is always a process within one company basically, then in itself blockchain - smart contracts don't have that much added value.

So I would say only if you have, again, a multi stakeholder or multi actor environment where multiple parties need to agree on certain logic, then smart contracts have added value otherwise they don't.

Q4: What are the biggest advantages and disadvantages that blockchain technology can offer to public procurement processes?

First of all, the design of such a system needs to be done very carefully and thoroughly, because if you design it from then due to the transparency of blockchain in itself, company sensitive information and maybe even privacy sensitive information can be out there in a manner you don't want to use it. So basically, that is one of the concerns you always have to have when designing such a system. It is not impossible; you can easily design it in a way so it is usable but you really have to think it upfront.

Also in regard to the type of system you have to choose what kind of system it is and I wouldn't say that you use a permissionless blockchain for this, you will always be in the area of the permissioned blockchain.

Q4.1: why?

If you build it on a permissionless blockchain then your procurement process, the governance of the infrastructure where you build up is completely in the hands of everybody that has to agree upon it and I don't think that any government will ever allow that the governance of the infrastructure and thus also the smart contract code in itself, because that is embedded into infrastructure, will be in the hands of people they don't control.

The best example is if you build an application on Etherium and the Etherium community decides to change something to the infrastructure, in this case the Etherium network, that would lead to disfunction of your application and there is nothing you can do about it. You have very little to say in the governance of the infrastructure in itself. You only have a saying on the application level that you are building yourself and only so if you design it in such a way that not all the code is hardcoded into smart contracts that live in the blockchain in itself because as of that they become an integrated part of the infrastructure. So if you want to have some control over your application in this case, a tender application, you need to be very sure that you can influence the governance system of the infrastructure and also be sure that what you build in the application itself isn't completely set in stone in the blockchain in itself because then you don't have any influence if you want to change something through the process. So you have to be very careful with using permissionless blockchains.

In a permissioned set up that is much easier to build up in such a way because then you are in control of the nodes and thus in control of the governance of the infrastructure and changing the rules in the infrastructure is completely in your hands. [This is regarding my PhD]

Q5: Do you think that blockchain based public procurement would make the employees and suppliers involved "feel" more accountable [e.g. due to the hashing of transactions]?

The fact that you can undoubtedly prove that somebody handed-in or made a certain decision(s) etc. can increase the feeling of accountability. A negative side is that it can result in a certain freeze of people who will be bound to or really scared to make mistakes because every mistake is undoubtedly recorded. It is a double edge sword.

People are afraid to make mistakes. If a mistake is not record people are "easier" to act than when every decision is recorded. So it could have unexpected side effects. But that is every psychological though.

Q6: What do you believe would be the economic impact of using blockchain technology in public procurement processes?

Especially on the operational side of procurement, the economical effect is that we spend less time on administration and handling conflict etc. so that would mean that in the end-to-end supply chain or supplier chain we would have a certain decrease in cost. So the economic effect would redundantly be lower cost in complex environments and on the other hand it will also have the effect speeding up processes because unnecessary waiting will be much more visible in processes and in itself which if you consider time equals money, then it is a cost-saver as well. So yes, I think that we will have positive economic effects.

Q7: What do you think are the biggest challenges that blockchain technology based public procurement could or would face in order to be implemented and established?

First of all it is general trust in the technology. The technology, although it exists for 10 years, is not that old. 10 years for a new technology (existing) is not that long ago. The first AIs were launched 70 years ago. They don't have many big AI implementations yet (in blockchain), although people claim they are, they are not. So it is an intern stage technology. It is still available, so we need to get out and try our chances of technology in order to implement it in the public sector.

Secondly, if you implement this per definition, it is the implementation over the supply chain in itself. Any good blockchain implementation is convincing the whole ecosystem that the implementation is for the better of the whole ecosystem and not per se for the individual company (as such). And that is where we run into the problem that we tend to think as pure individuals all the time. So we always think and also on a company level, what's in it for me instead what's in it for supply chain. So if it means that a certain link in a supply chain has to incur a little higher cost while the rest of the supply chain can have much lower cost then your solution is not going to survive-fly because the individuals will say this is not beneficial for me so we are not going to do it. It is an ecosystem - and that is always the hardest one to do. That is one of the biggest challenges you are going to run into.

Lastly, do not underestimate how much people like in-transparency. A lot of people thrive by in-transparency. Transparency is a great good, but a lot of people do not like transparencies. Because it means, they are going to be hold accountable for their actions. We were referring to it earlier, and people don't want to be held accountable for their actions. That is a challenge in itself.

Q8: Do you think decentralisation can be of added value to public procurement?

Yes, disintermediation in that sense, might make processes in a certain supply chain more efficient and maybe you can take out the link in the whole ecosystem, that would be great, because that leads to less paperwork and less red tape etc. So yes, disintermediation is always a good thing, or at least, can lead to good things. It is not always the best thing, sometimes you want to have an intermediary in between for certain reasons.

