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Replacing Trust:

A study of blockchain applicability in maritime logistics

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ABSTRACT

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In situations entailing risk, trusting others can leave you vulnerable to opportunistic behaviour. This holds true in domains where organisations work in alliances and there is a need for interfirm trust. Blockchain technology aims to solve trust challenges by enabling transactional data sharing and decentralisation. It can be used to reach consensus about shared states between collaborating parties without trusting a central authority. With the rise of research and projects about the use of blockchain technologies in maritime logistics, our study aims to further explore the possibilities of blockchain as a solution for trust challenges in maritime logistics.

Our study drew inspiration from Design Science Research Methodology (DSRM) and we chose to explore challenges in maritime logistics through the lens of trust. We conducted four qualitative semi-structured interviews with experts in the maritime logistics domain in combination with a literature study of the current state of blockchain research. Since this is an explorative study with a limited time-frame, we realised the first two steps of the original six in DSRM. These steps were used to identify problems in the chosen domain and define which problems can be solved with blockchain solutions.

Our findings suggest that there are four main challenges related to trust in maritime logistics. (1) Lack of communication, (2) Opportunistic Behaviour, (3) Distrust in information and (4) High interdependence between actors. For each identified problem, objectives for a solution have been created. For the four problems discovered in this study, the solutions include more transparent transactions of information; a lower involvement of the shipping agent; incentivised information sharing; and lowering of interdependence between actors.

Keywords: Blockchain, Maritime, Logistics, Interfirm, Trust, Opportunism, Decentralise

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1. Introduction

In today's business, the utilisation of Information Technology (IT) resources is paramount for companies to work in collaboration and to remain competitive. It is inherent for most companies today to apply IT as a tool for e.g. information management, and investment in IT resources can be linked to more effective and efficient processes if done right (Prasad et al. 2010, 2012). Organisations today engage in interfirm relationships to create value through co-creation which might contribute to e.g. development of new products, facilitate the management of complex processes and share costs (Rai et al. 2012). However, for interfirm value to be possible, some measure of interfirm trust must be reached to streamline the cooperation between the actors (Laaksonen et al. 2009; Das & Teng 1998).

Although the creation of trust between multiple organisations is not a simple task, it should be considered a worthwhile venture to create competitive advantage (Barney & Hansen 1994). Researchers such as Barney & Hansen (1994) have for a long time been studying the complexity of trust within organisations without finding any one clear answer for how to solve issues related to it. However, with the use of modern technology new possibilities are made available. One of these possibilities is blockchain technologies, which aims to create a solution to trust related issues in transactions of information.

Transactions of information in the modern era are often centralised and controlled by a third party. One prime example of this is how we manage money with the help of banks (Yli-Huumo et al. 2016). As this structure not only applies to money, but to other domains such as digital ownership of music or contracts where all data and information are handled in a centralised manner and controlled and managed by a third party, there are some prominent challenges where e.g third parties charge fees for transactions (Swan 2015). Blockchain technologies have been proposed as a solution to these challenges. Being a technology created to enable decentralised environments where no third party is in control of transactions and data (Nakamoto 2008).

At its core, the blockchain is a decentralised database technology that records transactions in a way that allows it to be sequentially updated, but not manually erased or altered (Lindman et al. 2017; Tapscott & Tapscott 2016; Swan 2015). This allows the blockchain to keep a historical trail of all data that is or has been stored in the blockchain and can potentially enable better data security than ever before (Mougayar 2016). This historical trail of data is shared and available to all nodes in the network, which makes the blockchain a more transparent way of storing information than centralised third party solutions.

To study blockchain technology as an enabler for untrusted transactions between individuals in different organisations, the research context needs to be a domain where trust is a central issue and where we can identify challenges related to trust. With studies and projects for blockchain solutions already being conducted in the domain of logistics (Andersson & Sternberg 2016; Higgins 2016), we chose maritime logistics as the research context for our study.

Maritime logistic and transport by sea make up for around 90% of global trade today (IMO 2011) and is consequently an essential part of the global economy. The continuous importance of maritime logistics can be observed by the growing trend and increase in traded goods, with a volume surpassing 10 billion tonnes in 2015 (UNCTAD 2016). Arguably, efficient and effective transport by sea is important for global health and economic growth (Imo.org 2017). Stopford (2010) emphasise the importance of maritime logistics as follows; *"If shipping stopped for 3 months, so would modern life as we know it."* However, the need for sustainable methods to decrease the environmental footprint of maritime logistics is of great interest for the future, e.g. by working with ballast water management, control harmful anti-fouling systems, waste disposal, the fuel efficiency of ships and management of sea traffic (IMO 2011; Andersson & Ivehammar, 2017).

In Sweden, 90% of all goods enters and exits by sea transportation. Also, a third of Sweden's foreign trade and about 60% of Sweden's total container traffic passes through the port of Gothenburg (Sjöfartsverket 2013; Göteborgs hamn 2013). This, and the 11,000 arrivals the port of Gothenburg handles each year makes it the foremost port in Scandinavia (Göteborgs hamn 2013). Gothenburg Port Authority is owned by the city of Gothenburg and responsible for maintaining and developing the infrastructure of the port of Gothenburg. Gothenburg Port Authority is also responsible for safe, efficient and sustainable arrival and departure processes (Göteborgs hamn, n.d.1). Actors handling towage, loading/unloading of goods and such are specialised private actors (ibid). Shipping agents, administrative authorities and hinterland logistics in addition to these are all involved at one point in the arrival and departure process of a ship (Sjöfartsverket 2013; Haraldson 2015). Consequently, these actors are dependent on collaboration and information sharing to plan and perform their business (Haraldson 2015). This calls for safe and effective means to share information among these actors to enable environmentally sustainable sea transports and operational efficiency for all involved actors (Haraldson 2015; Sjöfartsverket 2013). The actors relevant for this research are described in more detail in *4. Research Context*.

An example of the need for interorganisational trust between actors in maritime logistics can be seen through the collaboration between the IT company IBM and the logistic company Maersk. The collaboration aims to implement a blockchain solution to reduce the handling of trade documentation and to reduce the risk of errors in the physical movement of paperwork. By implementing a solution to solve these issues, and thus removing the need to rely on another human party to handle your documentation, the collaboration between Maersk and IBM aims to potentially change the way global trade is done (Hand 2017).

Maritime logistic, and logistics in general, relies on collaboration between a multitude of actors to function smoothly, and thus good communication between these actors is a necessity for efficient handling of ships to be a reality (Smith 2016b). It is therefore important that a trusting relationship is established between these actors to ensure that their partners will act in a way that is beneficial for them, and not in an opportunistic way (Wei, Wong & Lai 2012). Wei et al. (2012) also describe the benefits of a trusting relationship between actors as it reduces the cost of monitoring behaviour and information validity under uncertain circumstances. As Maritime logistics in an environment characterised by high uncertainty due to the unsteady circumstances of sea transportation, e.g. changes in weather, availability at port and ships breaking, trust between the partners working together help out by enabling an actor to trust in their partner to work through these unforeseen circumstances in an efficient way (ibid).

1.1 Research question and purpose

With the rise of blockchain technology in areas other than currency (Swan 2015; Tapscott & Tapscott 2016; Mougayar 2016; Beck et al. 2016; Lindman et al. 2017) a wealth of possibilities for governing, managing and storing information have been shown as possible applications (Swan 2015; Tapscott & Tapscott 2016). One of the big challenges in online transactions today that blockchain aims to find a solution for is trusted recording of large-scale P2P (peer-to-peer) activities (Lindman et al. 2017).

Information handling in maritime logistics is as mentioned a highly complex matter involving several independent actors relying on each other to conduct their business. Given the importance of maritime logistics for global trade and health, and the possible promises of blockchain technologies to facilitate trust, we conduct this research with the aim to investigate the possible application of blockchain to solve issues related to trust in maritime logistics. This results in the following research question:

"How can blockchain technologies be used to solve challenges related to trust in maritime logistics?"

To make a contribution to the field of Information Systems (IS) with our research and to explore the possible applicability of blockchain technology to solve trust issues in maritime logistics, we chose to conduct a partial Design Science Research (DSR). This was done by focusing on a realisation of the first two steps in Peffers et al. (2007) Design Science Research Methodology (DSRM) i.e. (1) *Problem identification and motivation;* and (2) *definition of the objectives of the solution*. Our choice to only perform the first two steps in the DSRM was consciously made based on the timeframe of this research. We are aware that choosing to realise the first two steps on DSRM and to not build and evaluate an actual artifact, brings with it questionable rigour of this paper. However, conducting a thorough DSRM process would lower our possibility to make any contribution of note as DSRM is a time-consuming process that takes time. Nevertheless, by focusing on the early stages of the DSRM process we believe that we still can make an acceptable contribution by paving way for future research. DSR and DSRM and how we chose to realise this is described further in *3. Research Method.*

2. Theory

This section will provide a description of earlier work on the topic of Trust, followed by an introduction to blockchain technologies including definitions, examples of applications and an introduction to methods currently used to reach computational trust. Most examples are based on the cryptocurrency Bitcoin, which also is one of the most rigorously researched blockchains to date (Yli-Huumo et al. 2016).

2.1 Trust

Trust among organisations plays an important role to facilitate the cooperation between two or more organisations working in the same environment (Laaksonen et al. 2009; Das & Teng 1998). Organisations pursue collaboration with the hope of leveraging advantages such as joint ventures, reduced cost through cost sharing, innovation, complex process management and access to new resources (Rai et al. 2012; Das & Teng 1998). However for this to be a possibility, a certain level of trust between actors must be reached to enable cooperation between them (Das & Teng 1998; Laaksonen et al. 2009).

When talking about trust in interorganisational cooperations, we first have to specify our definition of *trust*. We will adopt Boon and Holmes (1991) definition of trust as "*positive expectations about another's motives with respect to oneself in situations entailing risk"* in this paper. Laaksonen et al. (2009) point out that the element of risk is a core issue concerning trust. To develop trust among individuals, or organisations, risk and trust work in synergy as one has to risk oneself and be left vulnerable for another actor to prove himself trustworthy to not take advantage of the actor taking the risk (Laaksonen et al. 2009; Das & Teng 1998; Krishnan et al. 2006). Trust is in this regard the level of confidence the beneficiary puts in the trustee to not take advantage of the situation.

