Improving shipping contracts with the use of emerging technologies

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ABSTRACT

A set of contracts guides every movement of cargo from one point to another. In this thesis, we focus on the contract between the charterer and the ship-owner in the liquid bulk ocean-shipping market. The contracting process begins with the two parties finding each other suitable and ends with one party being compensated in compliance with the terms and conditions of the contract for meeting a set of considerations. The question we answer is how emerging technologies, primarily Blockchain, can be used to make this process more efficient in terms of time and cost. Our research shows that while there are a considerable cost and time savings possible for certain aspects of the contracting process, there are some problem areas, such as the negotiations, that cannot be solved with the help of existing technology. We also conclude that the proposed solution needs to offer an end-to-end contract and document management tool rather than just being an improvement for one particular step in the process. An industry-wide consortium led Blockchain-based solution has potential to find wide acceptability and impact in terms of increased efficiency.

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Dedicated to the enigma of Lipsi and the genius of Satoshi

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1. INTRODUCTION

1.1 Motivation and thesis outline

The motivation for this thesis is to understand the problems involved and assess new tools to make the process of carriage of goods through sea more efficient. The thesis focusses on the process of executing a contract in the liquid-bulk market. The liquid bulk ocean-freight is regulated through United Nations-backed international regulations managed by the International Maritime Organization (IMO). However, the process of contracting is largely governed by free-market practices and is mostly untouched by recent advancements in technology such as Blockchain. Other major ocean-freight markets are container shipping, dry-bulk and general cargo. Each of these markets has their unique dynamics, but the conclusions drawn from one can be broadly applied to another. We begin by identifying key players in this sector and then move on to mapping the entire process of executing a contract. The thesis will identify the problems in each step of the process and come up with possible solutions using emerging technologies – primarily Blockchains.

1.2 Methodology

Research approach

A researcher has to decide the methodology before the research can begin. The decision between different strategies is made based on the type of question the research is trying to answer. Research strategies can be divided into five categories – experiment, survey, archival analysis, history study and case study (Yin, 1994; as cited by Henriksson and Nyberg, 2005). For this thesis, we relied heavily on surveys and interviews with industry leaders to collect information.

Reengineering is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality, service and speed (Hammer, M., Champy.J., 1993). The thesis uses Business Process Reengineering (BPR) to look at the existing process of executing a shipping contract for ocean freight from end-to-end and come out with recommendations for new processes based on emerging technologies.

The idea of this thesis is to explore the application of emerging technologies to a process where they have never been applied. The questions that the research aims to answer are which emerging technologies, primarily Blockchain, can (or cannot) be applied to the process of contracting and what might be the pros and cons of applying them.

The overall approach involved the following three steps. First, mapping and understanding the process of contracting in ocean freight to identify existing problems and scope of improvements. Then, understanding the emerging technologies and their applications. And finally, analyzing the application of emerging technology in each of the problem areas or areas with the scope of improvement earlier identified.

Research methods

The research methods include carrying out a survey to understand the relative importance of steps involved in the process of contracting concerning the problems. Interviews were carried out in the shipping industry to map and understand the process of contracting and identify problem areas. Finally, the concept of Business Process Reengineering was applied to imagine a new flow of processes.

1.3 An Introduction to the Tanker Shipping Market and Contracts

Multiple parties are involved in every movement of liquid bulk cargo from one port to another. The first one is the consignor (or the supplier). The consignor can be the producer of the goods or someone who has purchased the goods from a producer and is engaged in the business of export. In the liquid-bulk market, the consignor is mainly the producer of the cargo. They can be state-owned or private oil refineries who typically own a terminal in a sea-port.

On the other end of this movement is the consignee (or the receiver). Receivers can be the importers of clean petroleum products for consumption of the end users (for example - petrol, diesel, Palm oil, LPG, etc.) or refineries/industries that use the import as a raw material (crude oil, condensate, etc.). The receivers also might own a terminal or lease storage tanks within the terminals.

The port terminals at both ends serve as a facilitator of the loading and unloading operations on a ship. While the port authorities are responsible for the safe navigation of these ships within its waters, the terminals are responsible for safe cargo operations once the ship is moored at the berth.

Traders are the business entities who identify a demand-supply gap and invest in the practice of buying and selling goods to make a profit through the margin. Charterers are the entity to whom a trader delegates the responsibility of handling the logistics for movement of the commodity from a consignor to a consignee to the charterer. Usually, the trader and the charterer are part of the same organization.

Another key player in this system is the ship-owner. The ship-owner represents the group of individuals or companies that engage in the business of ensuring that it remains seaworthy at all times. In most cases the ship-owner delegates the task of technical management (ensuring that the ship remains seaworthy) of a ship to another company, known as the technical managers (or technical operator). The task of "commercial management", that is ensuring that the ship remains hired for movement of cargo, is delegated to another entity, known as the commercial manager (or commercial operator). For the purpose of this thesis, they all can be treated as one unit, referred to as the ship-owner.

A network of brokers helps connect the charterers looking for a ship to the ship-owners looking for cargo. The charterers and the ship-owners who have been in the business for long usually have a set of brokers they trust. Sometimes they have a broker who gets exclusive right to look for a suitable vessel/cargo, as required. As brokers are in a long-term relationship with their client (a charterer or a ship-owner), they proactively collect information on the availability of cargo or vessel. To expand their reach in a global market, the brokers depend on their network with other brokers to find a suitable match. The ship-owner and the charterer frequently indulge in business with an opposite party they have never worked before because of this chain of trust that the network of brokers helps establish.

Finally, there are port agents at each end. These agents are certified and approved by the local port authorities. The charterers appoint them to act as the charterer's local representative and to assist with communication and logistics at each port. Ship-owners also may appoint their own "protective agent" at each port to handle operations not relevant to this thesis.

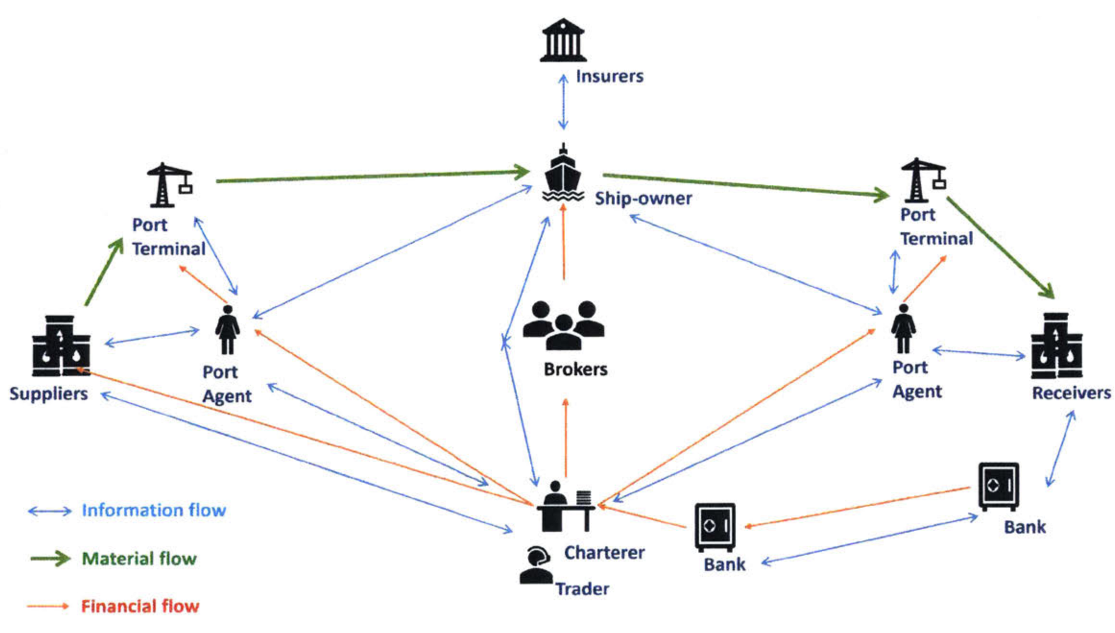


Figure 1: Information, Material and Financial flows in tanker shipping market

Figure 1 shows the interaction among various parties which results in the carriage of cargo from the supplier to the receiver. Every interaction in the Figure is governed by a certain agreement. In this thesis, we explore the agreement signed between a charterer and a ship-owner for the carriage of goods through the sea. This agreement is called a Charter Party.

The entire process of executing this contract can be divided into three major steps, as shown in Figure 2.

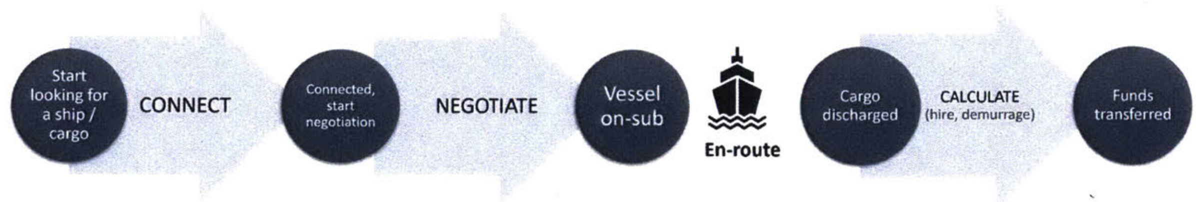


Figure 2:Steps involved in the process of contracting

The trader identifies a supply-demand gap for a certain commodity between two ports. They delegate the task of moving this cargo from the supplier's port to the receiver's port to the charterer. The Charterer starts looking for a suitable ship to move this cargo and this is where the process of contracting begins.

The Charterer approaches a pool of brokers to look for a ship. Once a suitable ship is found and the two parties are connected (step 1), they move on to the next step (2) of negotiating terms and conditions of the carriage. After agreeing to the terms and conditions, the contract is finally signed. Signing is done either physically in the presence of each other, or electronically wherein a confirmation on email is treated as an act of signing the contract. In the latter case, an "email clause" is inserted in the agreement to document such understanding. Subsequently, the ship proceeds to execute the obligation of the contract and transports the cargo.

After discharging, the calculation is done for hire and demurrage (step 3). The final stage is that of funds transfer by the charter. The first two stages (Connect and Negotiate) are referred to as the "pre-fixture" stage while the third as "post-fixture".

Each step is explained in further detail below:-

Step 1: Both the charterers and the ship-owners are looking for each other and pass on their details to their respective brokers usually communicating through emails and phone calls. Increasingly, messenger chatting apps are also being used for official communication. The charterers send out the details such as the type of cargo, the quantity of cargo, date a ship is required from, the port where the ship is required, etc. The ship-owner shares details such as the ship's details (type, size, etc.), the location the ship will be available at, the date the ship will be available from, etc. The brokers share such information with each other and wait to get a positive response. This may go on for a period as short as a few hours to as long as a few weeks. Subsequently, one of the brokers involved finds a match and the two parties are connected to each other.

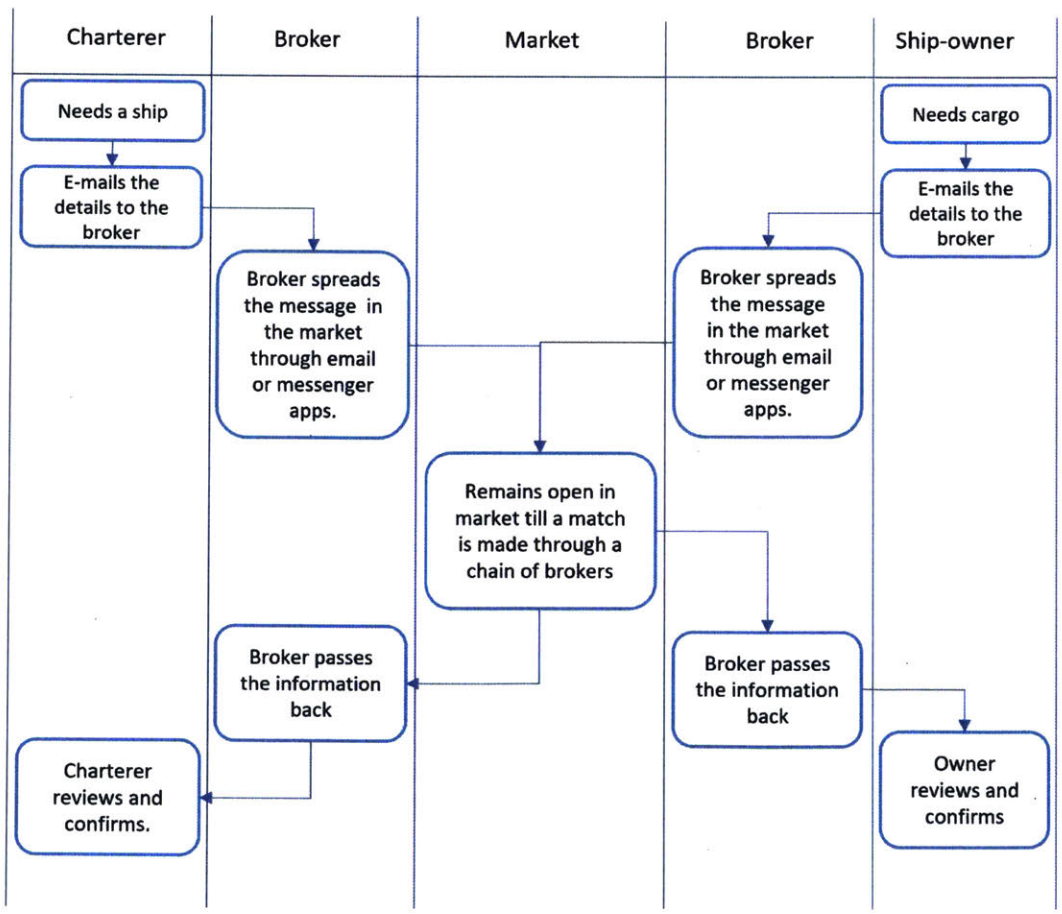


Figure 3: Step 1- Connect

Step 2: Once connected, the two parties (ship-owner and charterer) start negotiating with each other. The negotiations involve two things – 1. The rates, both hire and demurrage and 2. The terms and conditions of carriage.

In the spot market, the ships are hired for a particular voyage. The load-port and the discharge-port are known and explicitly mentioned by the charterer's broker in the initial query for a vessel. The ship-owner knows the distance for this voyage and calculates for expenses needed to cover this. A profit margin is added to this figure, and that is how the ship-owner comes up with the initial hire idea for this voyage. However, there is also a time-factor associated with any such voyage. At times, there is congestion at the ports or the rate of loading/discharging is too slow. This means that the ship will have to spend more time than what the ship-owner has accounted for in their calculation for the hire, primarily based on the distance. This is where demurrage comes up. Demurrage is the pre-agreed penalty paid per unit of time for any time spent on the voyage additional to an agreed period for executing the port operations. In most voyage charter parties, a period of 96 hours is assumed to be the allowance for berthing, un-berthing and cargo operations. If a ship spends additional hours beyond these 96 hours, the ship-owner is eligible to be compensated by the charterer as demurrage. The charterer and the ship-owner negotiate and finally agree to a certain hire, demurrage and other terms and conditions of carriage as mentioned in the charter party agreement.