Q9: Do you think that blockchain based public procurement would be more efficient than a traditional procurement process and why?

It could be, but that completely depends on the set-up. Especially if you use blockchain to guard the progress of the process of procurement we can have benefits with regards to speeding up the process in itself and because then you basically have an external workflow management system if you guard the progress through smart contracts or whoever you want to do it that could make the process more efficient but I am not sure if that is going to be the big denominator of why you want to use blockchain in the first place.

Q10: Is blockchain according to your opinion a technology that is suitable for proper public procurement?

It could be, if you want to use it to create transparency throughout the chain, yes absolutely. I think it is a proper technology to use for it but you always have to be skeptical - if it's the only technology you want to use; if it's the most straightforward technology to use for it because maybe another technology is more suitable. But given the advantages and also challenges that I gave, it is suitable. You shouldn't go blindly on blockchain technology as the most suitable technology to support these processes. If it is purely out of efficiency reasons, if its for reasons of immutability, handed in documents in combination with progress monitoring through the smart contracts etc. etc., then it could be the most logical technology, but you should always be critical towards this technology stack in itself to start with.

Q11: Would you prefer a public or permissioned blockchain for public procurement processes and why?

That is a hard question because it is an inner struggle. I always used to be a big permissionless fan but given the kind of information you might want to store and the lack of governance control you have in a permissionless set-up, given that it is a public procurement process and taking also into account the stakeholders who are behind it - I would go for permissioned in this case. Although I am a big fan of permissionless. And I don't see any technical/performance reasons why you should want to use a permissionless blockchain in this one, because the amount of transactions is not really important in these kind of processes but I think in the end from a governance perspective you want to be in a permissioned set-up.

3. Interview - Brendan Abbott

Q1: What is your experience with Blockchain and/or public procurement (any governance and/or procurement related projects)?

I am a Senior Manager at Deloitte and I work at our government and public services blockchain practice. I've been doing blockchain for about four to five years now and I have worked with government(s) in the US. Primarily federal government but some state governments to evaluate blockchain and implement blockchain. So I have a fair amount of experience working with government agencies and seeing some of the challenges that they have and the benefits that they can get from blockchain. I also have a degree in Public Policy and Management from Carnegie Mellon University, at Pittsburgh.

Q.1.1: how did you start working with blockchain?

I have been working in and out on emerging technologies for twenty to twenty-two years now. It was one of the latest technologies, and I was working for a government agency and I was running for them a digital incubator where we were evaluating new technologies that can help them potentially lower costs and generate more revenue and as part of the ones identified it was also blockchain. So we looked at a bunch of technologies and ended up at looking at blockchain. I was just very excited about the potential for blockchain and how it could potentially revolutionise a lot of the way(s) we do IT systems today and we integrate IT systems, so I started getting involved and I have been working on it ever since. And I have worked on government blockchain projects for federal and state government agencies.

Q.1.2: is it possible to give me an example?

We are not allowed to share who they are specifically but I can tell you that federal agencies are mainly what we call civilian, so civilian are the ones that are related to military, health or defence or intelligence so mainly civilian agencies who provide citizen services.

Q2: What are your thoughts about blockchain based public procurement?

From the capability side I think blockchain provides a lot of potential. There are a lot of potential projects where they are trying to identify trust in suppliers, so there are blockchain networks where people are indicating potential suppliers to work with, they could be used in procurement. So these trusted supplier networks are one way it's being used. Another way it's being used is the procurement process. Frequently there are a lot of different touch points and potentially different

organisations included in it and blockchain is providing a secure way for people to go all the way from requesting a proposal, through actual selection process, project initiation, all the way through kind of project close-out and it's providing the audit trail all the way along the process. So if anyone comes back and needs to audit if this procurement was done appropriately and following the correct rules, they would be able to have that audit. So that is another good way that is being used.

From government's procurement side, so how do they procure blockchain, if we look at that angle, that's where there's a fair amount of challenge. Based on the community nature of it, it is not a party of one or two, blockchain is a party of five or ten or a million. So it consists of P2P technology, having governments collaborate to fund it and operate it, that is where the big challenges are right now for the implementation. We get over a lot of the technical hurdles but there are a whole lot of government hurdles on how do you actually procure and manage and operate these blockchains That is one of the biggest challenges right now.

Q2.2 How do think that can be tackled?

I do think it is definitely possible to tea scare of the governance concerns and the process concerns and to circle back a little bit, there definitely are some challenges. Some of the ones you've probably heard about or probably already know based on your personal research is privacy - how do you handle personal identifiable information or making sure that you are in compliance with GDPR or US privacy laws. You have to be really smart about how you are implementing something to make sure you are not putting publicly identifiable information on the chain where it is going to be there forever if it immutable whereas GDPR says you have the right to be forgotten. So you don't want to save that on a chain if you can't back delete it later if somebody executes their right to be forgotten. So there are definitely some technical challenges there. I just think always of the governance once and the process once being more of a challenge.