Organisations working in alliance rely on the *interfirm trust* i.e. that their partners will not take advantage of them by e.g. cheating, distort information, mislead them and provide them with inferior products or services (Das & Teng 1998; Krishnan et al. 2006). Interfirm trust is the confidence among organisations that one will not take advantage of another's weakness when faced with the opportunity to do so (Krishnan et al. 2006; Barney & Hansen 1994). The issue of interfirm trust is problematic as an organisation pursues their own interest while simultaneously working together with other organisations, with interests of their own (Krishnan et al. 2006; Das & Teng 1998). Though the benefits of good interfirm collaboration may generate advantages such as reduced costs and, the benefits may decrease under certain circumstances according to Krishnan et al. (2006). Environmental uncertainties environments that are inherently volatile and subject to changes is an example of such circumstances where trust may be a problem. (Krishnan et al. 2006) argues that trust in information from partners in such an environment may lead to inadequate control of that information, and thus not always unproblematic as it opens up the possibility of biases in review of the information received, leading to poor decision-making.

The behaviour we have mentioned above, taking advantage of a partner in an exposed position, is a behaviour we will address as *opportunistic behaviour*. Opportunistic behaviour is dependent on the existence of vulnerabilities to exploit (Barney & Hansen 1994) and we adopt the view that opportunistic behaviour directly affects the level of trust between two or more partners. Alliances operating in a competitive environment may have strong incentive to not trust each other as the risk of

the partner acting in an opportunistic way to gain a competitive advantage is possible (Laaksonen et al. 2009; Krishnan et al. 2006). This can lead an organisation to withhold resources to the alliance, and thus weaken the advantages of benefits of the alliance (e.g. reduced cost, innovation, complex process management) (Krishnan et al. 2006; Barney & Hansen 1994). Interfirm trust can mitigate such problems as it increases the organisation's confidence that their vulnerability will not be taken advantage of, and thus not withhold fewer resources from the alliance and the strategic advantages of the collaboration (Krishnan et al. 2006; Barney & Hansen 1994).

Information Technology(IT) is a collaboration tool has been shown to help the firm with the co-creation of value and enhancing their performance, through information sharing in interfirm collaboration, advantages such as economies of scale, risk and cost sharing has been shown (Kumar & van Dissel 1996). As blockchain technology is an IT-solution with the purpose of enabling untrusted transactions of information between individuals, the technology could be applied in organisations with these three aspects in mind.

2.2 Blockchain

Blockchain is an emerging database technology that is characterised by being trust evoking and decentralised in nature (Seebacher & Schüritz 2017). The technology was first conceived in the paper *Bitcoin: A Peer-to-Peer Electronic Cash System* (Nakamoto 2008). In this paper, a conceptual infrastructure consisting of a peer-to-peer network and multiple protocols that would allow a digital transaction system without the need of an intermediary to prevent double spending of digital assets; that timestamps each transaction and creates a historical record of transactions; and where the users in the network provide their own computer's computational power to validate *blocks* (a collections of transactions).

In the case of Bitcoin, a new block is created and added to the blockchain roughly every ten minutes (Nakamoto 2008), but different blockchains use different timeframes based on its use cases. In the case of Bitcoin, each block contains its own unique, irreversible cryptographic key, a timestamp and a reference to the most recent block's cryptographic key. This creates a chain of blocks where each block has a reference to the most recent preceding block - hence, the technology is called *the blockchain* (Swan 2015). The blockchain can also be described as a public ledger of all transactions that have been executed within the blockchain network since the creation of the *genesis block* (the very first transaction ever executed within each blockchain) (Swan 2015).

Another implementation of blockchain that has met considerable success since its release is *Ethereum* - an open blockchain platform enabling anybody to build and use distributed applications that run on a platform which distributes computational tasks of decentralised applications between the nodes in the network (Yli-Huumo et al. 2016). Ethereum has been used to create decentralised versions of existing applications e.g OpenBazaar, a digital decentralised marketplace not unlike Ebay; and Storj, a decentralised peer-to-peer equivalent to Dropbox, among many others (Swan 2015).

As stated earlier, trust in an alliance of organisations is dependent on the level of confidence the organisation puts in its partners to not exploit vulnerabilities (Barney & Hansen 1994; Laaksonen et al. 2009; Krishnan et al. 2006). It is also stated by Weber et al. (2016) that a lack of trust may lower innovativeness and hinder the effectiveness and performance of the alliance, which consort with the argument by Krishnan et al. (2006) that distrust in an alliance may lead to withholding of resources.

Blockchain technologies can in instances of distrust among organisations act as a solution to such problems, as the organisation would not have to trust partners to not exploit their vulnerabilities. Instead, they trust in the blockchain and its network of untrusted nodes (Weber et al. 2016). As blockchain is not reliant on any centralised authority, and the data stored on the blockchain is inherently immutable (Nakamoto 2008; Mattila 2016; Swan 2015), it is arguably an enabler of trustless collaboration among organisations, as they would not have to trust in each other to work together.

The inherent characteristics of blockchain technologies ensure the integrity of data by securing direct interactions with the use of cryptography and transparently enabling every user in the network to verify registered transactions (Seebacher & Sürich 2017). This fact, in combination with the technology's immutable design, meaning that broadcasted transactions cannot be altered (Nakamoto 2008), helps facilitate trust. Also, the decentralised nature of blockchain ensures that there is no single intermediary who controls the system (Seebacher & Sürich 2017). These mechanisms enable participants in the network to establish a relationship where they can interact directly with reduced friction when transactions of information are needed.

There are several startups working on new applications of blockchain. One of these is Everledger, which focuses on the identity and legitimacy of objects (Underwood 2016). One of their earlier projects was a distributed ledger of diamond ownership and verification of transactions for owners, insurance companies and other stakeholders in the diamond industry. Another startup doing work with blockchains is Factom, a company focusing on making data more secure in different fields such as land registry, information management and financial technology solutions (Underwood 2016). The success of these two companies shows that blockchain technologies can be effectively used for applications other than monetary transactions.

Initiatives to use blockchain as a solution to challenges in maritime logistics also exists. Maersk and IBM have partnered up in a project which aims to "[...] digitise the complex paper trails associated with tens of millions of containers [...]" (Hand 2017). The goal of this project is to reduce fraud and errors, improve inventory management, minimise courier costs, reduce delays from paperwork, reduce waste and to identify issues faster than traditional means of information management (Storgaard 2017).

Yli-Huumo et al. (2016) have identified four research gaps in current Blockchain studies. The four identified areas are: a current lack of research on limitations of blockchain technologies; a lack of research on usability of blockchain; a majority of current research is conducted in the bitcoin environment; and a low number of high-quality publications about Blockchain. During our own study of literature on blockchain technologies, we found these research gaps to hold true, with the most important research gaps for us being the last two of the four earlier described.

2.1.1 Smart Contracts

According to Szabo (1994, see Tapscott & Tapscott 2016) description of a smart contract was:

> *"A smart contract is a computerised transaction protocol that executes the terms of a contract. The general objectives are to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimise exceptions both malicious and accidental, and minimise the need for trusted intermediaries. Related economic goals include lowering fraud loss, arbitrations and enforcement costs, and other transaction costs."*

Since then the conceptual explanation has been utilised by the blockchain which offers most of the solutions to these requirements for smart contracts. If we were to give a simpler explanation of what a smart contract is, it could be described as a set of rules and conditions written by a user of a transaction platform with the goal to automate transactions of a given digital asset when said rules and conditions are met.

A simple example of a smart contract in the Ethereum blockchain would be a case where someone writes an application for Ethereum which keeps a live record of the exchange rate of oil. When the exchange rate for oil hits a level set by the user, the smart contract can, for example, buy all the oil it can currently find for sale on the internet. Smart contracts, in essence, allows you to automate transactions without the involvement of a middle-man.

2.1.2 Consensus Mechanisms

For a blockchain application to effectively decide if a given set of transactions is valid, it needs some kind of algorithm or process to let the involved computers in the network reach a consensus about which version of the block is the "correct" one. There are many proposed models to reach computational consensus. Bitcoin, for example, uses *proof-of-work* which lets each *full node* (a computer which has a full copy of the blockchain and is available to be used for validation) try to come up with a solution to the current block's cryptographic key, with a new block being created every ten minutes. This requires computational power and electricity that is paid for by the user, but the computer that finds a solution to the given block is rewarded with a set amount of bitcoin and is chosen by the network as the holder of the correct version of the blockchain. This give-and-take philosophy is ultimately this consensus model's biggest strength (Swan 2015; Tapscott & Tapscott 2016).

The Ethereum blockchain uses *proof-of-stake* which deterministically (pseudo-randomly) chooses the creator of the next block based on each node's wealth (Swan 2015). This means that the more Ether (the cryptocurrency used to pay for calculations in the Ethereum blockchain) a node holds, its chances to create the next block increases. The point of this consensus model is that the right to create a new block is given to those who are holding the currency, and its presumed that these people are large stakeholders in the system which makes them less inclined to attack it (Poelstra 2015).

There are many more consensus models e.g. *proof-of-burn, proof-of-validation, proof-of-importance, proof-of-storage, ripple protocol consensus algorithm* amongst others (Mattila 2016). There are variations of these consensus model currently being used by different blockchains, but those won't be explored in this paper. These all involve different methods of creating consensus between different nodes and enforcing computational trust between users. However, there isn't any one silver bullet for all computational consensus. Different blockchains will have to evaluate and choose its own consensus model based on its specific needs (Mattila 2016).

2.1.3 Design Principles for Blockchain Applications

According to Tapscott and Tapscott (2016), there are seven design principles needed to be taken into consideration when designing software, services, business models, markets and organisations with the goal of applying blockchain technology to a real problem. These design principles are inherent within to blockchain technology itself and one needs to ask whether the blockchain is a suitable candidate for a solution to the given problem. They were designed to give creators of blockchain solutions a way to think about the possibilities of the technology, and our aim is to evaluate whether these design principles can be used to discuss the usefulness in the context of a specified problem.

The design principles are:

1. **Networked Integrity**
   The level of trust one places in the integrity of someone or something is highly dependent on the level of integrity the other party can prove (Tapscott & Tapscott 2016). When Satoshi Nakamoto first published his paper on *Bitcoin (Nakamoto 2008)* proposing a solution to handling integrity of digital value, the solution revolved around replacing money. The basic idea can be applied to any type of digital asset and disrupts current, centralised solutions by creating a way to place trust in the hands of the network itself, rather than individual members (Tapscott & Tapscott 2016).

   On the internet, direct transactions of money historically have not been a possibility. If you were to transact digital information between two parties using the traditional internet protocol the transacted information can be stored both on the sending and receiving ends, much like how you can copy a picture file on you PC and send it to someone. This obviously creates some problems if instead of a picture, we were to send liquid assets. Copying and spending liquid assets is called *The Double Spend Problem* (Tapscott & Tapscott 2016).

2. **Distributed Power**
   The blockchain, by design, has no single point of control. No single party can shut the system down, tamper with information within the system or be the target of a hacker attack. Also, every member of the network can see what is going on in the network, further proofing the network from an attack where more than half of the members in the network attempts to overwhelm the whole. This kind of attack is also called a *51% attack* (Swan 2015).