As soon as the two agree on these issues, the charterers put the ship "on-sub". Putting a tanker ship "on-sub" implies that the ship will be hired by the charterers subject to approval from the loading and unloading terminals. The terminals have their own set of requirements which the ships must meet. These requirements include the size of the ship (to ensure the terminal is designed to handle that size of the ship) and other qualitative requirements (such as holding a certain certificate showing a high standard of maintenance) in some cases. As the charterers already know these requirements, they vet the ship in the very beginning before going further into negotiations with a ship-owner and so it is highly unlikely that the ship will not be ultimately hired once she is on-sub.

Given the same, in practice, a vessel on-sub is considered to have been hired, and most ship-owners start their journey to the load-port. A display of mutual trust is again seen here wherein one party begins to exercise its obligation under a contract which has not yet been signed. As soon as the approval is received from the terminals, the Charter party agreement is signed between the ship-owner and the charterer.

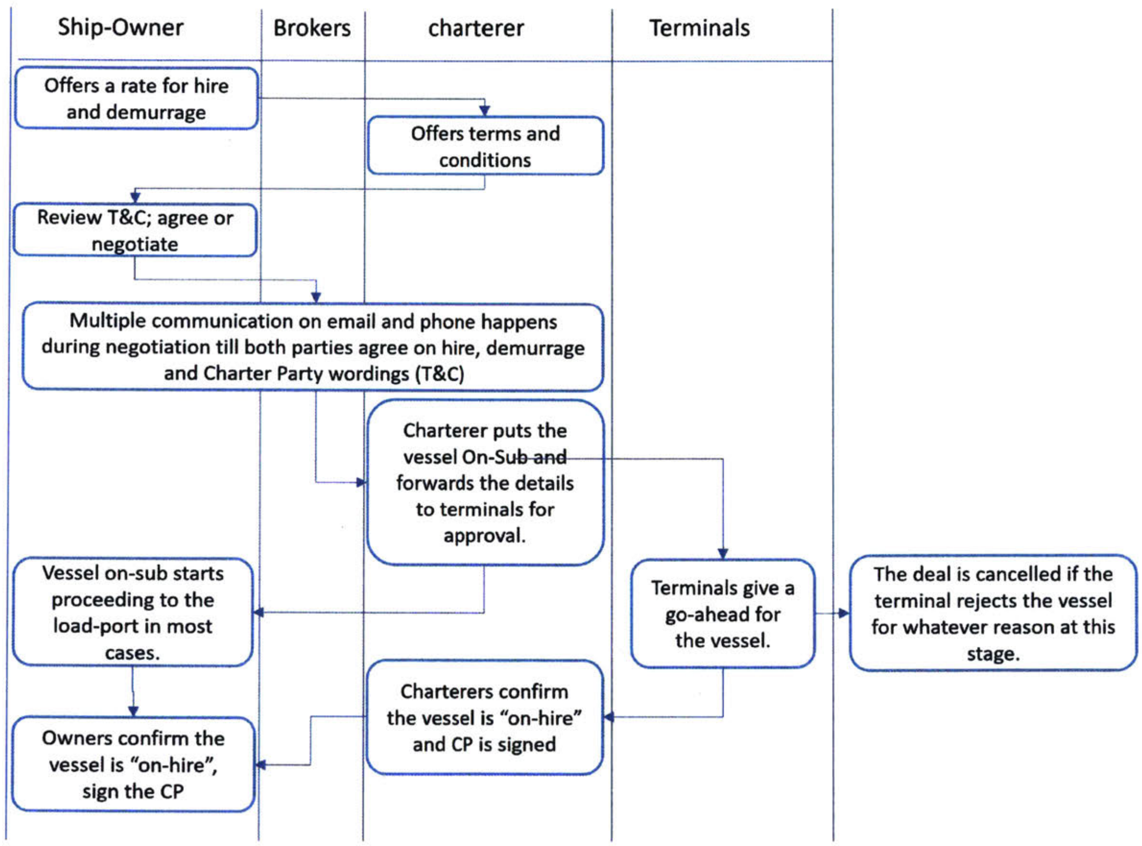


Figure 4: Step 2- Negotiate

Step 3: The ship goes on to load and discharges the cargo to meet the obligations of the ship-owner in the charter party agreement after completion of step 2. The next step relevant to the contracting process begins as soon as the discharging is complete*. The ship-owners now do the calculations based on the agreement and raise an invoice to get compensated. A similar calculation is done by the charterers. If they are found to be the same, the charterer proceeds to make the payments. If there is any ambiguity, a chain of communication ensues which delays the payment at times.

[*- *Except for cases when the Charter Party specifically states otherwise. For example, if the CP includes a BBB (Before Breaking Bulk) clause, then the ship-owner is liable to receive the hire before the discharging is completed*]

1.4 Problems with the present system

The Charter Party is an agreement signed between two parties – the ship-owner and the charterer. For any agreement to come into existence and be executed undisputedly, there needs to be

- Two parties who mutually trust each other making an offer and a counter-offer which gets accepted,
- Maintenance of a series of supporting documents to evidence that the obligation under the contract are adequately met, and
- A value transfer as a consideration for the obligations under the terms and conditions being adequately met.

Most inefficiencies in the process of executing a charter party agreement stem out of these three processes.

In the pre-fixture stage, a lot of time is wasted when the two parties are looking for each other. The queries remain open in the broker market for several hours and days before a suitable match is found. Subsequently, the two parties spend a lot of time on negotiating and vetting the terms and conditions of a charter party. After a series of offers and counter-offers, an agreement is made.

Most of these processes are not automated and need human interaction. Multiple communication channels and the need to maintain a trail of documents among multiple parties make the process slow. In a survey conducted by a brokering portal, opensea.pro (2016), 82% of the respondents either partly or strongly felt that receiving too many irrelevant emails during the process of connecting various parties was a major problem for them. Need to be constantly online to monitor market trends and search for new clients were other top concerns. The survey was conducted on 86 respondents, representing 29 countries and included almost equal percentage of ship-owners, charterers and brokers.

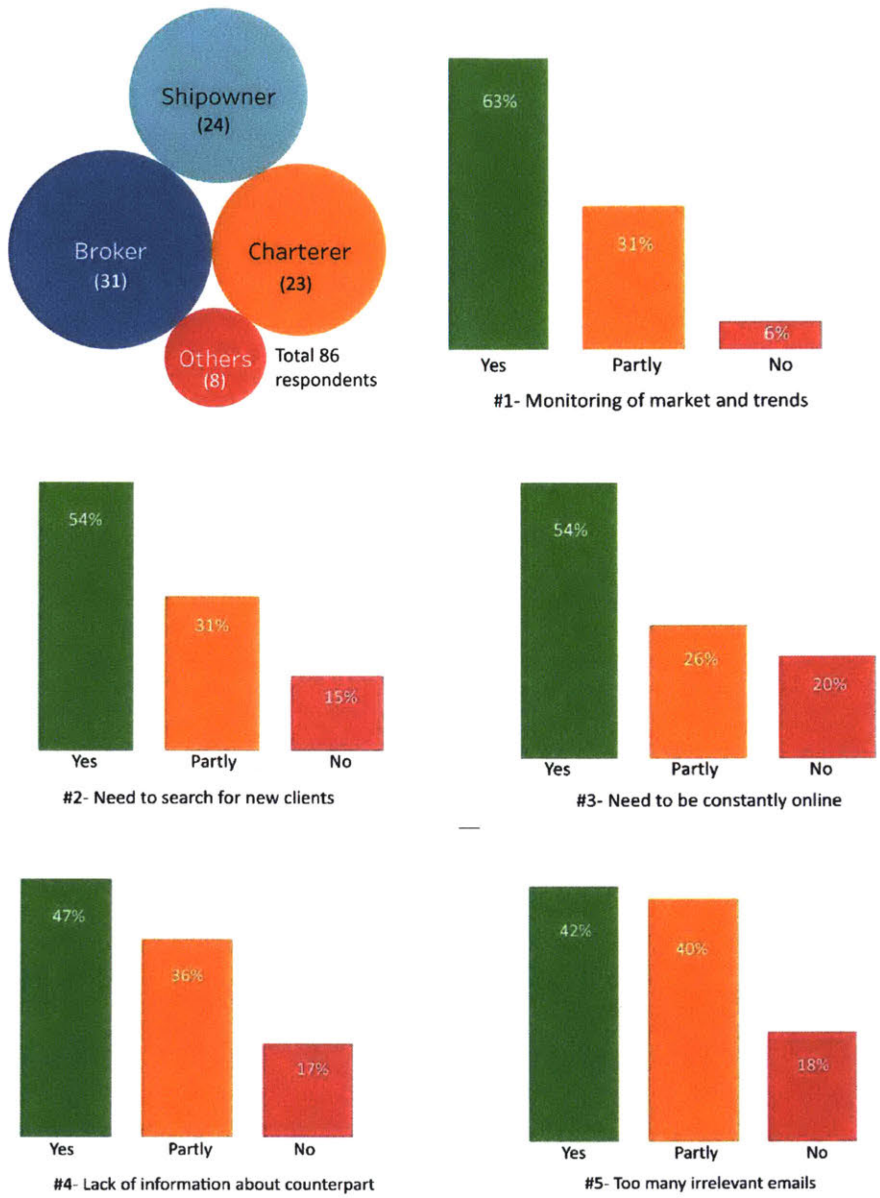


Figure 5: 5 common problems of chartering market. Source: opensea.pro (2016)

During interviews done for this thesis, respondents complained about delays caused by poor document management. For example, one of the most important shipping documents, the Bill of Lading, needs to be received in original by the cargo receivers. In the post-fixture stage, there have been cases of delays in executing the operations because of delay in receipt of a Bill of Lading. It is more common in the dry-bulk market for the operations to get delayed due to Bill of Lading's unavailability.

Once the cargo is discharged, demurrage and hire are calculated, and fund transfer is done by the charterer. The calculations are done independently by the operations team of both the parties involved. Although the calculation of demurrage is mathematically a simple process, it is common in the industry for this process to take several days because of documentation and disagreement in figures. The fund transfer is international in most cases, except when both the parties are in the same country. International fund transfers are done through a network of banks, and so it takes several days for funds to arrive.

A survey, done as a part of this thesis asked respondents for the number of days they spend in going from the point when they start looking for a suitable cargo (or a suitable ship) to the time the cargo is transferred, and the hire is paid. The results showed that on an average this might take as little as 15 days to as long as 163 days; with an over 50% probability that the process will take more than 70 days. This excludes the number of days the ship spent at sea sailing from one port to another and the number of days it was engaged in loading/unloading operations.

The brokers play an important role in connecting the two parties and establishing trust between them. However, the ship-owners end up paying as much as 2.5% of the hire they receive to the brokers. There are other administrative expenses as well which make the entire process expensive.

The process of signing a Charter Party is also not so straight-forward in the tanker shipping market. In some cases, an original paper-based agreement is signed and couriered by the parties to each other. Although this takes several days to do, the parties do not wait till they receive a signed copy and already begin to act on their obligations based on trust to avoid any delays. More recently an "e-mail" clause is added to the charter party agreement which states that the email communication is accepted as the acceptance of the offer and hence there is no need to sign and maintain a paper-based agreement. In either case, the process of actually signing a Charter Party hardly cause any delay and hence is not considered a problem.

Summary

The shipping industry consists of players from around the world. There is no central authority setting binding standards and rules for interaction among the various players. In the absence of such standards, the interactions depend on mutual trust. Stakeholders use intermediaries and additional contracts to mitigate risks of the opposite party defaulting on any condition of the contract. Intermediaries are expensive and contract hard to enforce through international courts, resulting in high dependency on established relationships. Contracts are negotiated, shared, and agreed upon using multiple communication outlets and a combination of physical and digital documents. All of this results in a complex system which is expensive in terms of time and money to execute. The thesis will analyze these inefficiencies and come up with solutions to improve them.

The remainder of this thesis is organized as follows. Chapter 2 describes Blockchain technology, including Blockchain-based smart contracts and briefly discusses literature from academic and business press exploring the application of Blockchain technology in ocean shipping. Chapter 3 details the practitioner survey conducted for this thesis. Chapter 4 is the analysis of all the problems and proposed solutions. In the first part of this chapter, we break down the entire process into three major stages and analyze the problems at each stage. For each stage, we explore possible application of technology as a solution, and then we explore the benefits and the challenges in the implementation of these solutions. In the second part, we take the entire end-to-end process as a whole and come up with solutions reengineering the process. Chapter 5 draws the conclusions and is followed by appendices for a glossary.

2. BLOCKCHAIN

Blockchains refer to a Distributed Ledger Technology (DLT) wherein a list of records (called blocks) are linked in a chain and secured using cryptographic techniques (Narayanan, Bonneau, Felten, Miller and Goldfeder; 2016). The records saved on these blocks are immutable and permanent. Iansiti and Lakhani (2017) define Blockchains as an open and distributed ledger which records transactions between two parties efficiently, in a verifiable and permanent way. The data is stored across multiple computers (called nodes) in a peer-to-peer network. The network of nodes run an open-source software to record information in chronological order. Periodically, a set of information is collected and recorded as a block. A majority of participating nodes verify the authenticity of the information in the block and agree to its validity through a consensus mechanism. Thus, the block of time-stamped information gets added to the chain of blocks, and the information becomes immutable. All this happens without a central authority or any trusted third-party validation. Figure 6 shows a simple example of a blockchain having three blocks. Each transaction is time-stamped and verified by each node to meet a set of pre-defined criteria to ensure the validity of the transaction before getting recorded on the block. For example, the transactions in the Bitcoin Blockchain are checked to ensure that the person transferring a Bitcoin to another has enough Bitcoin in the first place. The below figure shows that in its most basic form, every Blockchain is just a database or a ledger storing information.

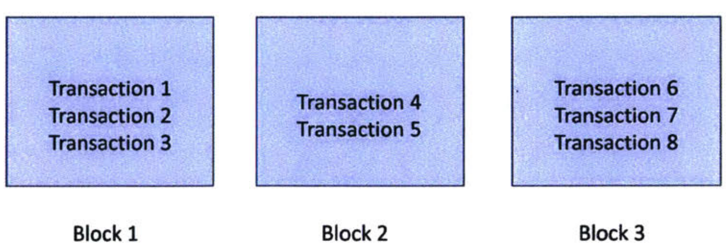


Figure 6: A simple representation Blockchain - A

The same information is recorded on each participating node. To ensure that the transactions are not altered once entered a cryptographic technique is used. Before adding the next block, the entire data-set of the previous block is "hashed" using a hash function. Hash functions are one of the fundamental primitives in modern cryptography. It is defined as a mathematical function mapping binary strings of arbitrary length to binary strings of some fixed length, called hash-values (Menezes, Oorschot, Vanstone; 1996). Hash functions are a type of trap-door functions which make it easy to calculate the hash-value for any arbitrary set of data but make it computationally impossible to find the original set of data given the hash-value. A cryptographic hash function is deterministic. This means that the same input will always produce the same output. Another important characteristic of the hash function is that it is computationally infeasible to find two distinct inputs which hash to the same hash-value. This is known as being "collision proof". There are different algorithms for hash functions such as MD5, SHA-256, KECCAK-256, etc. This thesis does not go into detail on hash functions.