Q3: What is your opinion about smart contracts and their potential to improve public procurement processes in action?

So most of the parties that we see in the government in the US are permissioned blockchains they are not the public ones. None of our governments are, right now, using Bitcoin, or Ethereum, they are all using permissioned versions of their protocols because there are still a lot of trust considerations and security considerations.

Smart contracts are absolutely fantastic if we've used them extensively for government agencies using blockchain. There are of course challenges associated with it, but they are extremely powerful and valuable for blockchain implementations.

Q.3.3 What would you say are their biggest benefits?

In a sense it automates business rules that cross organisational boundaries. So sometimes we think about blockchain as being multi-organisation business process improvement or re-engineering. So within there, there are tons of business rules some of which cross organisational boundaries and the smart contracts automates that and provides the trust in the technology.

Q5: Do you think that blockchain based public procurement (if achieved) would be more efficient than a traditional procurement process?

In some cases, certainly in the very complex situations that I've talked about, in situations where you want to have a shared ledger of vendors-suppliers and experiences that you want to be able to quickly look for other examples of where the work has been done before. In other cases, it's going to be heavier than you need. One of the things we always tell people is "if another technology works you should do that instead of blockchain because blockchain brings some other baggage along with it."

Q: 5.5 Could you provide me an example? Is there a specific alternative solution often seen?

Probably the biggest test here is if it is from within a single organisation. So a single government organisation may want to still have immutability, audit-ability, transparency but it does not include other organisations. There are a lot of technologies out there, non distributed ledgers technology that are similar and can play that role. They are kind of internal or single organisation solution(s) that still provide the audit-ability, immutability, transparency. Amazon Ledger Database is an example. There are other things like Hashgraph, there are a whole bunch of different solutions out there that are not distributed ledgers/blockchain that can provide the alternative.

Q6: Is blockchain according to your opinion a technology that is suitable for proper public procurement?

Absolutely, especially because public procurement(s), governments, there is always need for additional transparency. Citizens want to see where their tax dollars are going and ensure that is being done in the most open and secure way. So from that perspective I think there is tremendous potential.

Q7: Would you prefer a public or permissioned blockchain for public procurement processes and why?
Please refer to Q3.

Q8: Do you think that blockchain based public procurement would make the employees and suppliers involved "feel" more accountable [e.g. due to the hashing of transactions]?
I wouldn't say that it is the hashing that provides the accountability. I think it is the transparency that provides the accountability. But I do. The key there is that as with any of these implementations you have to show the value of "what's in it for them" otherwise there is no need for them to contribute. That is why you've seen some of these larger blockchain consortiums get stalled, into a certain point, because mainly it was a single infant lead blockchain versus a community and they didn't take time to figure out what's in it for all the members so the members stopped contributing.

Q9: Do you think decentralisation can be of added value to public procurement?
Decentralisation…, I do, because I think it has potential to make the process more efficient with a better quality results. So if the promise is filled, if we can do public procurements, have a better quicker list of trusted suppliers, once again if you are looking at it from the from-end versus the post-award, this is how I am thinking of it. If you have a better qualified list and better information that is available at real time, that can help provide some great efficiencies.

Q 9.1: Is it possible to provide an example?

Sure. One of the things that we talked about a little bit was that there are blockchain initiatives in public procurement around trusted suppliers. So, who are the suppliers of materials and services. So having kind of the Blockchain be able to create appropriately available about suppliers, services, ratings - in the US we have these things called C pars, I don't know if you have them overseas or not - where they are essentially grades for service providers and contractors. Having that available to the appropriate focus in the procurement ecosystem gives you much better information much faster.

We have a lot of requests for information rights so like the freedom of information act and things like that where certain information needs to be made public. And having that trusted audit of who promised what when is super valuable as well.

Q10: What do you believe would be the economic impact of using blockchain technology in public procurement processes?

I think it is much more of an expense. It is more of an expense in compliance benefits than revenue unlike in banking where most blockchain initiatives are based on potentially new revenue. In government it is frequently based on "can we do something that we do now more efficiently and can we have better compliance".

Q11: What do you think are the biggest challenges that blockchain technology based public procurement could or would face in order to be implemented and established?

I think it is all the non technology challenges. I think it is the governance. The fact that blockchain is a P2P or community-based technology, it makes it difficulty. I always try to give the example - you know that doing process improvement in a single large organisation is hard and then trying to do it across organisations and industries working together, which can sometimes include competitors working together [inter-coopetition is the term they use a lot], that is hard. It is the governance, how are you going to run it, who is going to pay for it, how do updated get made, what rules do you agree to? That is the hard part.

Q11.11: In procurement, if you have multi-stakeholder relationship between a government and multiple vendors is it an issue of government again?

I think these relationships exist today, so I don't think that is so much the problem. I think it is hard I don't think it get any harder with blockchain, I think it is more of the getting everyone on the same page on why they want to work together on this platform and it could totally be because it is a government mandate but getting everybody to see the value and what's in it for them to participate, that is the hard part.