   There are however ways that some of these blockchains are actually being used that points toward a centralization of the technology. In the case of Bitcoin, a relatively small group of miners in the Bitcoin blockchain has significantly more power than all the other users combined (Gervais et al. 2014). It has also been found that the rich gets richer, quite literally. Apparently, the wealth of rich users increases faster than the wealth of users with a lower

balance. In fact, as of 2014, 6.28% of the addresses in the bitcoin network possesses 93.72% of the total wealth (Kondor et al. 2014). This, of course, raises the question whether Bitcoin is on its way to becoming a more centralised currency, much like the paper money it originally set out to question.

3. Value as Incentive

In order to make sure the information handled in a blockchain is valid and up to date, different consensus mechanisms are used to enable the network as a whole to reach consensus on the validity of the information (Tapscott & Tapscott 2016). In the case of bitcoin, the consensus mechanism being used is called *Proof-of-Work* (*PoW).* PoW lets members of the network with extra computational power - also called *miners* - help validate the current block in the blockchain, rewarding those who manages to find the correct solution to a very complex mathematical problem with liquid assets within the blockchain. So, by acting in one's self-interest, miners also contribute to the P2P network (Tapscott & Tapscott 2016).

In the Bitcoin network, the average user typically acquires bitcoins by either earning them as compensation for goods/services or by buying them at an exchange site. This can be seen as a consequence of the fact that the effort needed to generate new blocks has increased over 10 million times, which means that mining today requires specialised, expensive hardware in areas where electricity is relatively cheap to be a worthwhile activity (Kondor et al. 2014). The set quantity of bitcoins that are rewarded to nodes that manage to create new blocks are also halved every four years (Tapscott & Tapscott 2016). These facts in combination could mean that the value of mining diminishes as time goes on and creates an economy where only a few, very powerful nodes control the validation of the bitcoin blockchain (Kondor et al. 2014). However, consensus models that limit the work required to create blocks have been proposed, which can serve as solutions for these kinds of problems (Luu et al. 2015).

4. Security

Blockchain technologies heavily rely on cryptography and anyone who wants to participate must use cryptography. The consequences of reckless behaviour are isolated to the one who acted recklessly and won't affect the rest of the network. Since a blockchain is designed to rely on consensus among the participants of the network, the security of the network increases exponentially with its size (Tapscott & Tapscott 2016). The entire history of a blockchain is also available to each and every participant in the network, which means that any discrepancy can be traced back historically.

The most fundamental fear in the Bitcoin network is the so-called *51% attack*. There are however more security issues in the Bitcoin blockchain (Tschorsch & Scheuermann 2016). One of these is the issue of securing each user's wallet, which in essence is a pair of strings consisting of numbers, letter and other symbols. These strings are called private/public keys. Wallets can be stored in everything from software to paper or a user's mind. All that is required is for the private/public keys to be stored in tandem. Each bitcoin has a reference to a public key which is used to transparently keep track of which wallet owns which coin. If someone were to gain access to someone else's wallet, there is nothing stopping them from spending all the currency you hold or send it to themselves. This creates a need for secure and rigorous third-party software where users can store their bitcoins while keeping them safe from hackers. The need for a safe way to store information about wallets remains true for every blockchain application (Tschorsch & Scheuermann 2016).

5. **Privacy**

Surfing the internet and using online services often requires you, the user, to provide some set of information about yourself to the provider of said service. This information can then be sold to advertisers or be used to track your habits. Blockchain technology solves this problem by giving the user control over their own information and disconnecting the transaction from the individual. If the user has a reason to share some information about oneself, the user has the final say about which information gets shared (Tapscott & Tapscott 2016).

In a blockchain network, all transactions are transparent and announced to the public, without any information linking the transactions to identities (Yli-Huumo et al. 2016). The infrastructure behind this is based on a system where *wallets* (the medium used to store ownership information of assets in a blockchain network) only contains a private and a public key. These are used to prove ownership of both the wallet itself and the coins held by it (Nakamoto 2008). No information linking to wallets to identities are held within the wallet. There are however some studies arguing that one can analyse transactions and link them to traffic patterns of IP addresses in certain Blockchain networks (Feld et al. 2014; Koshy et al. 2014). This could lead to privacy issues in Blockchains which require a certain level of privacy for its users.

Multiple solutions for privacy issues within blockchain networks, and Bitcoin in particular, have been proposed (Ruffing et al. 2014; Androulaki & Karame 2014; Valenta & Rowan 2015; Ziegeldorf et al. 2015). According to Yli-Huumo et al. (Yli-Huumo et al. 2016), some of these solutions utilise a transaction mixing technique which allows users to move Bitcoins between wallet addresses without any direct linking between them.

6. **Rights Preserved**

In the digital era, everything from music to video and images is uploaded to the internet. There have been some major issues in the management and ownership of such information, to compensate the creators and where to store data about ownership. Some solutions are based on a service architecture where those who need to use a piece of e.g. artwork pays fiat currency to a centralised service which then allows you access to download this information. However, the issue arises when that data has been made available for the user, and the information is no longer in control by the network. The artwork in question can be copied and shared without any technical restrictions for free, without any requirement to compensate the original creator. Ownership of assets in a blockchain are transparent and enforceable, enabling each participant to have their rights recognised and respected. One needs to own something to be able to trade it and blockchain helps the network keep track of who owns what at any given time (Tapscott & Tapscott 2016).

7. **Inclusion**

The larger the number of participants, the safer the blockchain (Tapscott & Tapscott 2016). Therefore, blockchains benefit from including as many users as possible. Even though the system is designed to run on existing internet protocols (e.g TCP/IP), it could potentially run on older/lower-end devices using lightweight clients which would enable more users to participate (Tapscott & Tapscott 2016). This design principle is best exemplified with liquid assets in developing countries where modern banking is not publically available and high-end computers are not the norm.

3. Research Method

Here we present the procedure for data collection and analysis along with chosen research method to evaluate how blockchain can be used to solve trust related challenges in maritime logistics. We begin with describing our approach to design science research, following with a description on how our selection of interviewees to explore the maritime logistics domain and trust related issues therein. Following this, we lay out how we conducted our research and finally the method for analysis of data.

3.1 Design Science Research

One of the main contributions of Information System (IS) research is to further the knowledge on how to apply IS to make organisations more effective and efficient (Hevner, March, Park & Ram 2004). Venable and Baskerville (2012) define Design Science Research (DSR) as: *"Research that invents a new purposeful artefact to address a generalised type of problem and evaluates its utility for solving problems of that type"*. An wartifact in DSR is, therefore, an artifact designed with the aim to solve a generalised type of problem. The artifact is then evaluated to measure whether that has been sufficiently done (Hevner et al. 2004; Peffers et al. 2007). By solving a generalised type of problem in contrast to a specific one, the artifact can be implemented and used in different environments and context apart, thus making a greater contribution to the field (Venable & Baskerville, 2012; Peffers et al. 2007; Hevner et al. 2004). By evaluating whether the artifact actually fulfils the requirements imposed upon it, the rigor of the artifact and its contribution is tested (Peffers et al. 2007). As DSR is inherently an iterative process (ibid), the evaluation process gives feedback of the effectiveness of the artifact to improve the quality of the solution (Hevner et al. 2004).

An artifact in design science can be e.g. constructs, models, methods or instantiations. In theory, an artifact can be any designed object with a specific contribution in mind (Peffers et al. 2007), and is often not fully-fledged information systems, but rather constructs that define previous notion as to what is possible to do in an efficient and effective way (Venable & Baskerville 2012).

Hevner et al. (2004) present seven guidelines for design science in IS research; *Design as an Artifact, Problem Relevance, Design Evaluation, Research Contributions, Research Rigor, Design as a Search Process* and *Communication of Research*. These guidelines are to be used as a help for researchers in conducting a more effective DSR process and evaluation to help create purposeful artifacts. Below are the guidelines as described by Hevner et al. (2004):

Guideline	Description
Guideline 1: Design as an Artifact	Design science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-evacuated evaluation methods.
Guideline 4: Research Contribution	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilising available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

Table 1: Design science research Guidelines (Hevner et al. 2004).

These guidelines provide the researcher with an understanding of what is required by the output of a DSR project. Although Hevner et al. (2004) argue that all these guidelines should be used or at least considered, they are not to be used in a compulsory way. Each researcher has to adapt them to fit their specific research. A weakness in our research is that our decision to concentrate on the first two steps of the DSRM, we could not design an artifact for evaluation and thus, the relevance and rigour of our work can be questioned since we cannot evaluate, test and prove the validity of our artifact. We use the guidelines to evaluate our research, and as a help to think about how our proposed solution is relevant to the proposed problem domain. The arguments for the relevance of our research can be found in *6. Discussion.*

The DSRM by Peffers et al. (2007) introduces, implements and evaluates a methodology for conducting DSR in IS. This process consists of six phases; *problem identification and motivation, definition of the objectives for a solution, design and development, demonstration, evaluation,* and *communication* (ibid). Below, a description of each step is provided according to Peffers et al. (2007) definition:

Phase	Description
Problem identification and motivation:	Definition of the problem and motivation for a solution for the problem.
Definition of the objective for a solution:	Define the terms and goals for the new solution e.g. how the new artifact would solve heretofore unresolved problems.
Design and development:	Create an artifact. This step involves the creation of the artifact and the functionality and architecture of the artifact. An artifact can be any object e.g. model, method, system or construct that contributes to research with its design.
Demonstration:	Demonstrate how the new artifact solves one or more of the objectives.
Evaluation:	Observe and evaluate how the new artifact reaches the objectives and solves the intended problem.
Communication:	Reach out and communicate the artifact, its utility and effectiveness to relevant audiences.

Table 2: The six phases of DSRM (Peffers et al. 2007).

Peffers et al. (2007) point out that these phases, although presented here in sequential order, can be used with different approaches. These are; (1) *a problem-centered approach*, (2) *an objective-centered approach*, (3) *a design and development centred approach* and (4) *a client-/context- initiated approach*. A problem-centered approach would be e.g. if the research is based on an observation of a problem. An objective centred approach would be based on an observed need by industry/research that can be resolved by an artifact. The design and development centred approach could start with an artifact used in another context to solve different sets of problems, this solution would then be applied to the current problem domain as a solution to a different set of problems that those originally intended. A client-/context- initiated approach could be an existing artifact that in theory should solve a problem, but with no context to test it in. A client/context-initiated approach would be e.g. a client request to solve a problem, and the artifact is applied to the client's specific problem domain.