As the chain progresses and the hash of each previous block keeps getting recorded in the new blocks, it becomes computationally impossible for any evil node (a node attempting to record fraudulent entries in the blocks) to change information already recorded in old blocks. Any change will lead to a mismatch in the hash-value, and hence other nodes will reject the changed block. One can think of a blockchain as an immutable audit trail where the `DNA' of each block is incorporated in all following ones, making it impossible to alter history without being noticed (Catalini and Gans; 2017).

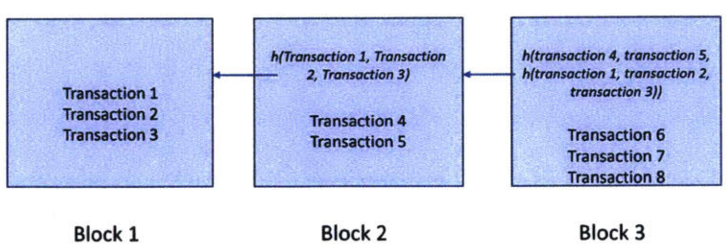


Figure 7: A simple representation Blockchain - B

The mechanism or algorithm that brings in a consensus among the participating nodes about a single source of truth is essential to a Blockchain. The challenge that Blockchains overcome is similar to the Byzantine General's Problem – the challenge of reaching an agreement among multiple members in a large system

(Jiang, 2017). Such a decentralized peer-to-peer network is then said to be "Byzantine fault tolerant" which means that they solve the Byzantine Generals Problem (Lamport,_Shostak & Pease; 1982) wherein a group of Generals who can communicate only through messengers come to a consensus on whether to attack or retreat. Similar to the Byzantine Generals Problem, the participating nodes in a blockchain need to agree that a particular new block created by one of them is true and hence acceptable to all the participating nodes in the system. Different blockchains use a different mechanism to solve this issue.

Cryptographically secured ledgers (or chains of blocks) have been discussed in academia since the 1990s (Dragos, 2017). The 2008 Bitcoin Whitepaper (Nakamoto, 2008) introduced the idea of a consensus mechanism based on "proof-of-work". The paper was intended to provide a system of electronic transactions without relying on trust between the transacting parties (Nakamoto, 2008). This gave birth to the world's first cryptocurrency, named Bitcoin, based on an underlying technology of what we call Blockchains today. The proof-of-work mechanism assigns a one-CPU-one-vote system. The participating nodes compete against each other using their computational power to solve a mathematical puzzle. The puzzle requires the participating nodes (defined as "miners" when engaged in the practice of creating new blocks) to come up with a string of digits called the "nonce". The nonce, when added to all the transaction data in the block being mined and entered as an input to the hash functions, leads to a hash-value which begins with a certain number of zeroes. The number of zeroes is decided by the software from time to time to adjust the level of difficulty of the puzzle so that on an average a new block is mined every 10 minutes. The nonce is generated by brute force method by the mining computers. The nonce is also recorded on the new block so that it can be verified by any of the validating nodes. The first miner to solve the puzzle gets to add the next block to the chain and is rewarded with transaction fees for all the transactions in the block and a certain number of new bitcoins. All the participating nodes check for the validity of all the recorded transaction and the proof of work. This is done automatically by the software and needs no human interference. The software on participating nodes will reject any block which records any transaction or any proof-of-work claim which cannot be verified to be true. The nonce is computationally expensive to find but very simple to verify. It becomes exponentially more challenging to make any change in the previous blocks. This ensures that an attempt at fraud is extremely expensive and unlikely.

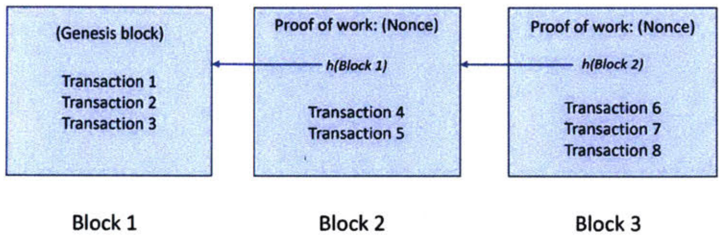


Figure 8: A simple representation Blockchain - C

Proof-of-work needs a lot of computational power and electricity and is relatively slow. There are alternative consensus mechanisms to solve this problem. The most popular among the alternatives is Proof-of-stake. A node is considered eligible to (verify transactions and) create the next block if it has a stake in the system. Having a stake means that the node holds some coin or token which is used to trade value on that Blockchain. For example, in Ethereum Blockchain it is Ether. An eligible node is selected randomly to create the next block, and the probability of getting selected is proportional to the share of the stake the node has in the system. An evil node will need to have over 50% of stake in the system to get a fraudulent transaction recorded on the blockchain. This is highly unlikely.

There are several other consensus mechanisms such as Proof of Reserve, Proof of Elapsed Time, Proof of Importance, etc. But proof-of-work and proof-of-stake are the most popular ones. A brief comparison between these two consensus mechanisms is tabulated below: -

	Proof of Work	Proof of Stake
Miner selection	The probability of mining a new block depends on how much computational work has been done.	The probability of getting to mine a new block depends on the amount of stake (how many coins one owns) one has in the system.
51% attack	An evil node needs at least 51% of the computational power of the entire system to execute fraud.	An evil node needs to own at least 51% of the coins in the system to execute fraud.
Mining communities	Tend to get centralized over time.	More decentralized.
Power consumption	Needs more energy and computational power; expensive.	Does not need any additional energy for mining. Hence, cheaper.
Speed	Slower	Faster
Examples	Bitcoin, Litecoin, etc.	Cardano, OmiseGo, etc.

Table 1: Proof-of-work Vs Proof-of-stake

Thus, we see how Blockchain is a decentralized peer-to-peer data-structure that can record and store data on multiple computers across the network in a way that ensures that all parties agree to a single truth and that the recorded data is immutable. In its earliest application, this technology was used to act as a public ledger to record the generation and transaction of Bitcoin crypto-currency. Subsequently, several other crypto-currencies have been created using Blockchains. Blockchain technology enables the creation of digital platforms where the benefits from network effects and shared digital infrastructure do not come at the cost of increased market power and data access by an intermediary (Catalini, 2017). As we can record any kind of data on these blocks, new applications in fields such as supply chain management, medical records management, etc. are emerging. The technology allows a network of agents to agree, at regular intervals, on the true state of shared data. The flexibility in terms of what such shared data represents across settings (e.g. crypto-currency, documents, other financial assets, contracts etc.) makes it a general-purpose technology (GPT). Such technologies typically take a long time to diffuse through the economy and become mainstream but once there, they lead to gains in productivity across multiple sectors. Electricity and the internet are other examples of a GPT.

2.1 Permissioned Blockchains

Private or permissioned Distributed Ledger Technology that has been gaining popularity over the last few years are similar to public Blockchains in most aspect except that they are not public. One needs permission to join the network, and hence it is called a Permissioned Blockchain. Only an agreed set of writers and readers are authorized to join. The underlying software is not open source. A permissioned blockchain can be owned by a consortium of parties with a common interest in some ledger when it is also called a "Consortium Blockchain", or a private company for its internal use; when it is also called a "Private Blockchain" (Vitalik, 2015).

Using permissioned Blockchain makes sense when a limited set of mutually mistrusting entities, relevant to a particular business, want to interact and change the state of a system but are not willing to agree on an online trusted third party (Wüst and Gervais, 2017). Consortium Blockchains are already said to have found several applications in banking and supply chain management. For example, Walmart and Maersk have claimed to have done successful pilots with IBM to meet their food traceability goals using Blockchains.

Permissioned Blockchains have their pros and cons with respect to a public blockchain. One major difference between a Blockchain and a Permissioned Blockchain is that while the former is "trust-less" the latter is based on the premise that the participating nodes know and trust each other to a certain extent. The consensus mechanisms are hence a lot easier to implement in a Permissioned Blockchain. This makes them a lot faster than Blockchains.

	Public Blockchain	**Permissioned Blockchain**
Access	Open read/write	Permissioned read and/or write
Speed	Slower	Faster
Security	Proof of Work Proof of Stake Other consensus mechanisms	Pre-approved participants, Practical Byzantine Fault Tolerance (PBFT)
Identity	Anonymous Pseudonymous	Known identities
Cost	Miners need to be compensated; hence relatively expensive	No need to compensate public miners; hence cheaper

Table 2: (Public) Blockchain Vs Permissioned Blockchain

Going forward we will use Blockchain as a generic term referring to all types of blockchains – permissionless (public) or permissioned.

Public and permissioned blockchains differ in that a public blockchain allows anyone to read the contents of the chain and thus verify the validity of the stored data, while a permissioned blockchain only allows a limited number of approved participants to read the chain. Note that for any blockchain based solution it is possible to make use of cryptographic techniques to hide privacy-relevant content (Wust & Gervais, 2017). Techniques such as zk-SNARK (Zero-Knowledge Succinct Non-Interactive Argument of Knowledge) allows applications to take advantage of a public Blockchain while keeping certain information private as in a permissioned Blockchain. A discussion of zk-SNARK is beyond the scope of this thesis. The idea is that with such techniques, privacy is not that important a concern when choosing between a public and a permissioned blockchain. Scalability, cost, speed and security are more important factors, especially for a consortium, as is the case for most supply chain applications.

The flowchart in figure 9 below gives a structure to decide if one needs a public or permissioned or no blockchain at all for a particular application. TTP refers to Trusted Third Parties such as a bank or other centralized authority.

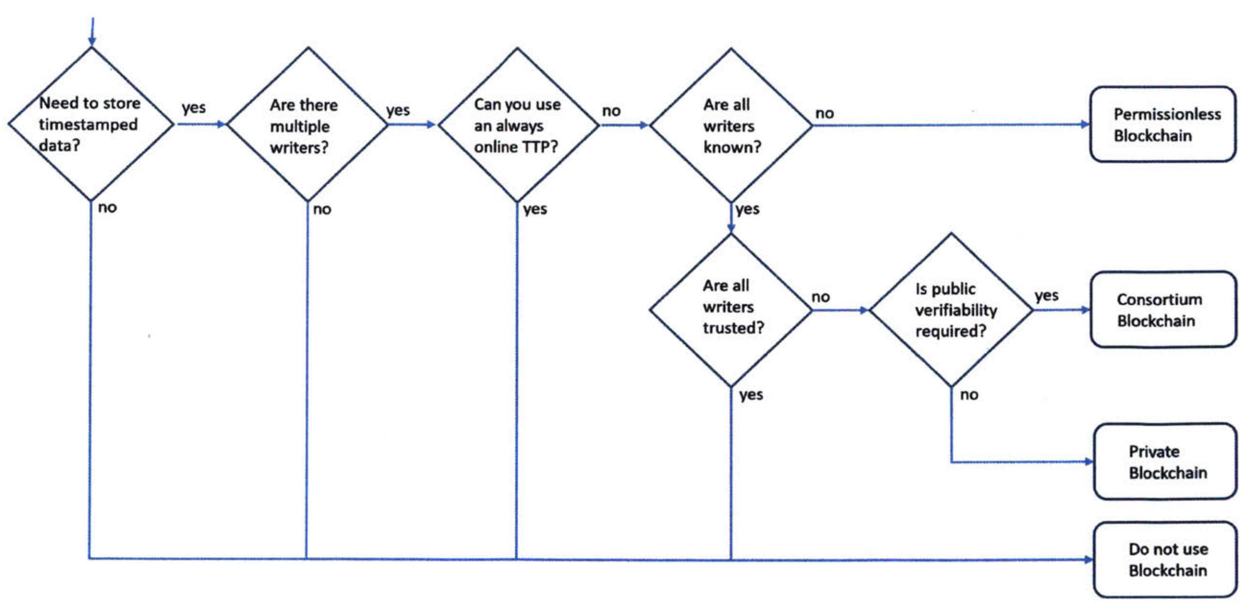


Figure 9: Flowchart to determine whether a blockchain is an appropriate solution for a problem (Source: Wust, Gervais; 2017)

Blockchain based applications in shipping industry would require multiple stake-holders to share data with each other. These stake-holders have a varying degree of trust among themselves. At the same time, there is no need to verify the information related to a shipping contract publicly. Given the same, a Consortium Blockchain will be ideal.

A global survey of 321 retail professionals conducted by Cognizant Technology Solutions in July 2017 revealed that 43% of respondents believe a sustainable private blockchain will eventually emerge. Another 27% of them predicted the emergence of a sustainable open blockchain for the retail industry. A consortia-based blockchain was predicted to be the industry leader by 25% from the remainder of them.

2.2 Smart Contracts

Storing data is the primary application of a Blockchain. However, another application of Blockchain which has gained popularity in recent years is running software applications on it. These applications work on the IFTTT logic (If-This-Then-That) and are called smart-contracts. A smart contract is a computer program that runs on a Blockchain. Its correct execution is enforced by the consensus protocol of that particular Blockchain (Szabo, 1997). The software code is stored with all the necessary instructions on the Blockchain, and it executes on its own when the set parameters are met. The contracts are self-executing. They are activated when the flow of events triggers some pre-defined terms and conditions (Swanson, 2015).

The business logic of smart contract is presented below:-

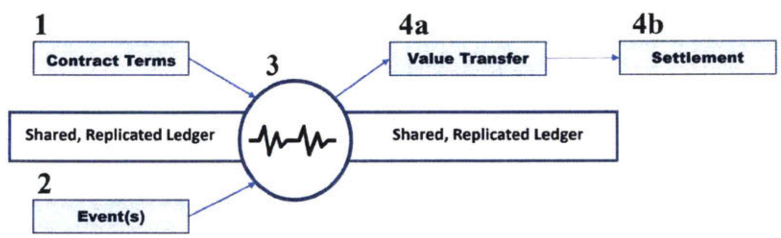


Figure 10: The Business logic of Smart Contracts. Adopted from (Swanson, 2015)

First, the counterparties establish the terms and conditions (1) and put some asset under the custody of the smart contract. The terms follow an "if-then-" structure for execution. Then comes the event (2) that triggers the contract execution. An event may refer to some information received or some transaction initiated. The smart contract itself (3) is stored on a shared ledger and is made up of the business logic that dictates the movement of value based on the conditions. On being triggered, the smart contract leads to a value transfer (4a) in digital format, as dictated by the contract terms. The changes in the account are reflected in the ledger and settlement (4b) is complete (Swanson, 2015).

Smart contracts can be automated in response to future events, adding substantial flexibility to the process of verification. Contracting parties can agree, ex-ante, on the rules for an audit, further reducing the need for dispute resolution if a problem emerges. Trusted, independent sources of information, can also be incorporated in the process. For example, if buyer and seller agreed to different terms based on the weather conditions, a smart contract could aggregate information from multiple weather sources (including sensors) to adjudicate a dispute. (Catalini, 2017)

However, for the above to happen the Blockchain must be "Turing-complete". A computational system is said to be Turing-complete if it supports execution of an algorithm to do any type of mathematical calculation. In other words, any Blockchain that stores and provides a virtual machine for execution of a computer program is turing-complete. Although recent research claim that the Bitcoin Blockchain is also Turing-complete (Wright, 2018), Ethereum was created as a more user-friendly Turing-complete blockchain with support for Solidity, a programming language, to run smart contracts.