3.2 Chosen method

In our research, we decided to implement the first two phases in Peffers et al. (2007) DSRM; (1) *Problem identification and motivation* and (2) *definition of the objectives for a solution*. We started off from an already existing artifact, Blockchain, and thus our approach is design and development centered as we aim to study the applicability of blockchain in a new context. Although the use of blockchain in logistics in not a new notion (Stan Higgins 2016; Bitkan 2016) there are no examples of how blockchain can be used to deal with trust issues in interfirm relations to our knowledge.

3.2.1 Problem identification and motivation

This step involves discovering the research problem and justify why the problem needs to be resolved. Discovering the research problems involves researching the problem domain and the challenges they experience there. Following problem identification, a justification for why a solution is desirable needs to be developed. The reason for this is to motivate the researcher to develop the solution, and to facilitate the reasoning of the researcher and his/hers understanding of the problem (Peffers et al. 2007). Depending on the research approach, whether it is a *problem-centered approach, an objective-centered approach, a design and development centred approach* or *a client-/context- initiated approach*, this process will look differently for each research (ibid). The result of this phase is the identification of problems and the motivation for the solution to work further on the next step of the research.

3.2.2 Definition of the objectives for a solution

This step of the process involves defining the goals the future artifact. It is built upon the knowledge achieved in the problem identification phase. Depending on whether or not there the researcher describe how the new solution is better than the old one, or how it solves a heretofore unsolved problem. If the artifact is inferred from a different context than originally intended, that is, *a research and development centered approach*, hence not a new artifact, the possible objectives and possibilities of the artifact would be known (Peffers et al. 2007).

We chose to use a qualitative approach using semi-structured interviews and a literature review. We chose to use a qualitative approach with interviews over other methods such as a survey study since qualitative interviewing allow us to probe deeper on certain topics and to analyse the interviewee's reactions in a way written material would not allow (Bell 2010). As we needed to get insight into "how" blockchain can be used to solve trust issues in maritime logistics, we first needed to understand what kind of problems existed, and how they were experienced by people with an understanding of maritime logistics, and information handling.

We used semi-structured interviews for data collection as it allowed us to ask the people working in the maritime logistics domain about their view on the subject, and also to probe deeper on certain topics that revealed itself during the interviews (McCracken 1988; Silverman 2009; Bell 2010). To ensure that we asked relevant questions for our research and to help us gather the data we needed, we did a literature review on blockchain, trust and the maritime logistic domain to help us create an interview guide (see Appendix 3) (McCracken 1988; Rubin & Rubin 2005). We did this by constructing the interview guide using main themes containing topics we wanted to know more about in large, and then using *ad-hoc* follow-up questions to encourage the interviewee to elaborate upon topics that were revealed during the course of the interview (Rubin & Rubin 2005).

3.3 Selection/limitation

The respondents we spoke to were all in some way associated with the maritime logistics domain. Two of the respondents were employed by the Swedish Maritime Administration (SMA), one was working for Gothenburg Port Authority and one for RISE Viktoria. The interviewees were chosen based on recommendations by external parties for their expertise in the problem area and their technical work roles. We needed respondents with expert knowledge in their respective roles and insight in both operative workflows in maritime logistics as well as their information systems for them to be able to be to help in our research. Below is a short description of each respondent and their work experience:

Respondent	Expertise
Respondent **A**	Former shipping agent and captain. Works with Research and Development (R&D) at SMA
Respondent **B**	A former worker at Gothenburg Port Authority in an unspecified role. Works with R&D at SMA
Respondent **C**	Former shipping agent. Experienced with information system sciences, currently working with R&D at RISE Viktoria
Respondent **D**	Former pilot and captain, currently a deputy harbour master at Gothenburg Port Authority

Table 3: Summary of respondents

We limited ourself to four respondents even though more were available to us. The four respondents described above were experts in their respective areas and we concluded that our understanding of the research problem was reached after speaking to them. It is plausible that further understanding would be reached with more respondents, though with the limited time for this research that would prolong the time for transcription and thus affect the analysis, which is a crucial part of this process (Silverman 2009). Thus we concluded that four respondents were sufficient for our research, and given the respondents' diverse set of skills, we concluded that a holistic view of the domain was created after speaking to them.

3.4 Data Collection Process

We chose to use semi-structured interviews for our data collection. As the maritime environment is complex and contains a number of different actors, we needed to understand the view of the problem area from different perspectives and thus concluded that semi-structured qualitative interviews were best suited (McCracken 1988; Rubin & Rubin 2005). All interviews were performed face-to-face in Swedish and recorded after receiving either written or verbal consent (see Appendix 2), using a smartphone as the recording device. We chose to record our interviews to reference them later in the research process for enhanced understanding, and to better relay what was said (Silverman 2006). The interviews were all performed in the respondent's offices after scheduling for the interviews by e-mail or phone in advance.

As blockchain is a relatively new occurrence in the maritime logistics domain, we started off with introducing the basic concepts of blockchain to the respondents. We did this to provide them with a comprehensible view on what blockchain is, and to give them some understanding as to what we are researching. Following this, the interview was carried out by asking the respondents our main questions from our interview guide. We designed the interview guide in a way that allowed us to explore the concepts of blockchain without explicitly mentioning blockchain terminology in the questions. We did this to avoid confusing the respondents with specialised terminology.

After the interviews were finished, we began our transcription of the interviews as soon as possible as not to forget hand gestures or different kinds of body language (Rubin & Rubin 2005). We used the web-application oTranscribe (Bentley, n.d) for the transcription of our interviews. As there were only four interviews to transcribe, we did a detailed transcription of each. During the transcription of the interviews, we marked and coded interesting quotes the respondents mentioned as a first part of the analysis. The upside to doing detailed transcriptions of our interviews is that it allowed us to recollect what was said in more detail and thus enabled us to extract more information from each interview and to facilitate the analysis as mentioned above (Silverman 2009).

3.5 Analysis

To make sense of our data, we conducted thematic analysis (Braun and Clarke 2006) to structures the respondents' answers about their views on different problems or situations in the maritime logistics environment. This was made by marking and coding text from our transcripts on sticky notes with either a quote from the interview or a code describing the specific problem mentioned. After this was done, we went through all sticky notes and discussed each of them and how they did or did not relate to our definition of trust. We filtered through the results several times, discarding sticky notes that did not fit our research, putting several notes together that dealt with the same issue or some issues that we found fit the blockchain domain, but not directly related to trust, in a separate category.

Working the material over and over again in this manner gave us a deeper understanding of the problem, and the possibility for new finding and also some differences in opinion between the respondents regarding some instances in maritime logistics. A possible risk though by doing the aggregation of findings across several interviews and trying to define the deeper meaning of the respondent's answers is that through our own cultural lens as IS scholars, we run the risk of imputing meaning to the answers that were not the intention of the source (Rubin & Rubin 2005). We made certain to read the material thoroughly to not misinterpret its meaning.

4. Research Context

This part of the report aims to give context and understanding of the actors and the complexity of the maritime logistics domain. This information will be focused on the non-regular traffic in Gothenburg harbour, and will not contain information about cruise ships and other regular traffic. It will also be focused on the actors involved in the handling of arriving ships. It is by no means a complete description of all the aspects and actors involved in the day to day work in the port of Gothenburg, but should instead be seen as a description of the complexity of the environment. The last part introduces an exiwting initiative to solve some of these issues, namely *Sea Traffic Management*.

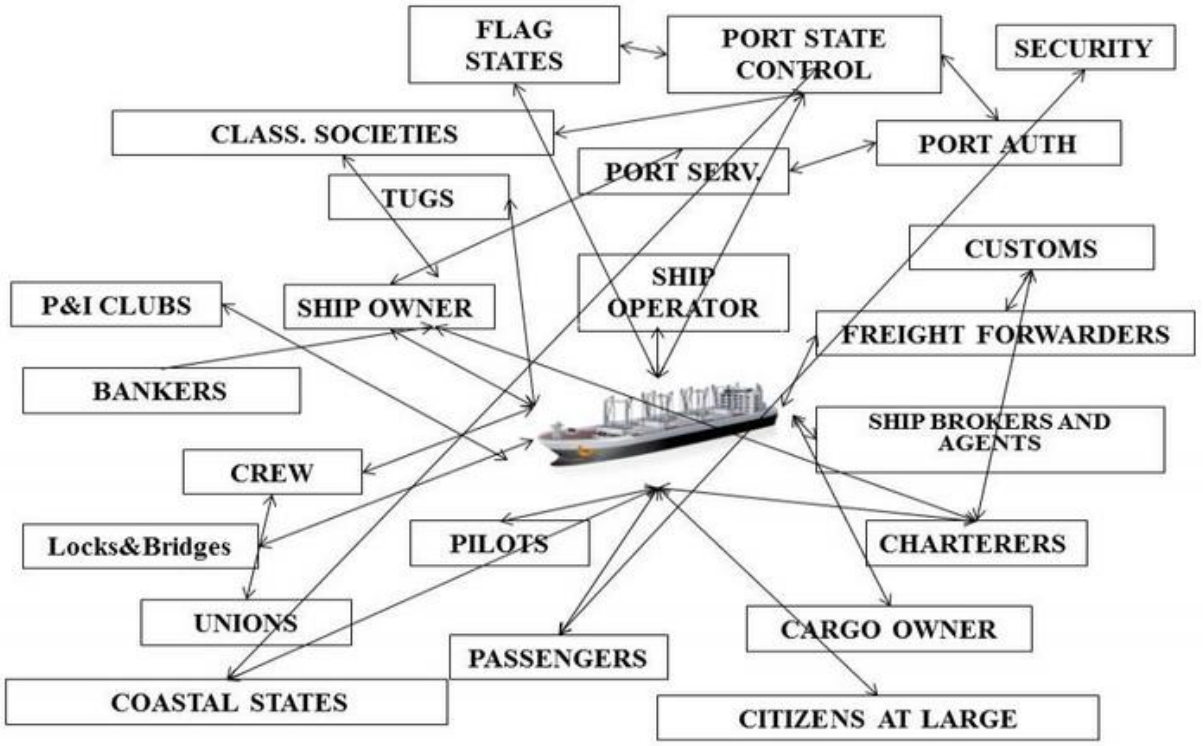

Figure 1: The ship in an information hub (Smith 2016a)

Figure 1 shows an example of the complexity in maritime logistics by illustrating the communication between the ship and the rest of the world (Smith 2016a). The ship updates different actors, either automatically or manually, about e.g the estimated time of arrival, passengers onboard and cargo. Drawing a conclusion from this figure, it is apparent that some level of trust has to be established for the actors to work in collaboration. For example, the pilot is dependent on the information about the ship's ETA, and so is the port authority and tug boat operators. This information is today reported by the agent that receives the information from the ship's captain. If these actors are to plan their business based on this information, it is important that it is reliable. However, this is not always the case as information gets lost along the way due to different factors such as the human factor (Smith 2016a; Smith 2016b).

4.1 Actors

Here we describe the actors in the port of Gothenburg relevant to our study based on our literature review of the maritime logistics domain and our results. To fully grasp what our respondent and we are describing throughout *5. Results* and *6. Discussion*, the reader needs to have a basic knowledge of what the different actors in the Port of Gothenburg do on a day-to-day basis and which issues they might face in their work.

4.1.1 The port of Gothenburg

The different actors that have to communicate and work together in the arrival and departure of ships are all part of the Port of Gothenburg. It also includes the infrastructure and the land area. All these actors are dependent on each other to ensure efficient, secure and environmentally friendly arrival processes. The port of Gothenburg have the largest container terminal in the Nordic countries, and process 60% of Sweden's total container traffic. The port is also responsible for nearly 30% of Sweden's foreign trade and is thus an important commercial centre for Sweden (Göteborgs hamn 2013). All actors in the port of Gothenburg conform to the regulations of the Swedish Transport Agency (STA) who is responsible for the attainment of transports of high availability, quality, security and efficiency (Transportstyrelsen 2017). The STA is also responsible for observing whether the regulations are followed. The STA follows regulations and takes advice from the International Maritime Organisation (IMO). IMO is an organisation concerned with the development of international regulations and legislation to ensure safe, secure and efficient transportation by sea (IMO n.d).

4.1.2 Gothenburg Port Authority

The Gothenburg Port Authority is a self-sufficient company owned by the city of Gothenburg responsible for maintaining and developing the infrastructure in the port of Gothenburg (Göteborgs hamn, n.d.1). Management of ships and other cargo-related activities are handled by private a function of Gothenburg Port Authority called Port Control which is a coordination tool for port calls in collaboration with all terminals in the port of Gothenburg. All approaching ships have to send a notification to Port control prior to the ship's arrival. Port control is also responsible for issuing services e.g sludge handling, fresh water and beyond that authorises diving and various maintenance work. Port control works in partnership with the Swedish Maritime Administrations (SMA) pilot ordering function and VTS-central in what's called the Gothenburg Approach which will be described below.

4.1.3 Swedish Maritime Administration

SMA is a government agency providing the maritime transport in Sweden with efficiency, safety and environmentally friendly services, e.g pilotage, fairway maintenance, maritime traffic information and more (Sjöfartsverket 2013). The most important customer of the SMA is the merchant shipping. The SMA provide pilotage within Swedish sea territory (Sjöfartsverket 2016). Pilotage is mandatory for ships exceeding a certain size or ships carrying certain types of cargo (Sjöfartsverket 2013). When a ship is about to make port in Gothenburg, the pilot boards the ship and help the captain navigate their ship safely and efficiently while making port. To make port in Gothenburg, ships need to report their Estimated Time of Arrival (ETA) in the Maritime Single Window (MSW) Reportal system at least 24 hours before arrival. At least five hours before the actual arrival of the ship, a definite booking for pilotage needs to be made. This is carried out by the SMA's *Pilot Ordering Function.*

The *Vessel Traffic Service* (VTS) is a service that provides ships with traffic information in heavily trafficked areas (Smith 2016b). In the port of Gothenburg, all ships above 300 tonnages, or 45 meters long, are obligated to report the ship name, ETA and more according to the VTS central. The VTS central in turn provides an extensive image of a limited geographical area to help operators navigate the waters safely and effectively using radar, closed-circuit television, VHF radiotelephony and Automatic Identification System (AIS) to track ship movement (Göteborgs hamn 2015; Sjöfartsverket 2012).

MSW Reportal is a reporting system hosted by the SMA. Ships entering a Swedish port need to report information required by different authorities, e.g The Board of Customs, SMA and the coastal guard to be allowed to make port. When the information has been entered in the system it is automatically forwarded to the connected authority. The Port of Gothenburg's system PortIT is one example of the connected systems that make use of the information entered in MSW Reportal (Sjöfartsverket 2017b).

4.1.4 The Gothenburg Approach

The Gothenburg approach is an initiative by the Swedish Maritime Administration (SMA) and Gothenburg Port Authority to provide faster, simpler and more environmentally sustainable port calls. It's a coordination of SMA's *VTS information, pilot ordering function* and Gothenburg port authority's *Port Control* (Sjöfartsverket 2012). The objective is to streamline the make port processes of the ships by providing them with information about the situation in port, thus enabling them to e.g. adjust their speed accordingly. The Gothenburg Approach integrates and houses these function in one office to provide faster information sharing and coordination of services. This is a way to gather every involved partner in one make port process, and thus facilitate planning, increase control and optimise capacity utilisation at the dock. This creates collaboration advantages for everyone, especially for private actors at the dock who is dependent on correct information at the right time for arrivals and departures (ibid).

4.1.5 Shipping Agent / Ship Broker

The shipping agent represents the shipping company and the captain at the port and is nominated and hired by either the shipping company or cargo owner (Sveriges Skeppsmäklareförening 2017). It is the shipping agent's responsibility to order all the necessary services for the ship at port, which includes e.g. ordering pilot, towage, linesmen and informing authorities with the information required to make port in Swedish territory. The shipping agent is required to enter all relevant information about a ship's port call in Reportal; the Swedish Maritime Single Window system (MSW) at least 24 hours prior to arrival.

The shipping agent is also responsible for updating the actors at the port about changes in a ship's Estimated Time of Arrival (ETA) and Estimated Time of Departure (ETD). In addition to this, the shipping agent is also responsible for ordering necessary services for the ship and the crew onboard. This may include services such as sludge disposal, ship maintenance, hospital visits and transportation for the crew and change of crew if needed. The shipping agent makes cost calculations for the shipping companies before arrival, and attend all documentation in connection to a ship's call to port (Sveriges Skeppsmäklareförening 2017).

As the Shipping agent acts as the ship representative at port, he or she is responsible for updating information regarding a ship's arrival and is consequently an important actor that hold information that other actors in port have to rely on in their planning of their day to day activities. An issue with this is that an agent usually manages several ships at the same time and communicates information between several different actors. This opens up for the possibility of information getting lost along the way as a result of the human factors, as information such as the voyage plan for a ship can be updated several times during the course of a day (Smith 2016b).

4.1.6 Tug Boats / Escort Tugs

Towage in the context of maritime logistics is the act of hauling or moving one vehicle with the use of another. In the port of Gothenburg, this is handled by Svitzer (Göteborgs hamn, n.d.B) which provides tug boats and escort tugs for arriving and departing ships. Towage is mandatory for ships with a tonnage above 30 in the port of Gothenburg. Each terminal has different rules regarding the required number of tug boats for ships and this is decided between the Gothenburg Port Authority and the SMA (ibid). The tug boat's assist ships that are too big to operate by themselves in the narrow passages of the port to navigate and steer. This is done by attaching powerful cords at the rear of the ship. The pilot onboard the ship operates in close communication with the tugboat operators to steer the ship to berth.

It is important for the towage company to have access to the right information about the arrivals and departure of ships to be able to plan their resources effectively. For example: if Svitzer receives an order for a towage of an arriving vessel at a specific time-frame, resources and tug boats will be allocated to that order. In the case that the arriving ship is late or for some reason doesn't arrive on time, the tug boats will have to wait. Having tug boats operational but not doing any real work aside from just waiting can cost large sums of money for all actors involved.

4.1.7 Terminal

A terminal is a private company providing different kinds of services, of which there are many in the port of Gothenburg. The Ro/Ro (roll-on/roll-off) terminal handles the shipping of cars, trucks and similar vehicles. The APM Terminals handles over 60% of Sweden's total container traffic and the Energy Port is the Nordic countries' largest Energy Port, handling goods such as oil, petrol and diesel (Göteborgs hamn 2013). As mentioned earlier, each terminal is a private company, but work in close collaboration with the other actors in the port community and is dependent on the information sharing between actors to plan and execute their day to day activities.

Since the each terminal is in charge of ordering services such as towage for arriving and departing vessels, it is crucial that they receive timely and reliable information about the parties involved. If a terminal receives a faulty timeframe for an arrival, services such as towage and cargo loading may be ordered, leaving the operators of those two services with faulty information about the arrival or departure of the vessel. This can lead to involved actors having to wait for the vessel to get ready, costing large amounts of money and ultimately hurting many actors involved in the specified process.

4.2 Sea Traffic Management

The Sea Traffic Management (STM) project's goal is to raise security, reduce environmental impact and increase effectiveness at sea through activities such as route optimisation for the departure of ships and route exchange between ships (Sjöfartsverket 2017 a). This project is part of a long-term plan to achieve more sustainable and effective logistics The MONALISA project (2010-2013) and the MONALISA 2.0 project (2013-2015) proved this possible through information sharing and new services and following this, the STM project was initiated 2015 (ibid). The STM project is co-funded by the European Union (EU) with 50%, with a total budget of 43 million Euros (STM, n.d.). The STM project is a collaboration between 50 partners from e.g. industry, academia, administrative authorities and with over 13 countries participating (Sjöfartsverket 2017).

STM includes five activities which aim to solve different issues with information management in maritime logistics. These five activities are Port Collaborative Decision Making, Voyage Management, Maritime Simulator Network, SAR Simulation Exercise, Maritime Service Infrastructure and Analysis & Evaluation. Of these five activities, the most relevant one for our research is Port Collaborative Decision Making (PortCDM).

PortCDM is a tool used for information sharing among stakeholders with the objective to increase punctuality, reduced waiting, lowered anchoring time and higher predictability. The stakeholders are e.g. shipping companies, ships, towage companies, terminals, port and hinterland operations (Lind et al. 2015). The goal of PortCDM is to make information available for the purpose of improved situational awareness to support better decision making (ibid).

5. Results

To present the findings of our empirical work in a clear and methodical way, we have chosen to categorise our findings over four themes we identified in the analysis of our data. Each section begins with an explanation of each theme related to trust, and then the problem we found related to each theme from our interview. In each part we present the respondents view on challenges in maritime logistics, and our explanation of how those views relate to our research. The quotes presented in this chapter are free translations of recordings done during data collection. The original Swedish quotes can be found in *Appendix 1*. Note that the quotes in the *appendix 1* are not entire transcripts, but rather outtakes from different interviews conducted during this study. The translated quotes in this chapter have been indexed for cross-referencing against the originals.

5.1 Opportunistic behaviour

Opportunistic behaviour is the act of taking advantage of another's weakness in the opportunity to do so (Barney and Hansen 1994). In our interviews, opportunistic behaviour tended to be brought up when discussing the role of the shipping agent and issues related to competition. For this reason, we have chosen to divide this theme into two parts: Opportunistic c*ompetition* and *Opportunistic shipping agents*. The first section, *Opportunistic competition* shows findings of opportunistic behaviour related to competition between multiple actors. The second section, *Opportunistic shipping agents,* contains findings of the opportunistic behaviours some shipping agents might exhibit in their day-to-day work.