Smart contracts can be run on both public and permissioned blockchains and have wide application in any industry where contracts are used. As the contract is stored on the blockchain, it becomes immutable and undeniable. In most practical applications the contracts hold some value which gets transferred to a pre-defined party when a set of parameters are met. This makes it possible for two parties to enter into a contract without having a trusted third party or without having to trust each other.

One of the primary characteristics of blockchain is immutability of data. This means that anything once recorded on a block can never be changed. This raises a question of what happens if one enters something wrong by mistake and needs to correct it. As discussed earlier, any entry needs to meet a pre-defined set of parameters and need to pass certain checks before it gets recorded as a valid entry on a block. This set of parameters and checks is unique to each blockchain and is designed to meet the purpose of that particular blockchain. For example, every transaction is traced back to a previous valid transaction and is checked to be valid before getting recorded on the Bitcoin Blockchain. A person can transfer one bitcoin only if they own at least one bitcoin. If not, the software will reject a request to log this transaction on the blockchain.

The software does these checks automatically and do not need any human interference. On a public blockchain, each node does this verification, and hence there is no room for a mistake. Even on a permissioned blockchain, similar rules can be set to ensure that no mistake is made while recording any piece of information. A consensus mechanism where multiple participating nodes must agree before a piece of information gets recorded on the Blockchain will help detect errors and stop them from getting into the Blockchain. Smart contracts can also be coded to follow a particular pre-defined recourse if it encounters a certain error; for example, a mismatch in data received from different sources.

With these limitations and possibilities associated with the Blockchain technology, we explore its application in different stages of the contracting process in chapter 4.

2.3 Blockchain technology in Shipping Contracts

When an open market transaction, such as the process of hiring a ship, is not performed promptly, it leads to a loss of value. When performed within a certain limit, the same transaction would have led to capturing of some additional value. This loss in value is referred as Temporal Specificity (Masten, Meehan and Snyder 1991). Shipping markets, particularly the bulk ocean-freight markets suffer from temporal specificities because of the time and space (location) factors involved. This leads to a haggling between shipper and carrier over the hire rates (Pirrong, 1993). Negotiations for hire rates and terms and conditions of carriage become more complex and time-consuming.

Self-executing smart contracts can be used to track a bill of lading for an ocean-freight and automate fund transfers. With certain limitations and challenges, blockchain based smart contracts can be used to execute a charter party agreement, calculate hire and demurrages based on a pre-defined formula and initiate a fund transfer between a charterer and a ship-owner. In all these transactions, the use of brokers obliterated as the parties contract directly with each other using the blockchain's consensus mechanism which does not require the two parties to trust each other (Letourneau & Whelan, 2017).

In exchange for their services, intermediaries typically charge a fee or monetize their ability to observe all transactions taking place in a marketplace. This informational advantage, combined with network effects and economies of scale, often gives them substantial market power. Consequences of market power include higher prices, lock-in, the presence of a single point of failure, reduced innovation, privacy risk and censorship risk (Catalini, 2017).

The fees paid to the intermediaries is one of the costs buyers and sellers incur when they cannot efficiently verify all the relevant transaction attributes by themselves. Additional costs may stem from the intermediary having access to transaction data (a privacy risk) and being able to select which transactions to execute (a censorship risk). These costs are exacerbated when intermediaries gain market power, often as a result of the informational advantage, they develop over transacting parties through their intermediation services (Stiglitz 2002, as cited by Catalini, 2017). Most interactions in the shipping market happen through brokers.

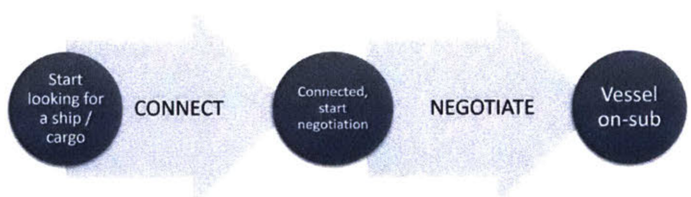
The brokers stop the free flow of information in the system and make the transactions expensive by charging a brokerage fee.

We will address these challenges in chapter 4 and see if we can use technology to overcome them.

3. SURVEY

A survey questionnaire was designed and sent out to the respondents including charterer, ship-owner and the brokers. The purpose of the survey was to understand the problems faced by the industry professionals relevant to this thesis and to quantify the delays. The survey was followed by a one-to-one interview with select respondents to discuss their response further and to understand the reasons behind certain outliers. A total of 20 respondents were surveyed: 16 brokers, 3 ship-owners and 1 charterer.

Part I of the survey asked questions about the time taken from the moment the two parties start looking for each other to the moment a vessel is put on-sub. The respondents were asked to tell the shortest, the longest, and the most common number of days it usually takes them to cover these steps.



The below box plots indicate the spread of the responses: -

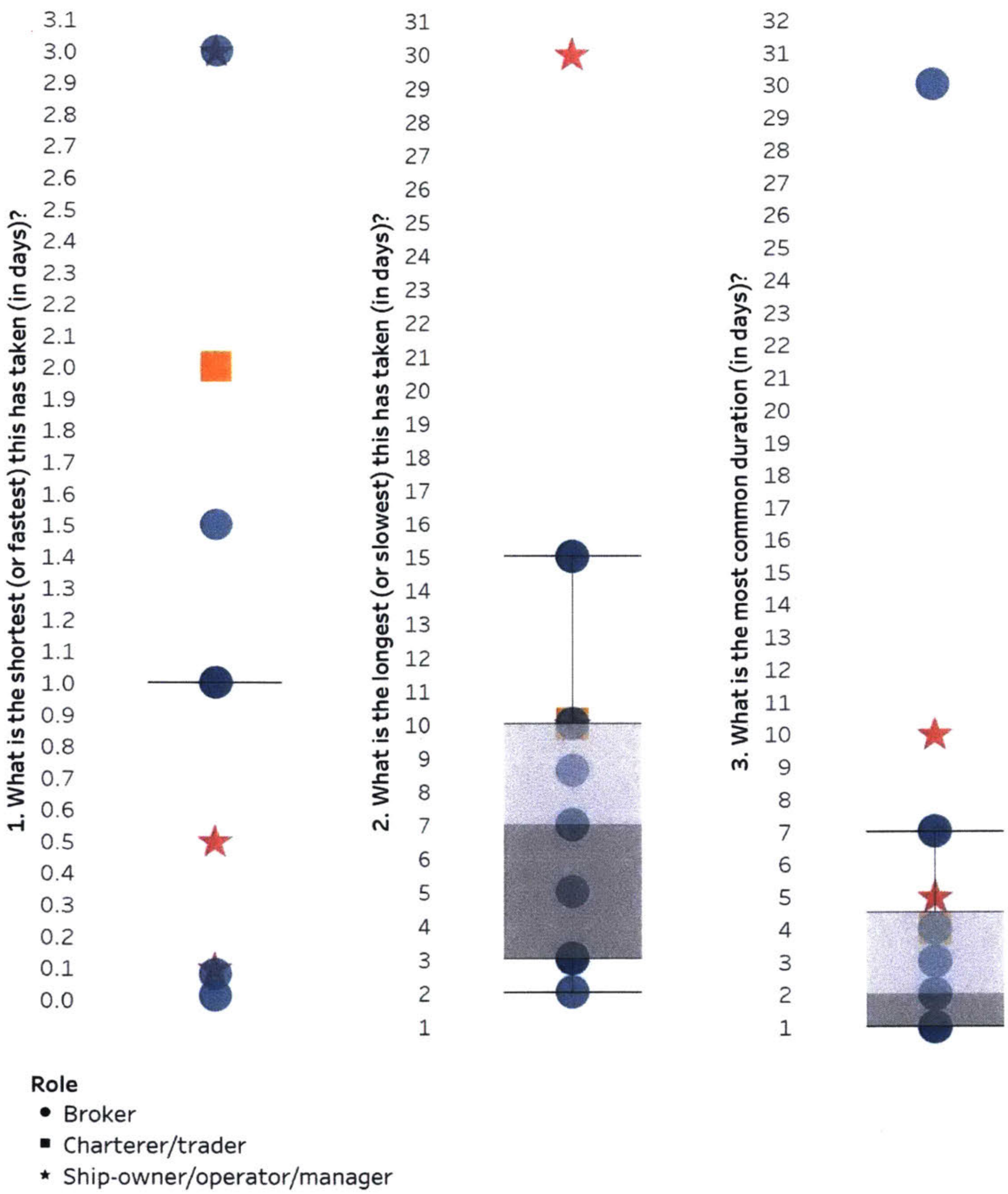


Figure 11: Box-plots for survey questions 1-3

Box plots show the minimum, first quartile, median, third quartile, and maximum values for each question. Data points above 1.5 times the inter-quartile range (IQR) are treated as outliers. The plot for the first question shows that for most of the respondents it took a minimum of a day to complete the said process.

For the second question, the larger box indicates a wider spread of responses. The inner quartile range is from 3 to 10 days, with a median of 7 days.

The below scatter plot shows the distribution for each of the respondents about their shortest and the longest experiences: -

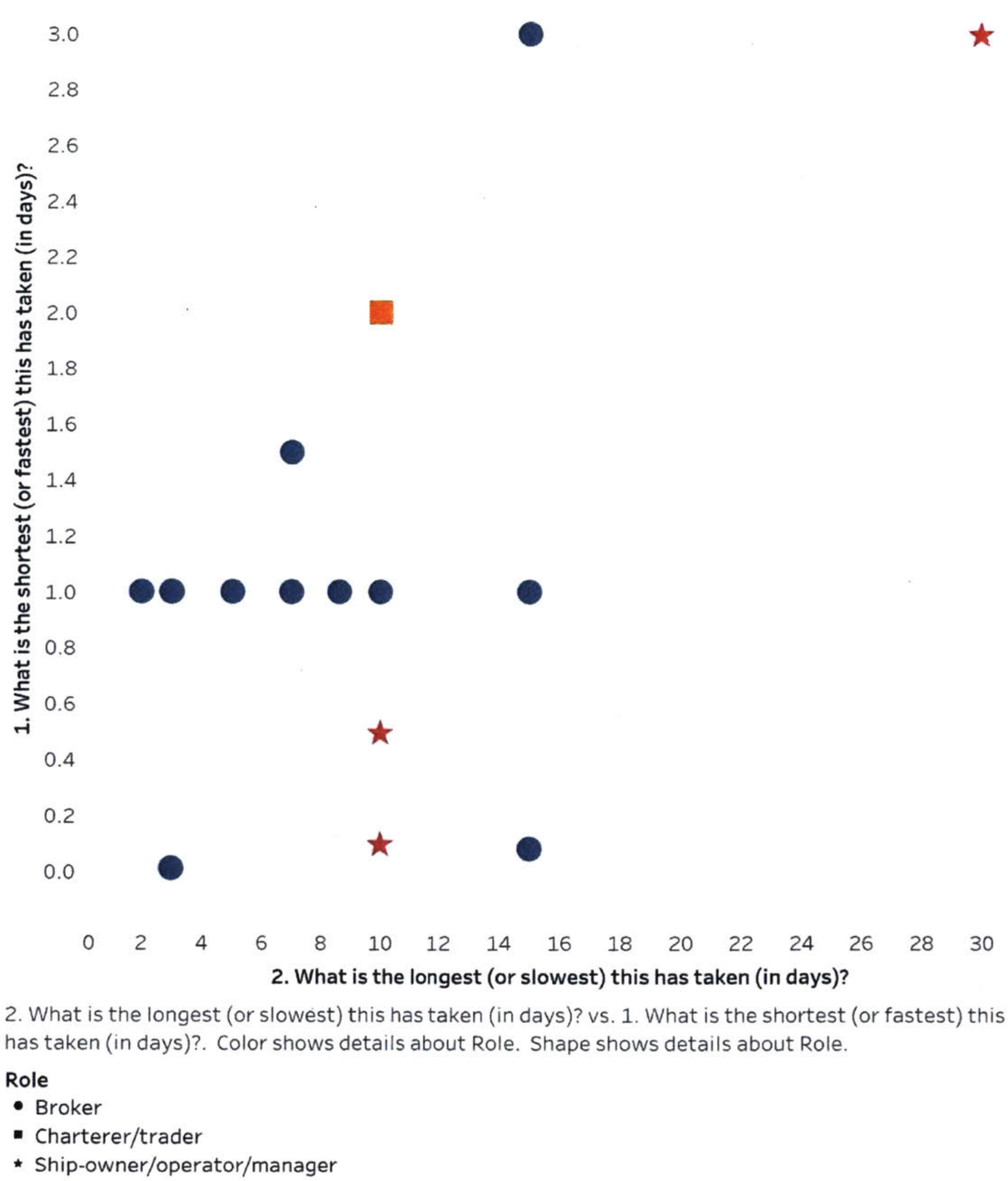


Figure 12: Scatter plot for survey questions 1 and 2.

The same information on the first three questions can be summarized in the below table: -

	Minimum	25th Quartile	Median	Average	75th Quartile	Maximum
1. Shortest	1	1	1	1	1	3
2. Longest	2	3	7	8	10	30
3. Most common	1	1	2	3	5	30

Table 3: Survey data summary for first part. All figures in number of days. Rounded up, to nearest integer.

In table 3 above, for calculating the 25th quartile, median, average and 75th quartile the outliers have been neglected. Data points beyond 1.5 times the IQR are treated as outliers.

Considering the highest of longest tender times, the smallest of the fastest tender times and the average of the most common tender times among all the data collected, we end up with the below triangle probability distribution. The plot shows that it might take as little as one day to as long as a month to put a ship on hire, starting at the moment the charterer and the ship-owner start looking for each other.

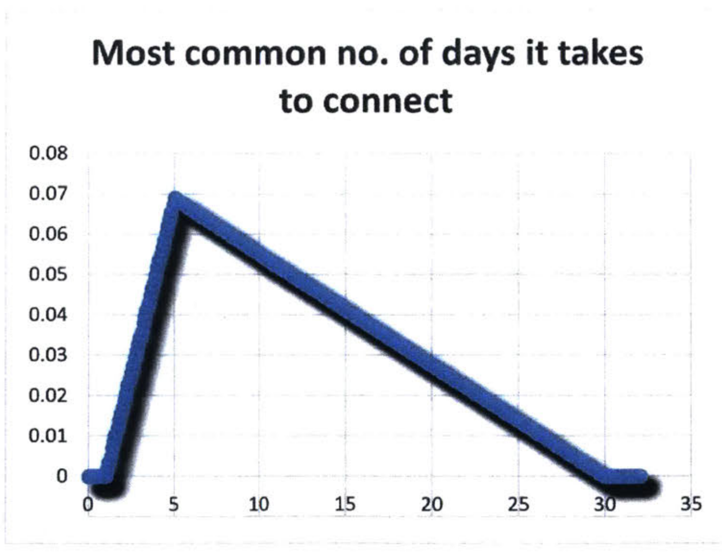


Figure 13: Triangle probability distribution for survey question #3

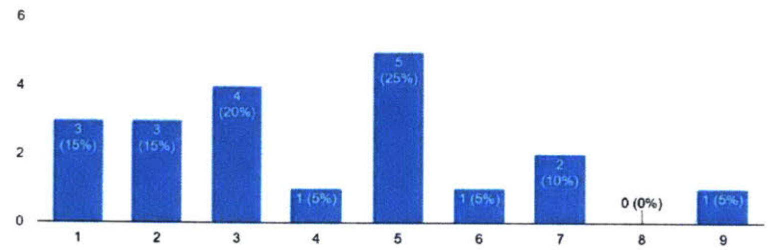
The above triangle probability distribution models the number of days it takes the charterer and shipowners to connect with each other. A triangular distribution is a continuous probability distribution plot shaped like a triangle, based on the below probability density function:

$$f(x) = \begin{cases} 0 & x < a \\ \dfrac{2(x-a)}{(b-a)(c-a)} & a \leq x \leq c \\ \dfrac{2(b-x)}{(b-a)(b-c)} & c \leq x \leq b \\ 0 & x > b \end{cases}$$

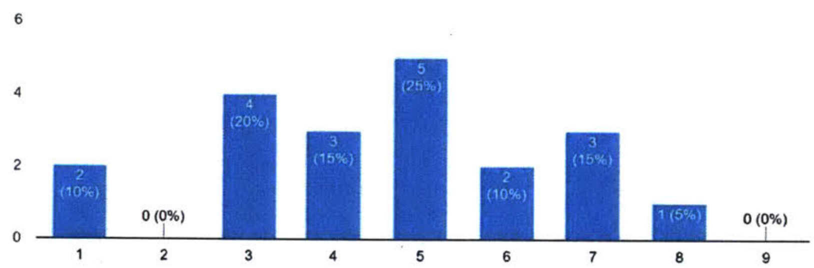
The two ends of this triangle represent the minimum and the maximum value while the peak vertex represents the mode (the most common value) for any event. The answer to the question asked in the survey were given mostly based on the memory. It is easier to remember the minimum (a), maximum (b) and the most common outcomes (c) of events than remembering the median or average values. Given the same, a triangle distribution is ideal for plotting the probability distribution for these events. In figure 13, a, b and c are 1,5 and 30 respectively. We will also analyze some histograms and box plots to understand the problems.

The next set of questions asked them about the percentage of time they spent in finding each other Vs the percentage of time they spent in negotiating the terms and conditions in each of those three cases – shortest, longest and most common tender times. Here, selecting "1" means 10% of the time was spent on "Connecting" and 90% on "Negotiating". Similarly, "4" means 40% of the time was spent on "Connecting" and "60% on "Negotiating", and so on.

For very FAST tender times, what percent of the total time was spent on Connecting versus Negotiating?



For very SLOW tender times, what percent of the total time was spent on Connecting versus Negotiating?



For the MOST COMMON tender times, what percent of the total time was spent on Connecting versus Negotiating?

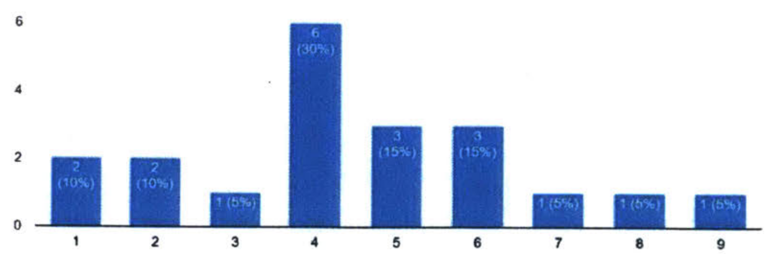
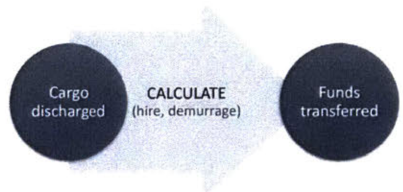


Figure 14: Bar charts for survey questions 4 to 6

When the tender time is low (fast) people are spending less time on finding each other and relatively more time on negotiating terms and conditions and rates compared to cases when the tender time is high (slow).

Interviews suggest that time taken in negotiating the terms and conditions and hire rates do not vary much across the deals while the time spent in connecting (finding a suitable match) varies considerably. In other words, it takes almost the same time to negotiate a deal every time but the time spent on finding each other varies, mainly because there is an element of chance involved in it.

The second part of the survey asked how much time is spent between the discharge of the cargo and the time a fund transfer is received in the accounts of the receiver. This includes both hire and demurrage.



The collected data plotted as box plots are as shown below in figure 15:-

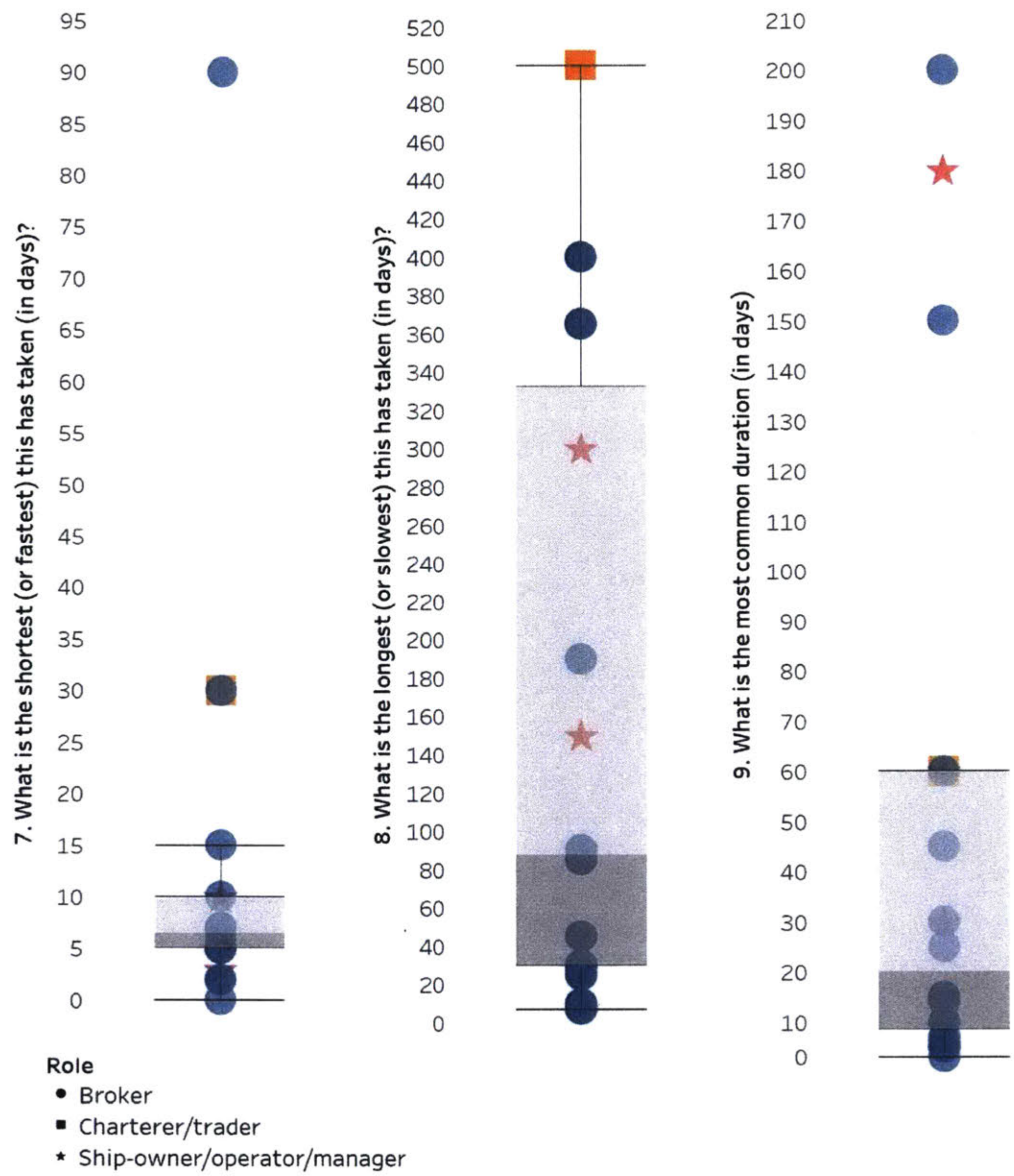


Figure 15: Box plots for survey questions 7 to 9

The same information on the first three questions can be summarized in the below table: -

	Minimum	25th Quartile	Median	Average	75th Quartile	Maximum
1. Shortest	0	5	6	6	10	90
2. Longest	7	30	88	75	332	30
3. Most common	0	10	20	23	60	200

Table 4: Survey data summary for second part. All figures in number of days. Rounded to nearest integer.

In table 4 above, for calculating the 25^{th} quartile, median, average and 75^{th} quartile the outliers have been neglected. Data points beyond 1.5 times the IQR are treated as outliers.

The median values for the shortest, longest and the most common duration it takes for this process are 6, 88 and 20 days respectively. The data points on the bottom of the first plot (number of days <2) represent the cases where entire hire and demurrage were paid to the ship-owner within two days of discharge. These cases are most likely an example of either the CP having a BBB (Break Before Bulk) clause and/or the voyage ending with no demurrage accrued. On the other hand, the data points on the upper side of the first plot (number of days >30) most likely indicates smaller owners and/or unprofessional charterer where payments are delayed despite all documentation being in order.

On the second plot, the data points on the bottom (number of days <20) might indicate that the owner and the charterers are in a long-term relationship (pool arrangement) and the hire is being paid promptly. On the other hand, the data points on the upper side indicate that there delays in payment of demurrage. These cases are mostly disputed, and arbitration might be in progress.

The below scatter plot shows the distribution of the number of days experienced by each respondent: -

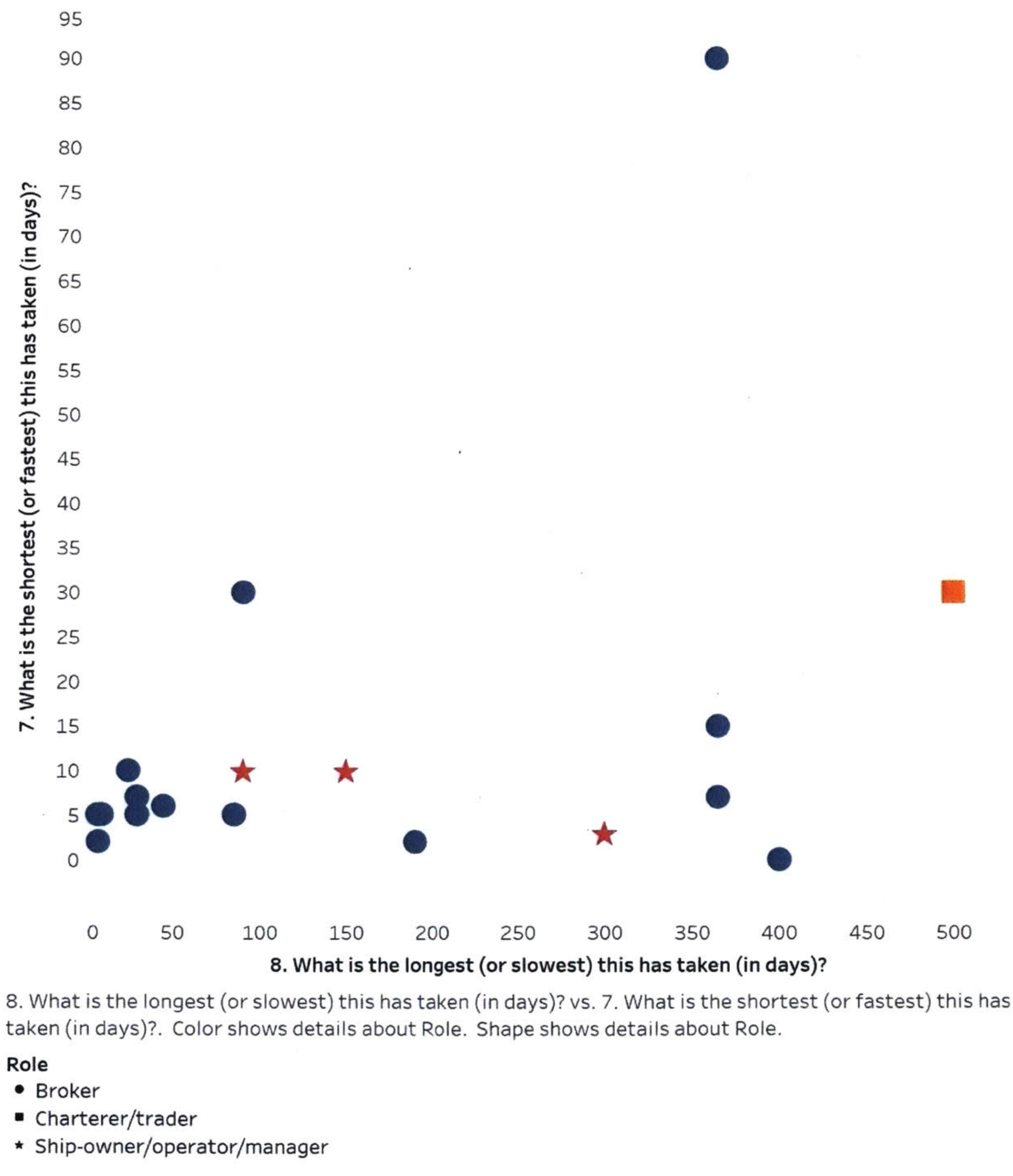


Figure 16: Scatter plot for survey questions 7 and 8

The above scatter plot shows the that the shortest number of days that it takes to complete this step is a lot less spread out than the longest number of days it takes for the same process.

Combining all results, the below triangle distribution was generated:-

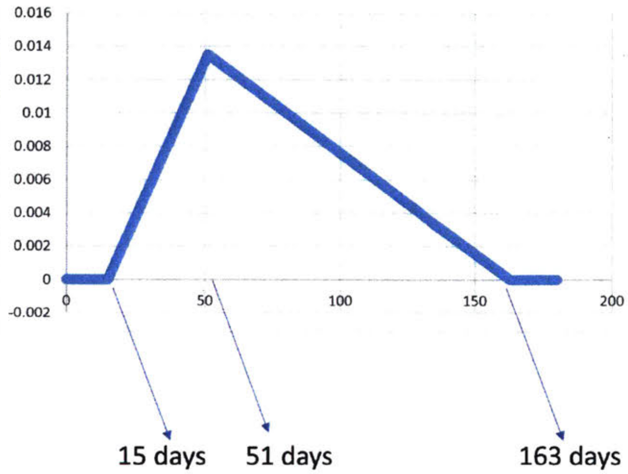


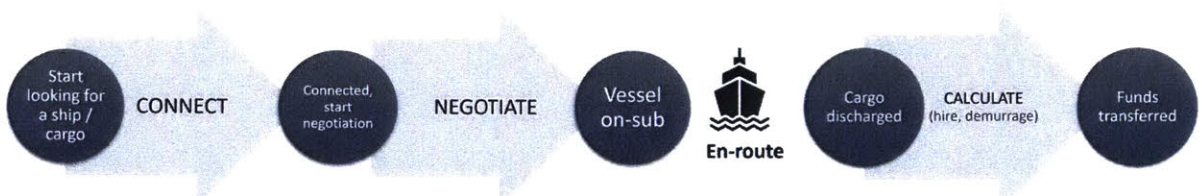
Figure 17: Triangle probability distribution for total time

This shows that it might take as long as 163 days on an average to conclude the entire process of contracting; excluding the days when the ship was engaged in doing cargo operations or sailing.