5.1.1 Opportunistic competition

> **B:** *"[...] but then there is the market structure… It involves some foul play with the contracts and company ships, they move back and forth, so by default, there can not be any trust because the system is in some way built upon the notion that you keep the location of your ship a secret to improve your negotiations with the cargo-owner."* Quote: 19

Respondent **B** claims that the maritime logistics industry is in some ways based on foul play (inappropriate, unethical or unlawful conduct) and withholding information from your competitors. This fact directly affects the level of trust one can place in others while working in maritime logistics.

> **B:** *"[The Energy Port] maybe do not want to release [their] information regarding Preem for instance. Releasing information about their ships to competitors like ST1, who you share a berth with. It is like a race: first come, first served when the ship… So you may want to hold on to some information… If you have something in there, to create the opportunity for your own boat to arrive first."* Quote: 20

Respondent **B** continues by comparing maritime logistics to a race between shipping companies where ships who are able to reach a destination before others can reap great benefits. With this in mind, people involved with each ship might be inclined to withhold certain information, e.g. the ship's location, from other actors in order to gain a competitive advantage.

> **B:** *"But there is also a lot regarding the arrival of the ships here because it is all different actors, except the pilots that are… It is managed privately somewhere and is supposed to generate money. And this foul play that I mentioned can be another example. Because of the tugboats there… They may not always feel like sharing how much resources they have at any given time, and where… It may be that you have two departures at four o'clock that both are in need of tugboats. Well, then [a tugboat company] may only have the resources to handle one ship at a time. While the optimal thing for the port and everyone else might have been if they had used two tug boats and handled the departures… Well, simultaneously."* Quote: 21

On an ending note, Respondent **B** further exemplifies the reasons for opportunistic behaviour in maritime logistics with an explanation of a case where a tugboat company is not upfront with the number of tugboats available at any given moment. This might lead to the tugboat company having the upper hand in negotiations over who to serve first.

5.1.2 Opportunistic shipping agents

> **B:** *"But anyway… That penalty fee, it consumes the shipping agent's commission. In that case, they'd rather order a pilot for the wrong time and let the pilot wait there for maybe an hour in vain and cost... Because your invoice would say 'cost for pilot' instead of penalty fee in that case... And that fee is easier to get paid for"* Quote: 5

Respondent **B** describes an example of the shipping agent knowingly scheduling a pilot at a faulty time in order to protect himself. As the shipping agent is responsible for payments to all involved actors, such a temporary solution might enable the shipping agent to protect some of his commission from penalty fees by disguising them as other costs.

> **A:** *"It's not certain that the shipping agent updates information in the system. It's not certain at all, you can't trust that."* Quote: 3

Respondent **A** emphasises that you can't trust the shipping agent to upload information in their systems at all times.

> **D:** *"[the shipping agent gets bad reputation] because they fribble with information that is important to update in our system. And that can cause serious troubles actually"* Quote: 2

Respondent **D** also explains that the reputation of shipping agents is affected by their actions.

> **A:** *"The shipping agent is actually a messenger of a helluva lot of documents. [...] There might be a blackout, or that [the ship] for some reason have to decrease your speed and arrive six hours late, and your new ETA might then be 6 p.m. instead. The shipping agent "forgets" to do the update in Maritime Single Window, then the other actors will not receive that information. So you still think: 'The port thinks that the boat is still arriving at 12 a.m' That is until you track the boat on your AIS for example and you notice that: 'Damn, this boat is moving way too slow to arrive at 12 a.m.'"* Quote: 4

Respondent **A** describes that the shipping agent might forget to update systems with all information, at the same time putting air quotes around "forget". The problems that arise because of this is exemplified with a case where some actors might not have up-to-date information about a ship's arrival, which later surprises and confuses them because the boat's automatic tracking system is showing that the boat might not arrive in time. He also shares his perspective of the shipping agent as a messenger of large amounts of documents.

5.2 Criticism of resources

In maritime logistics, different sources of information are considered more reliable than others. Our results show that this directly affects the level of trust individuals place in the information they are given, affecting the decision-making process.

> **B:** *"Well, no. I can not imagine [anonymous updates] would work. Sure, it might be fun, and it might resolve some issues if you could be anonymous, but at the same time… Then you could not trust that information if you did not know where it came from."* Quote: 18

When asked about his stance on anonymous sources in maritime logistics, respondent **B** clearly states that you need to know where the information is coming from in order to trust it.

> **A:** *You collect all information and then you make an assessment based on the information you have at hand. So you can not really get… Sometimes you wish you could control that, because some sources are more reliable than others.* Quote: 28

For several decision-making processes, respondent **A** claims that you try to collect all available information and then evaluate whether the information you've been able to collect is trustworthy. He ends by stating that some sources are more reliable than others.

> **A:** *"In some instances that is probably the case, [that the captain has the best information]. And as long as the ship is at sea then it is pretty reasonable to assume that the captain has the best information, not the agent, not the port, not the terminal but the captain. He resides on his boat so it is not strange to assume that. But you have other situations that we mentioned earlier when that is not the case. There are other situations where, depending on the source of the information, how probable or reliable it is."* Quote: 10

The reliability of information in maritime logistics is largely dependent on where it's coming from. According to respondent **A,** it's safe to assume that the skipper of a boat has the most reliable information about that particular boat while the boat is at sea, and other sources might be more reliable under different circumstances.

> **A:** *"[...] But ETD however, that's a whole other ball game. It's dependent on so many different variables, like, the terminal is super important there. Only the terminal knows when all the operations for a boat are finished."* Quote: 15

Respondent **A** brings up ETD as a time stamp that's particularly hard to decide. The departure of a boat is dependent on a lot of variables, which makes the role of the terminal especially important. Since the terminal might hold the total information about the departure, it is valued higher.

> ***C:*** *"[The terminal] claims [the ship] can make port by 11 p.m. And then you just… 'But they told me it's due 9 p.m. last time I spoke with them.' [...] 'When did you last speak to them and who did you speak to?' And then you get, like… 'Yeah, I spoke to them two hours ago.' 'Ok, but I called 15 minutes ago.' 'Well, then your information is more recent than mine, so it's probably more correct.' So basically, it's a lot of… negotiation over phone calls all over the place. So, a time stamp update might require nine calls all-in-all."* Quote: 26

Collecting information might not always be the easiest task. Respondent **C** gives us a re-enactment of multiple actors trying to agree on what the most accurate information is.

> ***C:*** *"There is a public site, LotsInfo, that is available to the public. There you can see ships that are piloting. But it's somewhat delayed and you can't see if it's a temporary or definite booking."* Quote: 25

Respondent **C** also brings up LotsInfo (eservices.sjofartsverket.se, n.d), a site containing information about piloting operations, as one source that is used by multiple actors. However, he also states that the information on the site is both incomplete and not always up-to-date.

5.3 Lack of Communication

The third cause for problems related to trust is a lack of communication. The theme contains findings related to information not being communicated properly, information getting lost while in communication and information not reaching the recipient in time. Lack of communication may lead to several problems, such as ships colliding, ships crashing into quayside cranes and wasted resources.

> ***D:*** *"Communication is tricky. Almost every time when you start analysing an accident or something... Almost every time you can trace it back to the lack of communication in some way. It's almost frightening."* Quote: 8

Respondent **D** claims that lack of communication is one of the main reasons accidents and other predicaments happen.

> ***D:*** *"[…] There are several examples of lack of communication when the ship arrives and the quayside cranes aren't raised and the workers are still left on the crane. That's very dangerous. When external actors are involved, more channels for communications are used and information gets stuck somewhere along the line. This leads to quayside cranes not being raised."* Quote: 11

The regulations of Gothenburg Port Authority (Göteborgs Hamn 2016) states that *"quayside cranes not in use should be raised and located in agreed locations with regards to waiting or departing ships."* The reason for this regulation is to prevent unnecessary security risks. According to respondent **D,** these regulations aren't always followed due to information not always reaching the external actors in charge of the quayside cranes.

> ***A:*** *"[…] And if there is a ship A for example, then ship B who travel over here doesn't know that in five nautical miles this ship [ship A] is going to veer starboard, this ship [ship B] doesn't know that. And this one might be on its way like this [scribbles on a paper the paths the ships are travelling]. Then you'll have an instant situation over here..."* Quote: 12

Another example of a security risk due to lack of information is the case of route information. Respondent **A** emphasises that the captain of one ship can't know what the captain of another ship might have planned for their future route. Without making contact with other ships directly, captains can only get information about another ship's current location, and maybe make a prediction of their future route based on experience.

> ***A:*** *"[Something is needed] to notify actors to look [when times stamps are updated], 'something is happening with this arrival. It's not going to arrive by 12 a.m. as scheduled but it looks like it will be closer to 8 p.m.' Then the actors can react accordingly. In a case when you don't have that information, everyone would be almost blind as a matter of fact. And not receive this information until very late... we are talking about a few hours until the boat arrives in the traffic area and you realise: 'Damn, it's really late.'"* Quote: 13

Security risks are not the only reason why clear communication is needed. When information about arrivals and departures gets updated, actors who need the information aren't always notified about the change, according to respondent **A**. Such cases can lead to wasted resources were people wait around for the ship or other actors without proper knowledge of the current state of affairs.

> ***B:*** *"[Instantaneous updates] are pretty important, as it is an around the clock business. If you sit there at night as an operator and watch, and you hear by repute: 'Blimey, this boat that we ordered for six o'clock isn't ready until half past eight. When was this pilot ordered?'. '[It was done] at 22:30…' Well, then the risk is that he… well, he went to bed and doesn't have a clue of what's going on."* Quote: 16

Sometimes information might not reach the right recipient just as a result of the human factor. Respondent **B** exemplifies such a situation where a pilot involved in an early piloting operation is unavailable just because he is asleep.

5.4 Paperwork

While initiatives to digitalize maritime logistics have been made (Smith 2016b), certain information in maritime logistics is still communicated and agreed upon with the use of documents and contracts. This theme explores findings related to issues with trust as a result of paperwork.

> ***B:*** *"The most difficult part, I think, when it comes to these ships is the departure process… It's all of this paperwork that is carried out… And the documents have to be transferred manually back and forth to a bank… or probably the owner of the cargo or whoever it might be… There have to be stamps on the documents or what you call it... If you could remove that, the middleman that is, and send the papers directly between the ships... If you trust each other enough for this and that the ships can depart and all the paperwork gets done in hindsight… I know this has been tried in the port of Gothenburg…"* Quote: 6

Respondent **B** claims that the most difficult part of the departure process is all the paperwork involved. Some work has been done to digitalize the handling of paperwork, but some documents still need to be sent manually to different actors.

> ***A:*** *"There are other documents that should be signed by the skipper. It's the crew list and some other types of documents the agent provide the skipper with, so to speak. [...] Then the agent receives the signed documents and bring them to the office to be sent to relevant actors. And those could be tolls, and sometimes it's the shipping company. [...] That's what it could look like: A lot of paperwork."* Quote: 27

Respondent **A** gives another example of traditional paperwork, this time between the shipping agent and the skipper.

> **C:***"As I mentioned earlier, you still had to fax the board of customs until the summer of 2016, that's when they enter the digital. They had digital tools before of course, but the clearance of ships was faxed. There are some documents that the board of customs needs, like crew lists and what cargo the ship is holding, and that was faxed. Today it's uploaded into Maritime Single Window and sent to the board of customs."* Quote: 29

Respondent **C** mentioned that the board of customs digitalised its clearance of ships the year 2016. Giving an example of how actors are entering the digital age bit by bit in maritime logistics.

> ***A:*** *"Yeah, the amount of paperwork is extreme. It's almost ridiculous, you got tired of signing all those paper that had to be all over the place."* Quote: 7

Respondent **A** finishes up by giving his opinions on all the paperwork that needs to be done in maritime logistics, and how tired it makes him.

6. Discussion

Here we discuss our empirical findings in relation to our theoretical knowledge in order to find ways in which blockchain technologies can help improve trust between actors in maritime logistics.

We started this research with the objective of exploring the possibilities blockchain could provide to handling trust issues in maritime logistics. To find whether blockchain is a possible solution to apply in this context, we decided to use Tapscott and Tapscott's (2016) design principles as guidelines for our conducted interviews. Even though the framework is a popular scientific piece of work with no academic background, we deemed the design principles a good frame of reference to start thinking about the possible applications of the technology in a new context. To justify our use of the design principles we first had to find scientific material to support each principle, we did this to provide more rigour for each principle, and to expand our own understanding of the possible applicability.

Once we had established more rigour to the design principles, we had the theoretical knowledge of the domain to start our interviews with people in the maritime logistics. To ascertain the problems therein, we developed an interview guide based on our knowledge of blockchain to be used as a guide in our interviews. After this, we did an analysis of our empirical findings to find out the cause for challenges mentioned by our respondents.

Our results show that there are several challenges related to trust in maritime logistics. Firstly, competition between companies and individuals causes opportunistic behaviour. Barney et al. (1994) argue that opportunistic behaviour directly affects the level of trust between two or more partners, which might, in turn, affect the performance of the alliance. The chapter *opportunistic competition* shows findings of opportunistic behaviour as a result of competition. However, one of our responses mentions issues that arise as a result of tugboat companies not communicating the availability of their resources to partners. Such behaviour would give them a stronger position during negotiations with shipping companies, but ultimately lower their trust in the eyes of their partners i.e. the port and everyone involved in tugging operations.

Secondly, shipping agents might show opportunistic behaviour in different circumstances. The main reasons for opportunistic behaviour from agents are related to them trying to protect themselves or their partners from penalty fees. When showing opportunistic behaviour, the trust for the parties being opportunistic might be lowered as a result (Berney et al. 1994). Aside from opportunistic behaviour lowering the trust for shipping agents, several issues might arise as a result. One of these issues is information not being updated in MSW Reportal. Certain information in MSW Reportal is used by authorities such as The Board of Customs, SMA and the coastal guard (Sjöfartsverket 2017b). If information is not updated properly, it might lead to future challenges where authorities can not access the correct information and cause administrative costs.

Solving these issues ultimately might require a solution larger than the blockchain technology itself. Blockchain technologies solve trust issues between actors based on computational consensus, where computers in the network have a common way of figuring out which nodes of the blockchain has most correct set of transactions (Nakamoto 2008). At a first glance, this might seem like an engineering problem, but we argue that automation of trust and integrity is something that can benefit maritime logistics and other domains in many ways. However, for issues related to competition, we are unable to conceive of a solution purely based on blockchain technologies.

Another trend we can identify from our result related the shipping agent is his role as a messenger of documents between several different actors, but mainly between the ship and the actors in port. If we compare maritime logistics to modern banking, the shipping agent could be compared to the bank in monetary transactions, and the currency shipping agents transact is information. Since the goal of Bitcoin by large is to digitalize, decentralise and automate modern banking processes (Nakamoto 2008), we believe this general hypothesis for other blockchain technologies could be applied to maritime logistics as well. By replacing the shipping agent with a blockchain solution, the lack of information and the scepticism of the information provided by the shipping agent could be solved. How the technological aspects of this solution would work in reality is outside the scope of this study, but the replacement of the shipping agent as the trusted information messenger is an interesting notion in our opinion as it could possibly help actors in port with their day-to-day business by enabling them not to rely on a central authority.

Another recurring topic regards more general issues with information integrity and the trust actors within maritime logistics place in the information they are given. Some of our respondents claim that communication is a difficult operation in such a complex social system as maritime logistics. With the duplication of information between many different systems and individuals, some sources are more highly valued than others. The many levels of communication needed to deliver information to certain actors can result in information being lost due to the human factor. The possible solution we see that as blockchain based technology could provide in this context is immutability. Blockchain technologies provide an immutable trace of records, with the possibility of storing time-stamped information with clear transparency of the information source. In the case of distrust of information, a blockchain solution would provide a source of information that each actor could not doubt, as it is the one source everyone would agree to trust.

Based on our understanding of the topic, one of the main arguments for the usefulness of blockchain technologies is that of minimising the human factor as a concern in transactions of currency and information. In the case of Bitcoin, the transactions contain information about the currency within the Bitcoin blockchain, while transactions in other blockchain technologies theoretically can contain any other information that normally would be stored in a centralised ledger.

As most of our results regard the topic of arrival and departure processes in maritime logistics, ETA and ETD are two recurring pieces of information brought up by our respondents. We currently do not know exactly how this information is stored, but we do know they are entered into the system via MSW Reportal. Also, according to one of our respondents, the ETD that is made available by some actors is not always trustworthy since it relies on many variables. ETA, however, is more straightforward information. While determining that ETA is still a complex process dependent on multiple variables, the ETD is the largest problem. With this knowledge in mind, creating a solution for storing ETA and other relevant information related to the arrival process might be a good domain for a proof-of-concept solution. However, a similar solution for information related to departures and ETD might create larger benefits for cost-savings and efficiency in the long term.

One possible solution is a smart contract built upon the blockchain. When information is entered into the system by either a human actor or dynamically through other systems such as the VTS or AIS, the smart contract would update the information and send notifications to relevant actors. As the information source, in this case, is the blockchain updated through terms specified in the smart contract, the information handling of ETA and ETD could be a more automatic process. Theoretically, a smart contract could handle the booking of tug boats, pilots and berth when requirements specified in the smart contract are met.

6.1 Limitations

If we would do this research again, certain improvements could be made. First off, we entered the research domain and the discussion about maritime logistics with a somewhat simplistic view of its complexity. Our initial conception on the number of actors collaborating in port was that the arrival and departure of ships was a streamlined process and that there was manual information sharing processes between the actors. The realisation that our understanding of the maritime logistic environment was somewhat poor lengthened the work process and increased the scope of the research as it forced us to study both the blockchain environment and the maritime logistics environment at the same time. Secondly, we found that blockchain technology is a new area of research, which has limited the amount of available research on the topic.

Another possible weakness in our research is our choice of interviewees. Our interviewees are experts in their respective fields and have all worked in an operative role in the maritime logistics domain. This opens up the risk of biased based on their experiences. We tried to mitigate this by choosing interviewees with different operational backgrounds.

As mentioned in the introduction of this paper, one weakness in our research is that we only did the first two steps of DSRM i.e. (1) *Problem identification and motivation* and (2) *Definition of the objectives for the solution*. The DSRM is developed to be an iterative process, where an artifact is generated through rigorous evaluation and testing. As we did not develop an artifact to evaluate, it stands to question the applicability of our solution. We do however argue that this should not be seen as a complete DSRM process, but rather as the first steps in that process to be expanded upon.

7. Conclusions

We set out in this paper to explore the possibilities blockchain could offer trust issues in the maritime logistics domain. Our conclusion based on the material we have gathered is that the domain of maritime logistics is a complex environment, containing a multitude of different actors, concerned with the success of their own business and at the same time reliant upon the function of their interfirm collaboration to perform their business. As the domain is inherently of such a volatile nature, narrowing down one source related to trust issues is in our meaning impossible. Thus, it is not likely that one single blockchain solution could solve the problems related to trust we found, e.g. lack of communication, distrust in information, opportunistic behaviour, interdependence, but would require a variety of solutions. However as stated in our discussion, we think a lot of the problems in maritime logistics could be facilitated if the information between actors was handled in a way that decreased the reliability of interfirm trust among human actors.

Blockchain is not the solution to all problems in maritime logistics, e.g. certain competition aspects, while others are plausible in the future, such as replacing trust in one central authority with that of a blockchain application or to automate the reservation of e.g. tugboats and pilotage with smart contracts. However, we did identify four problems related to trust, and present our take on what the objectives for the solutions to these problems should be:

Problem Identification	Objectives for solution
Lack of communication	Incentivise information sharing with increased transparency and accountability
Opportunistic behaviour	Increase transparency and enable untrusted transactions of information
Distrust in information	Decrease the involvement of the shipping agent as a middle-man
High interdependence between actors	Lower interdependence to increase self-sufficiency

Table 4: Problem identifications and Objectives for solutions

The table above summarises our findings and specifies the objectives for solutions that we suggest would mitigate the problems. The objectives can all be related to certain characteristics of a blockchain solution, e.g. increased transparency, decreased involvement of a central authority and lower interdependence. These solutions would require further research on its own to realise in our opinion, but the possible rewards e.g. more effective collaboration and cost-reductions, have the possibility to induce great rewards. We suggest that further, more specific research of these four problems and how they relate to blockchain should be conducted. Further research should explore the possibility of exchanging the human actor as the bearer of information, to enable efficient and effective trustless interfirm collaboration, as many of the problems we discovered originated from a lack of trust.