4. ANALYSIS

In the first part of this section, we again break down the entire contracting process into three major stages and analyze the problems at each stage. For each stage, we explore possible application of technology as a solution, and then we explore the benefits and the challenges in the implementation of these solutions. While discussing the benefits, we make some assumptions and based on those assumptions quantify the savings which can be made in terms of money and time. In the second part, we take the entire end-to-end process as a whole and come up with solutions which reengineer the process as a whole.

Part I



As explained in Chapter 1, the process of executing a Charter Party agreement begins with the charterer and the ship-owner looking for each other and ends when the ship-owner is paid the complete hire for carrying the cargo.

4.1 Stage 1: Connect; finding the right match.

This stage is about the charterer finding the right ship and the ship-owner finding the right cargo for the ship. By "right" it is meant that a set of requirements must be matched. For example, depending on the cargo, the charterer needs a ship of a certain type – crude oil carrier, product tanker, chemical tanker, etc., of a certain size, at a certain port within a certain range of dates to load the nominated amount of cargo. At the same time, several ship-owners are looking for a suitable cargo for the next voyage of their ship. The ship might be opening (becoming available to load next cargo) in a certain port on a certain date. Even if some static information, such as the ship size and type, might be available, the dynamic information such as the exact date and location of availability is not public. Both parties approach their respective brokers and pass on the details. The brokers go to the market with this information and start looking for a suitable match (as illustrated in figure 3)

The main challenge at this stage is the availability of information. The charterer and the ship-owner mostly do not know each other in the spot market. The information about the availability of ships and the information about the availability of cargo are not publicly released. Brokers at each end hold this information, and when they are assigned the task of looking for a match, they spread it across their network. Consequently, this process takes a lot of time. As we discovered through our survey and interviews, the time spent on finding each other varies considerably. On the other hand, the time spent on negotiations is more consistent. This is obvious as there is an element of chance involved in finding a suitable match, but once the match is made, negotiations follow a standard set of steps, which takes a more predictable amount of time. Also, the present process needs all parties to remain alert and online at all times to find a suitable match, as we can see in the opensea.pro survey mentioned in section 1.3. The present process is time consuming and can take anywhere from a few hours to several days. The problem has a huge commercial impact on the ship-owner if the ship has to go off-hire and wait for her next cargo. Similarly, for the charterer and the consigner, such delays expose them to additional inventory cost and impact of fluctuations in market price.

The solution

The key to solving this problem is making the information available while protecting the business interests of the parties at the same time. It is important to cut short the chain of communication. If there is a trustworthy platform, where the two parties could interact directly, then time will be saved.

This issue can be solved if the two parties interact directly on a web-based market-place platform. The charterer and the ship-owner can pass on all the relevant information to the system. The information is stored in a database which can be queried by a web application. Once one of the parties enter all required information, the application can query existing information from the parties on the other side and display a list of matches. This process can help them search for and find each other instantly, assuming there exists a suitable match. In such a case there will be no brokers involved and all communication will be direct, saving time. See figure 18.

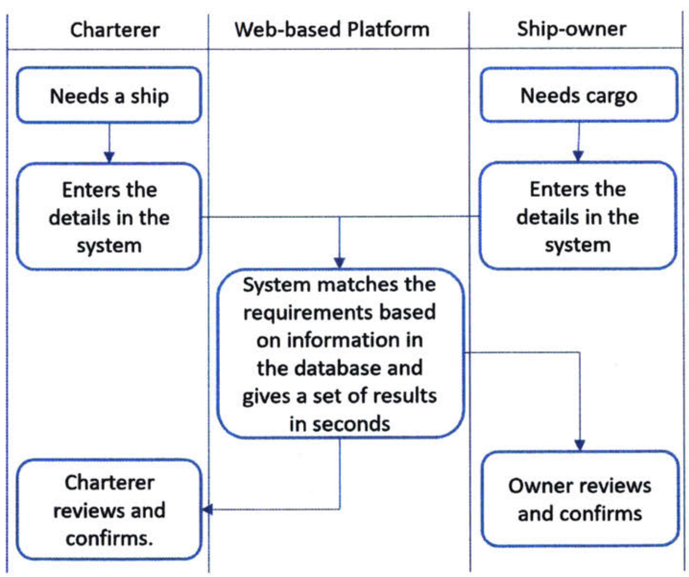


Figure 18: Possible future process for stage 1

There is no direct application of Blockchain technology in developing a solution like this. However, Blockchain being a general-purpose technology can be used to support such a platform. A blockchain-based identification system, for example, would help stop frauds (by stopping unscrupulous entities from creating fake identities to solicit users) and give confidence to the users. The identities can be reliably connected to previous transactions done on the Blockchain to further strengthen the profile of a user.

The benefits

Based on our survey, we estimate the present process takes between ½ a day to 4 days with an average of just over 2 days. In future, with an assumption that a suitable match exists somewhere in the physical world and has been entered in the virtual system, this stage can be concluded in a few hours. The potential time saved hence ranges from anything between a couple of hours to 4 days on an average.

The proposed process can connect the two parties to make a suitable match within seconds of receiving all the required information through a database query. The database can be searched using appropriate filters through a suitable user interface. While the match can be made in seconds, the two parties can take a few minutes to a few hours to review the details and confirm each other to enter the negotiation stage. Thus the process can be reduced from hours and days to minutes and hours. The saving in hours can be translated into a dollar value for each party. The centralized platform providing this service would charge a service fee accordingly so that each party finds it profitable.

In terms of costs, there would not be any direct saving in the number of person-hours as for every proposal approximately the same number of person-hours will be spent in feeding the information to the system and in reviewing the information received, on the charterer's and the ship-owner's ends. However, additional benefits can be gained from not having the ship and the cargo wait for each other, despite being ready to engage in such business. To quantify this saving, we take the example of an average size (Long Range 2 – 80,000 to 120,000 MT cargo carrying capacity) product oil tanker. We take the real hire rate for such 10-year old tanker on 1st January 2018 as $15,000 per day. Converting the potential time saved (2 hours to 4 days) into a dollar value, we get a potential dollar saving of $1,250 to $60,000 per transaction.

If the charterers and the ship-owners engage in such platforms directly, without getting involved with the brokers, there might be a potential saving in the brokerage. For the same assumed product tanker on a time charter, assuming a brokerage fee of 2.5% of hire, such saving will be $ 375 per day per transaction. This can lead to huge savings for the ship-owner over time. Subsequently, the ship-owner might reduce the hire rate to pass on a part of this saving to the charterer.

The challenges

Several attempts have been made in the past to create such an online market-place. Opensea.pro is the most notable among them. None of the attempts has been able to gain a considerable market share. We asked our interviewees about a possible reason for this. Based on what they believed, we concluded that there are two main challenges which remain to be addressed. First, such a platform does not help bridge the trust gap between the ship-owner and the charterer. For this reason, most of them still prefer going to a broker. Although the two parties will be able to find each other quickly, it is highly unlikely that they will readily trust each other enough to enter into an agreement. The brokers do not only connect the two parties but also establish a chain of trust between them. Second, when such a portal begins to function, there are very few participants. There are no major incentives for the early adopters to join the platform as in the initial days the chances of finding a suitable match is low. Such a platform will need a network effect to succeed.

4.2 Stage 2: Negotiations

The negotiations can be classified into two main categories- negotiations over the rates – hire and demurrage, and negotiations over the terms and conditions. Once these negotiations are done, the charterer accepts the vessel subject to approval from the port authorities/ terminals where the vessel is expected to operate. The vessel is then said to be "on-sub". It is rare for charterers to keep multiple ships on subs. The charterer screens the ships in the very beginning stages to ensure that there are very little chances of the terminal rejecting them at a later stage.

Lack of price transparency, a complex and dynamic market and ambiguous charter party terms and conditions lead to several rounds of communication between the ship-owner and the charterer, all through the brokers. These communications are spread across different time zones. All of this makes the process time consuming, from as little as a few hours to as long as several days.

The solution

Price transparency can reduce time spent over price negotiations. Given the market practices, it is more plausible in the container shipping markets than in tankers. The tanker market spot rates are very volatile, and the lanes are not always well-defined. It is a common practice to mention a range of load/discharge ports in a Charter Party agreement instead of stating a single set of ports. This opens up the possibility of a lot of variabilities and hence negotiations in the hire rates. The Baltic price index or the Worldscale 100 scale is used as a beginning point, and then the price is negotiated depending on the set of ports.

It looks challenging for any technology to resolve this issue at the moment. However, a blockchain-based consortium model is being tested in the container market. The New York Shipping Exchange (NYSHEX) is testing blockchain-based smart contracts technology to address price volatility, unused capacity, and a lack of transparency in the container shipping industry. The initiative takes a consortium approach involving various shippers and carriers. The shippers will be able to view listings (with details such as price, lane, dates, etc.) from carriers that have cargo space. Once the shipper accepts a listing's terms, the agreement becomes binding and is recorded as a contract, and the cargo space is removed from the exchange. The smart contract requires shippers and carriers to put up collateral worth up to a certain percentage of the contract amount and any party that doesn't follow through forfeits that collateral.

Negotiations over the terms and conditions, on the other hand, are time-consuming not because of the market dynamics but because of the manual labor put into going through every word of a complex legal document by both the parties. There are multiple standard formats of charter parties popular in the industry (such as BPVOY, SHELLVOY, ASBATANKVOY, etc.) but it is a common practice to edit these standard contracts and add "rider-clauses" which needs scrutiny by the other party. Various online tools (such as chinsay.com) have come up with NLP (Natural Language Processing) algorithms to assist humans in this process.

The benefits

Although there is no strong recommendation to improve the processes in this stage, the application of a blockchain-based exchange or an NLP algorithm, as discussed in the previous paragraphs, remain a matter of further investigation. If successfully applied, they will lead to savings in terms of the number of hours spent in negotiations.

The Challenges

Unlike the container market where most of the trade lanes are well defined, the liquid bulk market is more global and unpredictable. For example, a container ship knows months in advance about the date it will be calling a series of ports. The containers are booked, and the stowage is planned accordingly. On the other hand, the destination of an oil cargo is not well known even after loading in most cases, and it is common for the ships to sail out "for orders" towards a range of ports instead of going to a particular port. Building a consortium of consigners, charterers and carriers in the case of the liquid bulk market to establish an exchange for price transparency will be far more challenging.

4.3 Stage 3: Calculations and fund transfers

Although the process of calculating demurrage is fairly simple, time is spent in agreeing to the information which goes into the calculations. The formula for calculation of demurrage is based on the terms and conditions of the Charter Party (CP). As almost no two CPs are same, one needs to go through the CP carefully to come up with the correct formula. Often the ship-owner and the charterer enter into some dispute over the formula as there are certain aspects of even standard CPs which are interpreted differently by different parties. The timings are mostly received from the third-party cargo surveyor and agreed upon by both the parties. In practice, the charterers have been seen to delay the execution of demurrage for flimsy reasons such as non-receipt of a certain document. Finally, the actual fund transfer also takes several days to execute particularly when international transfers are involved.

The process is described in figure 19.

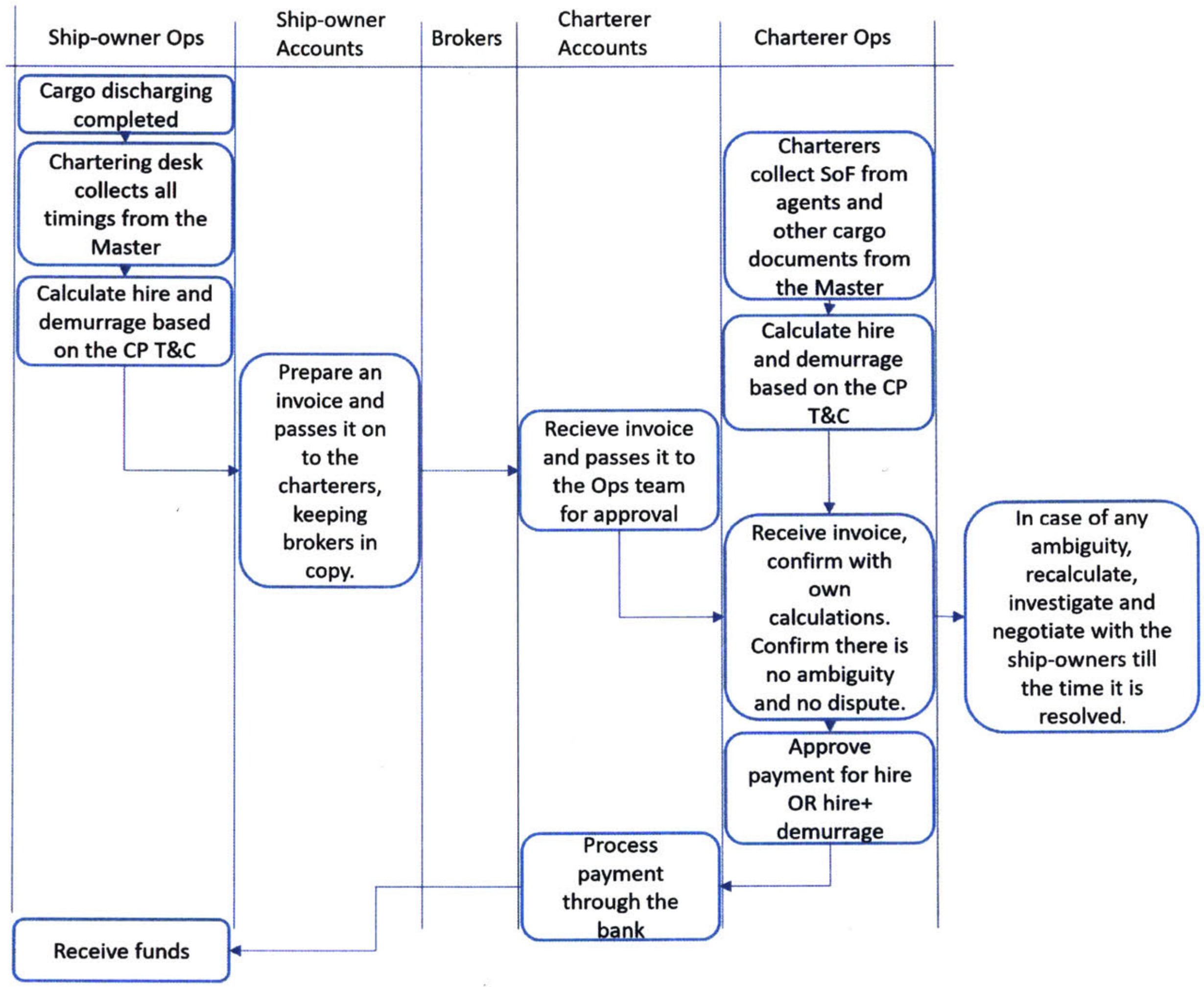


Figure 19: Stage 3- Calculation and fund transfer process

As explained briefly earlier in Chapter 1, the calculations are done independently at both the ends. Both the ship-owner and the charterer collect the time-sheets (also called a statement-of-facts or SOF) for all port operations and calculate the demurrage based on those timings as agreed in the Charter Party agreement. The ship-owner raises an invoice and sends it to the Charterer for payment. If the figures match, the charterer proceeds to make the payment. If there is any mismatch in the calculations either because of a disagreement over timings or because of a different interpretation of the Charter Party clauses or if there are any missing supporting documents, the payments are delayed.

The Solution

A Blockchain-based self-executing smart contract is a possible solution to these problems. The terms and conditions of the CP can be converted into a mathematical algorithm. Such an algorithm will take certain inputs, do calculations fitting those inputs in a pre-defined if-this-then-that formula, come up with a non-disputable figure and finally execute a fund transfer.

As smart contracts can be pre-loaded with funds, it would guarantee the ship-owner of receiving funds if they meet the obligations of the contract. In such a scenario, there will not be a need to trust each other. The system will be trustless, and hence there will be no need for a broker for this purpose.

Figure 20 explains the basic working of a smart contract.

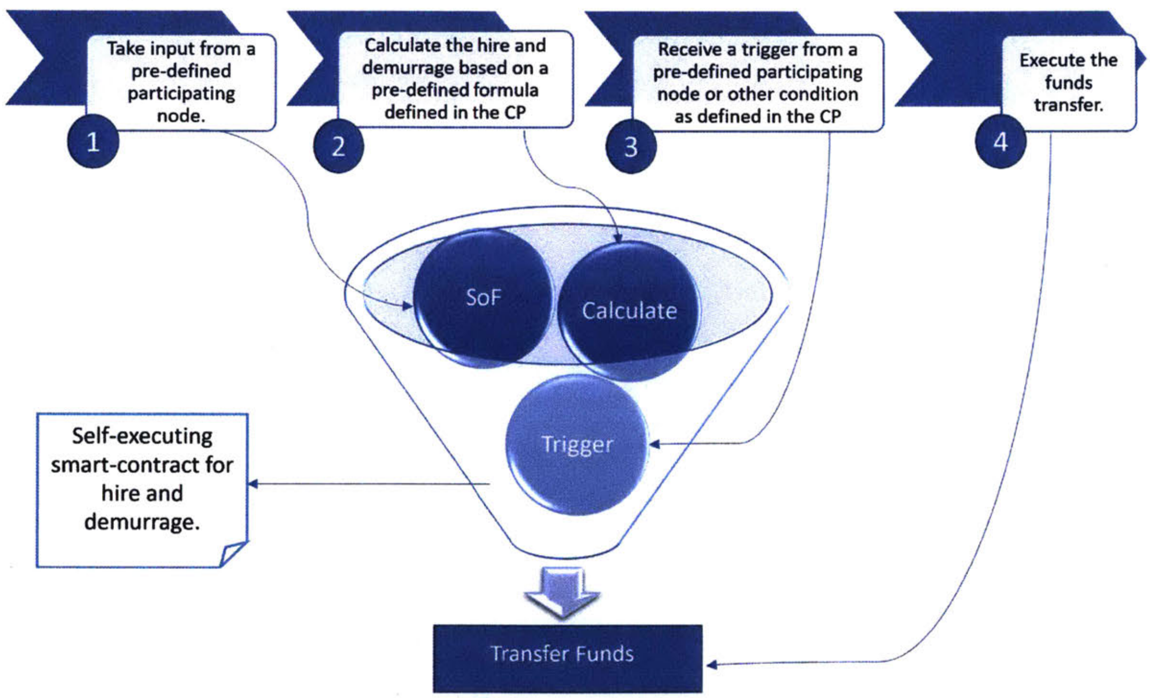


Figure 20: Self-executing smart contract

At the moment, in case of a paper-based CP, all these steps are being done manually and involve a series of email-based communication which is time-consuming. In the immediate future, various concerned parties can become a participating node on a permissioned blockchain and give inputs to the smart contract through a computer program. In the distant future, as ships become more sophisticated, the inputs and the trigger can come from various IoT devices. IoT stands for "Internet of Things", and it refers to electronic devices that can communicate with the internet. A GPS device fitted onboard the ship sending its location to a smart contract to confirm that the ship has arrived at a particular berth at a particular time is an example of an IoT device interacting with a Blockchain-based smart contract. The idea is summarized in figure 21.

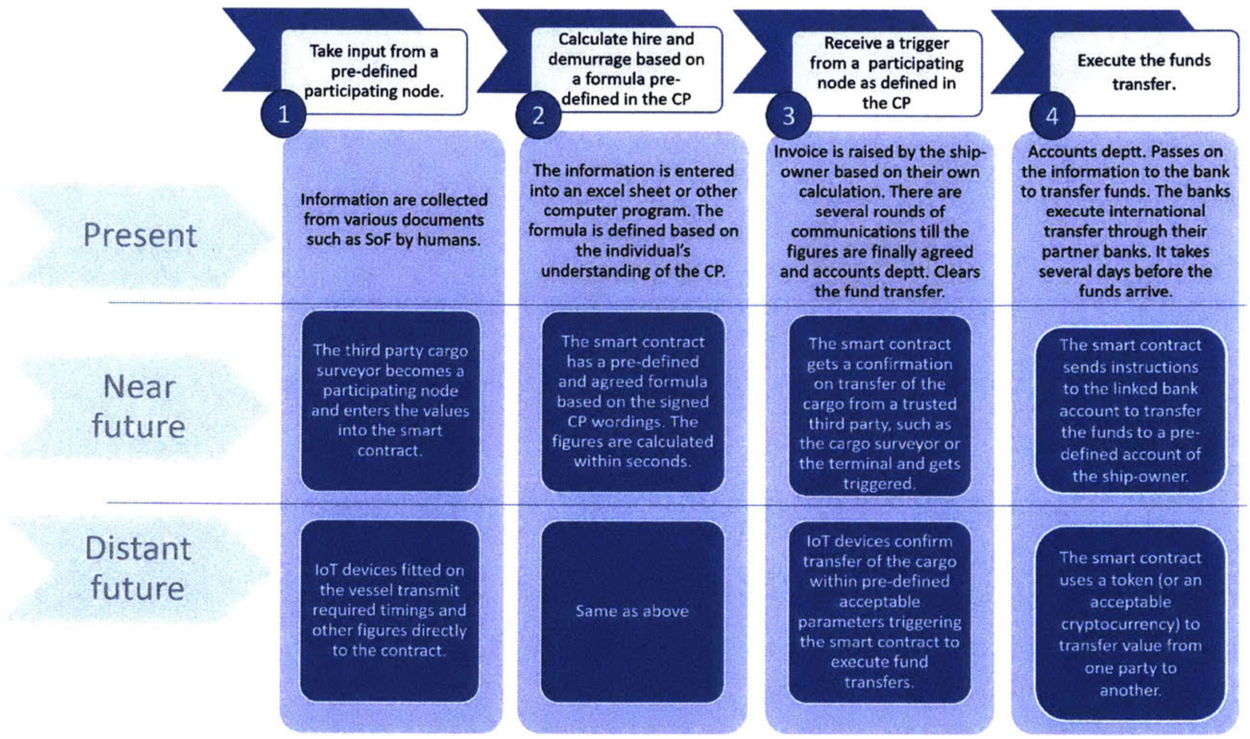


Figure 21: Application of smart contracts in future

<u>The benefits</u>

Our survey shows that it takes between 13 to 153 days to complete this stage. Use of a self-executing smart contract can eliminate any chance of a dispute and if the parties agree the funds can be transferred as soon as the discharging is done, within seconds. Even if the parties do not want to trade in a token or a cryptocurrency, the smart contract can be linked to their fiat bank accounts and can execute the fund transfer within hours or days. Thus, it can lead to a huge saving in the number of hours spent on collecting the information, calculating the figures and executing a fund transfer.

The cost benefits can be divided into two categories – the cost for calculations and the cost for funds transfer. Let's analyze the cost of doing the calculations first. We will compare the present process with the assumed future process wherein a smart contract handles all the calculation.

Assuming $50 per hour cost of labor and assuming on an average total of (including labor at both the charterer's and the Ship-owner's ends) 32 person-hours spent (based on interviews) on calculating data, doing calculations and carrying out the communication over email/phone calls; the cost is

= (number of man-hours spent) * (cost of labor per hour) = $ 1,600.

For the future, let's consider two scenarios:-

- Scenario 1: The contracting parties do not trust each other, and the contract is deployed on a public blockchain, say Ethereum.
- Scenario 2: The contracting parties are part of a consortium, and the contract is deployed on a permissioned blockchain, built on say Quorum.

Scenario 1

The cost of deployment and running a smart contract on a public blockchain depends on the several factors and keeps changing with time. This is similar to the transaction cost on the Bitcoin Blockchain. The cost is essentially the fee charged by miners to add the transaction/ contract to the blockchain and is driven by free market supply-demand gap.

Figure 22 shows the average gas price for running a transaction/contract on the Ethereum Blockchain. Gas is a measure of value which one needs to pay to the miners for adding their information to the Blockchain. As can be seen in the chart, the rates fluctuate with time. The peak in December 2017 is the day when the popularity of the smart contract application called Crypto-kitties was at its peak.

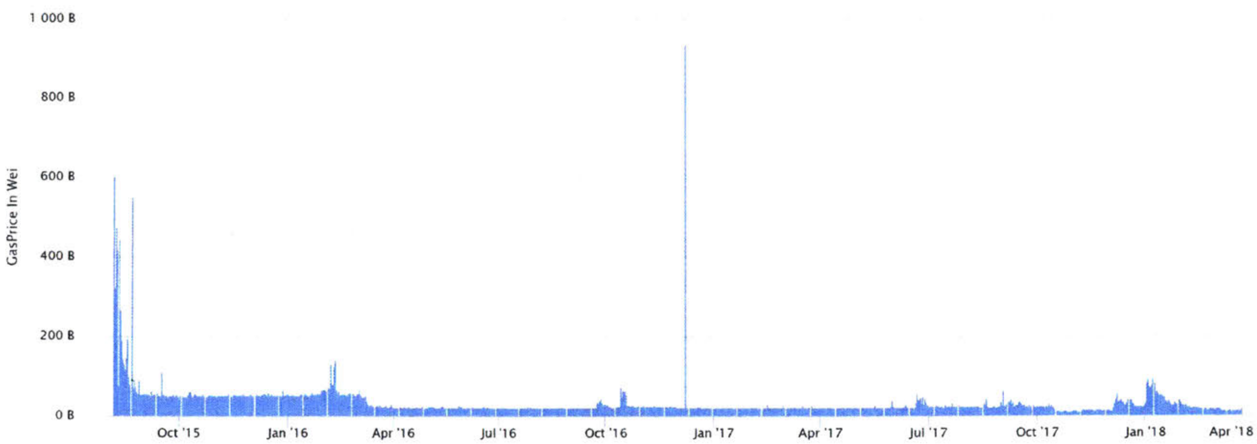


Figure 22: Ethereum average Gas price chart. Source – etherscan.io

Understanding Ethereum fee structure

Cost of running a smart contract is proportional to the complexity of the code. The unit to measure the complexity or in other words the required computational power or in other words the required cost is 'Gas'. Most of the smart contracts that run in the EVM (Ethereum Virtual Machine) are coded using the programing language called Solidity. Each line of the code in solidity requires a certain amount of gas to get computed. For example, to run a SHA3 hash function once, 30 units of Gas is required. The complete list of all such operation and their associated Gas price is available in Appendix G of the Ethereum Yellow Paper (Wood, 2017). This indicates that the exact cost of running a smart contract in terms of Gas can be calculated only when all the instructions in the smart contract are known. Once the contract is put on the Blockchain by the developer, every time it is called by any user application, the user must put a certain amount of Gas to get it executed. A dollar (equivalent to ETH) value must be associated with a unit of Gas, depending on the market condition. ETH refers to Ethers, the cryptocurrency used to exchange value on the Ethereum Blockchain. Subsequently, the miners execute and record the output of the contract as a transaction on the Ethereum blockchain if they like the Gas price. The miners decide whether to execute a transaction or not depending on the demand-supply of computing power in the system and the incentives offered by that transaction.

For example, the average gas price on Ethereum on 18th March 2018 was as described in the image below:-

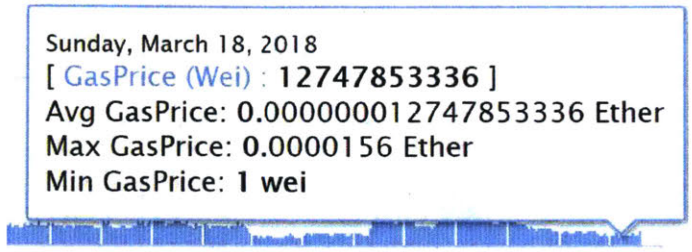


Figure 23: Ethereum Gas price on 18th March 2018. Source – etherscan.io

(Wei is the smallest unit of measurement of Ether where 1 Ether = 10^{18} Wei.)

It should be noted here that putting lower than needed Gas will lead to the contract being void. It will never get executed. However, putting a lower Gas price leads to a delay in execution of the contract as it becomes of less priority to the miners. Any unused Gas is not charged to the user.

In summary, the following steps are taken to execute a smart contract on the Ethereum blockchain: -

Step 1 – Calculate the units of Gas required

Step 2 – Associate a gas price - See the current market condition, add a safety margin.

Step 3 – Call the contract and let it execute.

Cost Calculations

The below charts show how the Gas price is distributed and how confirmation time varies with Gas price.

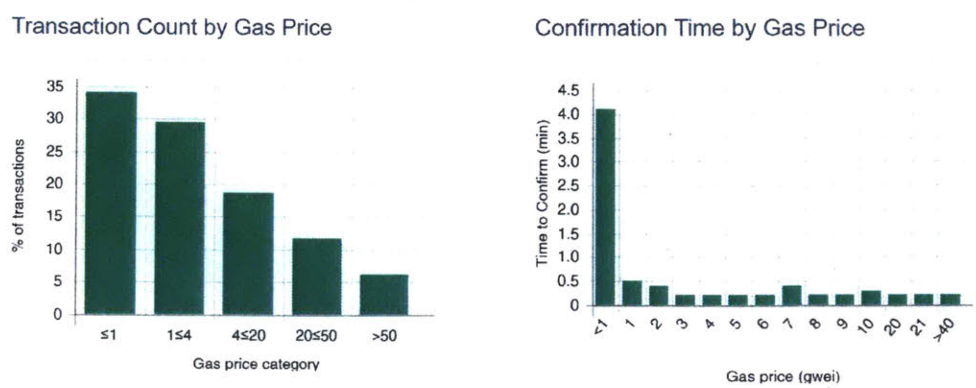


Figure 24: Ethereum Transaction count and Confirmation time by Gas price for last 1500 blocks as on 6th April 2018

The table below shows figures for the last 1500 blocks on the Ethereum blockchain as on 6th April 2018:-

Category	Value
Cheapest Gas Price (gwei)	0
Highest Gas Price (gwei)	1354431
Median Gas Price (gwei)	3
Cheapest Transfer Fee	$0
Highest Transfer Fee	$10523.93
Total Transactions	194832
% Empty Blocks	0
% Full Blocks	76

Table 5: Key prices for Ethereum Blockchain

The total cost of running a smart contract in USD = (Units of Gas) * (Gas Price) * ($/ETH ratio at a given time)

Units of Gas can be from 6M Gas to 0 Gas.
Gas Price can be from .03 Ether (==$15) to 0 (approximately)
$/ETH ratio can be from $10 to $ 1448

Taking Median Gas price for last 1500 blocks and a complex contract of 1M Gas, the cost in USD at the $/ETH ratio on 6th April the cost of executing a smart contract will be approximately

=$ 111

Scenario 2

On a permissioned Blockchain, for example, Quorum, the cost of executing a smart contract is almost NIL as no reward needs to be given to the miners.