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Appendix

Appendix:1 Interview quotes in Swedish

D: *"[Agenten får dåligt rykte] för dom slarvar med informationen som är viktigt att uppdatera i våra system. Och det kan ställa till det rejält faktiskt." Quote: 2*

A: *"Det är ju inte säkert att agenten går in i systemet och uppdaterar. Det är inte alls säkert, det ska man inte lita på"* Quote: 3

A: *"Så i princip agenten, om vi går tillbaks till att slutföra frågan där så är agenten egentligen en budbärare för en jäkla massa dokument. Så skulle man kunna säga. [...] [...] det kanske sker en blackout, eller av någon anledning så måste vi ändå dra ner på farten och du blir 6 timmar sen, och nytt ETA blir då 18. Agenten "glömmer av", att göra uppdateringen i Marine Single Window, och då får inte dom andra aktörerna den informationen. Så man tror fortfarande, hamnen tror fortfarande att båten kommer klockan 12. Fram tills hamnen trackar båten, på sin AIS tex och ser att: 'Jamen fasen den här båten den går ju jäkligt långsamt, den kommer ju aldrig hinna till klockan 12…'"* Quote: 4

B: *"Men iallafall... Just dom tusenlapparna [som penalty fees kostar] då, det äter ju upp, i många fall, agentens arvode. Och då tar dom hellre att dom beställer lots till en felaktig tid och låter lotsen stå där kanske en timme och tickar pengar... För i fakturan står det inte penalty fee utan då står det bara lots-tid för den summan då... Den summan är enklare att få betalt då." Quote: 5*

B: *"Ja, jag tänker ju just att... det som är svårast i avgångs-processen när det gäller fartyg... det är ju just det här pappersarbetet som görs... Dom säger att det är tre timmar papper på den båten, två timmar papper... Och det är att, dokument ska ju liksom manuellt skickas fram och tillbaka till förmodligen en bank då eller... förmodligen den som äger lasten eller vad det nu kan vara... Det ska stämplas och allt vad det heter. Kan man ta bort den... Vad ska man säga... huset eller mellanhanden och skicka direkt mellan fartygen eller kanske till och med ha den... att man litar så pass mycket på varandra att fartyget kan gå om man fixar papprena i efterhand Det vet jag har testats då i Göteborgs hamn…" Quote: 6*

A: *"Ja, så det är extremt mycket dokument va. Det är nästan löjligt mycket, man blev nästan trött på alla buntar papper som skulle signas och skickas hit och skickas dit" Quote: 7*

D: *"Kommunikation är ju väldigt svårt. Nästan alltid när man börjar analysera en olycka eller någonting… Nästan alltid att det beror på att man kommunicerat på ett dåligt sätt. Det är helt skrämmande alltså." Quote: 8*

A: *"Men i vissa fall är det säkert så [att skepparen har bäst information], Och så länge båten är till sjöss så är det ganska rimligt att anta i alla fall att skepparen har bästa information... inte agenten, inte hamnen, inte terminaler, utan det är skepparen. Han sitter på sin båt så det är inte så konstigt att anta det. Men du har ju andra situationer som vi har pratat om tidigare. Det finns en mängd olika situationer där, beroende på var informationen kommer ifrån, hur pass sannolik är den, eller trovärdig."* Quote: 10

D: *"[...]* det finns flera exempel på kommunikationsbrist *när fartyg kommer och kranar inte toppas, där det är arbetare kvar på kranarna, väldigt farligt. När externa aktörer är med i bilden, flera kommunikationsvägar och information som inte kommer fram gör kranarna inte toppas."* Quote: 11

A: *"[...] Och om det här är fartyg A då så fartyg B som kommer här vet ju inte att om fem sjömil så ska den här då fartyget gira styrbord, det vet ju inte den här [Fartyg A] om. Och den här kanske är påväg så [visar på ett block hur fartygen kan åka] Och då får du ju direkt en situation här…"* Quote: 12

A: *"[Något behövs] för att highlighta aktörerna om att kolla [när tider uppdateras], nu är det nåt som händer med det här anlöpet. 'Det blir inte klockan 12 som det är tänkt utan det ser närmare ut att bli klockan 18 här.' Och då kan ju aktörerna agera därefter. Alltså i ett fall där man inte hade den här informationen då skulle alla va nästan blinda faktiskt. Och inte se den här information förrän väldigt tätt inpå, det kanske… vi kanske pratar några timmar innan båten kommer till trafikområdet tex att amen shit det här, oj va sen han va."* Quote: 13

A: *"[...] Men ETD däremot, då är det en helt annan femma. Den är ju styrd av många andra faktorer som... till exempel terminalen är ju superviktigt där... Det är ju bara terminalen som vet när, operations på den båten är färdig."* Quote: 15

B: *[Momentana uppdateringar] är ganska viktigt, i och med att det är en 24-timmars-verksamhet. Om man sitter där på natten som operatör och tittar på... man får höra det ryktesvägen att 'men vad tusan, båten som vi beställde till klockan sex är inte klar förrän halv åtta.'Ja, men när beställdes den här lotsen egentligen? Ja, det gjorde han 22:30. Då är det ju hög risk att han... ja, har gått och lagt sig och inte har någon aning om vad som händer." Quote: 16*

B: *"Alltså, nä. [anonyma uppdateringar] kan jag inte tänka mig. Visst. det kanske hade varit roligt och kanske löst upp en del knutar om man fick lov att vara anonym, men samtidigt... då hade ju ingen litat på den informationen om man inte vet vart den kommer från." Quote: 18*
B: "*Tilliten ja. Men sen är ju själva marknadsuppbyggnaden... handlar lite grann om rävspel med kontrakten och fartygsflottor fram och tillbaka så att där kan det enligt min mening per automatik inte finnas någon tillit, eftersom systemet, på något sätt, underförstått är uppbyggt på att man hemlighetshåller sina fartygsposition då för att kunna förhandla sina kontrakt bättre med lastägaren." Quote: 19*

B: *"[Energihamnen] vill kanske inte släppa på information gällande till exempel Preem då... Släppa på information gällande deras fartyg till deras konkurrenter ST1 då som då delar kaj med dom ibland. Och det är ett race då att First Come, First Served då fartyget... Så vill man kanske hemlighetshålla litegranna då ... om man nu har något som ligger där... Skapa sig så att ens egen båt kommer in först då…" Quote: 20*

B: *"Men sen är det ju mycket också i fartygsanlöpen här i och med att det är alla olika aktörer förutom lotsarna då... det drivs ju någonstans privat och det ska ju generera pengar [paus]. Och det här rävspelet som jag nämner det kan ju vara ytterligare ett exempel... för bogserbåtar där... utan att nämna några företagsnamn då om man säger så... dom kanske inte alltid vill avslöja hur många resurser dom har då, och vart. Med tanke på att... Det kan ju vara så att man har två avgångar klockan 16 på två olika fartyg som båda ska ha bogserbåt. Ja, då Switzer har en båt i hamnen och kan ta ett fartyg i taget då... Medan i det optimala för hamnen och alla andra hade kanske varit att dom hade tagit ut två bogserbåtar och tagit... Ja, samtidigt."* Quote: 21

C: *"Det finns en publik sida. LotsInfo, som finns som publik. Där kan man se fartyg som lotsar. Men den släpar lite och du ser inte om det är tillfälligt bokat eller om det är definitivt bokat." Quote: 25*

C: *"[Terminalen] säger att [skeppet] kan gå in klockan 23 ikväll.' Så ba 'Men jag har ju klockan 19 när jag pratade med dom.' och då [mummel] '...När pratade du med dom och vem pratade du med' och så måste man liksom… 'Ja, jag pratade för två timmar sen.' 'Ok. Jag ringde för en kvart sen.' 'Ok,* men då har jag nyare *information, så det är den som är rätt.' Så det är mycket den här… förhandlingen och ringa fram och tillbaka till varann… Så [host] en tidsuppdatering kan vara nio samtal." Quote: 26*

A: *"Det finns ju andra dokument som ska signas av* skepparen, det är ju crew list och lite andra typer av *dokument då som agenten så att säga förse skepparen [...] och så tar agenten tillbaks dom dokumenten å tar med sig det till kontoret och skickar det till berörda parter. Och det kan vara tullverket, och det kan va i vissa fall till rederiet [...] Så kan det se ut: Väldigt mycket dokumenthantering." Quote: 27*

A: *"Man tar in all information och sen gör man en uppskattningen utifrån den informationen man har. Så du kan egentligen aldrig få... Ibland skulle man kunna önska att man skulle vilja styra det, för vissa källor ju mer pålitliga än andra." Quote: 28*

C: "*Jag tog upp innan att förut så faxade man till tullen. Och det var ju förra året under sommaren, alltså 2016 som… tullen kom in i det digitala. Dom har haft digitala verktyg också, men själva tull-klareringen av fartyg… Det är några dokument som ska in till tullen och det ska in lite besättningslistan om vad som finns ombord och det faxades i tullen."* Quote: 29

Appendix 2: Recording Consent

Recording Consent

This interview will be recorded and transcribed for the conductors of this study to analyse and cite parts of what has been said, based on relevance for the study. All given information will be anonymized and only be used for this study and this study alone.

Please read the text below. By signing you agree to this consent.

I understand that this conversation will be recorded and transcribed.

I hereby allow Niklas Andersson and Johannes Leander to use this recorded interview as a foundation for the study they're conducting for their bachelor's thesis at The University of Gothenburg, spring of 2017. I also understand that what's being said can be cited in said study, which will then be published in a national database amongst other thesis'.

Signature: _____

Print name: _____

Date: _____

Appendix 3: Interview Guide

Background

- What's your name and occupation?

- Have you worked directly with maritime logistics before?
    - If yes, where and how?

Processes

- Where are the largest challenges related to information in maritime logistics, according to you?

- Which parts of communication are managed by shipping agents?

- Please identify actors you consider to be middle-men.

- Are there any strengths in how information is being managed in maritime logistics?

- What's your take on foul play in maritime logistics?

STM

- Please describe the project.

- Which problems are solved with STM?

- Please explain how STM came to be.

Shipping agent

- What role does the shipping agent play?

- What's required to become a shipping agent?

Arrivals/Departures

- What're your experiences working with arrivals and departures?

- How do you think information about arrivals/departures can become more transparent?

- Which middle-men are involved in arrivals/departures?
- Please describe to arrival process...
    - From the port's perspective.

    - From the pilot's perspective.

    - From the terminal's perspective.

    - From the skippers perspective.

    - From the shipping agent's perspective.

- Please describe to departure process...
    - From the port’s perspective.
    - From the pilot’s perspective.
    - From the terminal’s perspective.
    - From the skippers perspective.
    - From the shipping agent’s perspective.

Blockchain Design Principles

- Transparency
    - What’s the stance on the transparency of information in maritime logistics?
- Trust
    - Please provide some examples of respected/un-respected sources of information.
- Accountability
    - How important is it to know the source of information?
- Privacy
    - How important is anonymity of individual actors?
- Security
    - Can you give some examples of some information that is sensitive?
- Inclusion
    - How difficult is it to get a hold of data normally not available to you, should you require it?
- Historical data
    - Are there any examples of historical traces of information being used today in maritime logistics?
- Latency
    - How long does it normally take for the agent to upload information into relevant systems?