Therefore, considering all scenarios, the savings in cost of doing the calculations offered by using a smart contract can be between $1600-$111= $1489 (scenario 1) and $1600-$0= $1600 (scenario 2) per transaction.

Next, we need to consider the cost of doing a fund transfer. At present, the transfers are done through banks. For international fund transfers, there is a network of banks which helps move the fund from one country to another. For this comparison, we neglect the taxes, and forex charges paid, if any, in the transaction. Assuming remittance in the same currency, transaction cost for an amount of $100,000 was approximately

0.1%

Now, we consider the cost of executing the same process on smart contracts through cryptocurrencies. Transaction cost varies with time. Considering average transaction fees in the most recent blocks mined on 6th April 2018, the transaction fee (in percentage) for ETH was

0.0012%

So, for a transaction of $100,000, this will lead to a saving of $98 approximately. This is not a big amount in terms of dollar value. However, a far bigger advantage of using a cryptocurrency-based fund transfer will be in time-saving. In the present process, international fund transfers are done through a network of banks, and so it takes several days for funds to arrive. On the other hand, a fund transfer using a cryptocurrency is done directly from the sender to the receiver, and it takes only a few minutes to get confirmed on the Blockchain.

The Challenges

The biggest challenge with a smart contract-based charter party agreement is the necessity of having a large amount of money locked into a contract for a period. Some voyage charters can take as long as two months to conclude. It will be a challenging task for any charterer to lock their liquid cash into a smart contract for so long. The smart contract can still work without locking-in the money but in that case, it will serve only the purpose of a time-saving tool and will not be able to fill in the trust gap existing between the ship-owner and the charterer. Further, any process that makes the payments faster will hurt the charterers and hence will face resistance from them. The charterers will have to be incentivized by the ship-owner in some other way to convince them to adopt a smart contract-based solution.

Part II

In this part of the chapter, we consider the end-to-end process of contracting as a whole instead of breaking it down into as-is steps. We first discuss how the process of document management affects the process of contracting and how it can be improved. Then, in the last section of this chapter, we reimagine the entire process with use of the emerging technologies.

4.4 Document management system

Document management forms the basis for executing a successful contract. The contract itself is a document, to begin with. Subsequently, a lot of supporting documents are generated by different parties that need to be generated, tracked and shared appropriately to avoid any ambiguity. Examples of such documents relevant to a charter party agreement include (but are not limited to):-

- Charter Party Agreement
- Bill of Lading
- Certificate of Quality, Quantity and Origin
- Statement of Facts (Timesheet)
- Various Cargo documents

Each of the above documents has been explained in the Definitions section. The present process tracks and shares these documents mostly using emails. A paper back-up is maintained by most of the parties. Stage 3 in the last section gives an example of how different parties collect the same information from different sources and do their respective calculations. Blockchain technology gives us an opportunity to store and share these documents in a much more efficient manner.

As the involved parties have already entered into an agreement, for the purpose of document sharing they trust each other. Therefore, a permissioned Blockchain is ideal for this kind of application. Let's take the case of the Bill of Lading as an example and understand how such application would work.

The Bill of Lading is a document of entitlement and hence is a very important legal document. It is closely associated not only with the procedures related to customs at the ports but also with the existing banking system which facilitates the fund transfer. For these reasons, it is a common practice to courier the original BL from one party to another. This takes several days to do. Also, it takes time to prepare BL once operations are done, and the ships waste several numbers of hours at load port waiting for the BL. (Some tanker terminals have started using an "Early Departure Procedure (EDP)" wherein the ship sails out without carrying any BL onboard. This is possible only when the charterer and the ship-owner are comfortable with this, which is possible in most developed countries these days but not in several developing or under-developed countries). Then there are times when the BL has not arrived at the discharge port by courier, and hence the ship has to wait before it can commence discharging.

To save the time spent on sending paper-based BL by courier, the Baltic Exchange has recently come up with electronic BL. But it has yet to get industry-wide acceptance because the problem with a digital bill of lading is similar to the "double spend" problem as there has to be a single original copy, accepted by all parties. A digital version of BL is not yet considered safe by several parties and has yet to be tested in a court of law for legal validity.

Figure 25 explains how the BL is closely associated with the payments. The process begins with the receiver's banks issuing a Letter of Credit to the charterer's banks, giving assurance that the receivers have enough funds in their account to pay for the cargo once they receive it. Based on this assurance, the charterer instructs the supplier to release the cargo for shipment. The cargo is then loaded on the ship, and this is when the Bill of Lading is created. A true copy of the Bill of Lading is carried onboard while the original is sent to the receivers by courier. Once the receiver has received the cargo, they submit the original BL to the bank and subsequently the bank releases the funds to the charterer/trader.

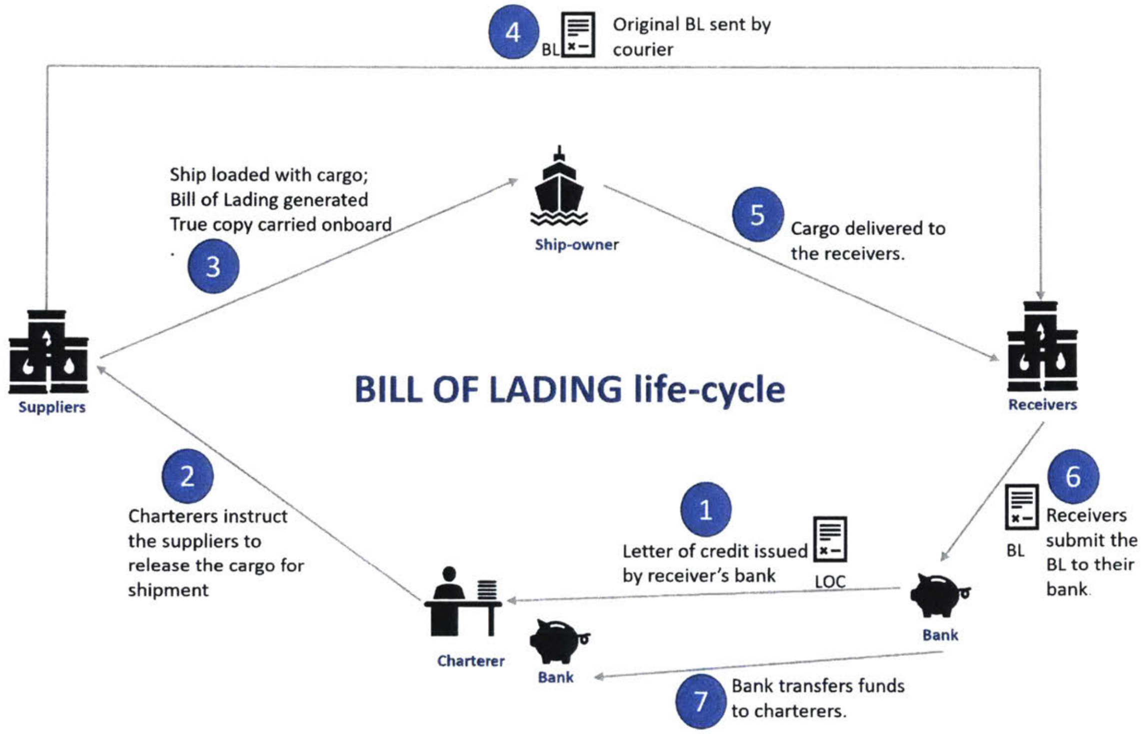


Figure 25: Bill of Lading life-cycle

<u>The Solution</u>

The solution lies in a blockchain-based file storage service. This kind of application is ideal for a permissioned blockchain wherein the parties are allowed to pass access to the digital document at different stages. In this new system, the various parties become a participating node on a permissioned blockchain, and there remains one BL as a single source of truth always. The parties agree to a consensus mechanism for each stage of the process. For example, when the BL is being generated, the carrier might upload it onto the system through a User-Interface. The terminal representative and the local agent (on behalf of the charterer) are other two parties present at the load port. So, the permissioned blockchain can set a rule that for the BL uploaded to the system by the representative of the ship-owner to be valid it must be validated by the agent and the terminal representative. Once all parties do so, the ownership of the BL can be assigned to the charterer, and all these details are stored on the blockchain, readily available to all parties. The charterer can use cryptographically secured signatures to assign the ownership to the receivers subsequently, and this will be recorded on the blockchain. The banks will also be a participating node in the system, and it will take minutes for the receiver to pass on the ownership of the BL to their bank. It should be noted here that it makes sense to include the bank in this system if the parties are still using them to create trust and transfer value. In a future state, if the banks and their letters of credit (LoC) are no more used they need not be included in such a Blockchain-based document management system.

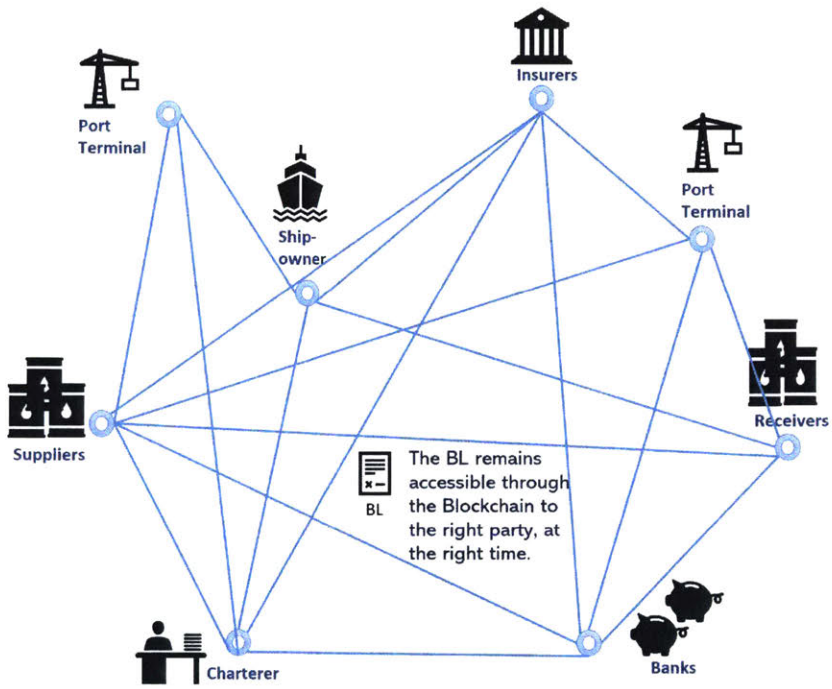


Figure 26: Blockchain-based Bill of Lading

Instead of each party maintaining a separate set of documents, with a Blockchain based solution now there is a single set of documents available to everyone. The same system can be used to generate, store and share all other documents mentioned at the beginning of this section. CargoX.io is a Slovenia and Singapore-based startup who claim to be working on creating a similar Blockchain-based Bill of Lading solution, expected to be released in the second quarter of 2018.

The benefits

As there is a single source of all documents and a system to ensure that the relevant parties validate all information well before it gets into the Blockchain, there is almost no chance of any ambiguity. This will lead to time savings. Moving from a paper-based system to a digital system will also lead the companies towards meeting their environmental goals.

The Challenges

As the parties involved are diverse with contrasting interests and incentives, it might be challenging to bring all of them on one platform. For example, it reportedly took an industry leader such as Maersk over a year to get a similar set of parties onboard to use a similar permissioned blockchain (for an entirely different problem of provenance).

4.5 Reengineering end-to-end process with Blockchain

In this section instead of breaking down the process of contracting into different steps, we look at the entire end to end process. For the entire process of contracting we can see the below three necessities: -

- Each party needs to have a continuous trust in the ability of the other parties in performing their obligations under the contract.
- Each decision and each activity needs to be documented throughout the process. The parties need to agree to a single truth through these documents.
- There needs to be a system to exchange values among the contracting parties.

We discuss each of these three points to understand where the industry stands at the moment.

Two parties who do not know each other depend on third party entities to assess and confirm each other's abilities. Banks serve as the biggest third-party entity when it comes to assessing the financial abilites. By issuing a letter of credit, the banks certify that their clients are financially able to engage in the risk the business or the contract might put them into. Brokers are another third-party entities who help establish the operational abilities through the record of performance of their clients. The fact that an entity has successfully engaged in similar activity in the past is verified by the brokers through their trusted informants. Other third parties such as the Classification societies certify the technical abilities of the entities by conducting audits on their assets and issuing various certificates. For example, holding a certificate of quality, such as ISO 9001, issued by a reputable Classification Society such as DNV or Lloyd's indicates that the entity maintains a certain minimum level of quality in all their offerings and encourages the other parties to engage with them.

Second, all this information need to be stored in some documents and shared through a trusted channel to ensure there is no forgery. As mentioned in the earlier section, several operational documents, such as the bill of lading, are generated and shared during the contracting process. Additionally, several certificates and documents generated by third parties are shared as mentioned in the last paragraph.

Finally, a reliable system is needed to transfer the ownership of various physical and digital assets throughout the contracting process. The cargo is the physical asset which gets transferred from one party to another. As a consideration for this and other services provided by other parties involved, a transfer of value is done in terms of money.

We have discussed the inefficiencies involved in all these processes by breaking down the entire process into multiple steps in the previous section. We also discussed the various solutions for each of those steps and the challenges involved in their implementation. Now we consider an end-to-end approach to tie everything together to see how we can overcome those challenges.

For example, in the first stage in chapter 4 when we recommend an online platform to help the parties find each other, we see the challenge of establishing the identity of the users as well as the challenge of the network-effect, wherein the proposed system offers no incentive to the early adopters.

In the third stage, in addition to various other points, we recommended a Blockchain-based smart contract for executing a charter party agreement and propose that in such a system the contracting parties will no more need a broker to establish trust between them. Then we discussed how this solution becomes challenging to apply in isolation. The brokers not only establish trust but also help the parties find each other (stage 1). So as long as the parties are using the brokers in stage 1, they will continue using them for other associated services as well.

Similarly, when we talk about a self-executing smart contract, we see that such a smart contract will not work unless we have an end-to-end document management system in place which is capable of digitally feeding the required information to the smart contract.

We can conclude from this discussion that whatever solution the industry comes up with, in addition to it being used by all the parties involved in the ecosystem, the system must also cover the entire end-to-end process of contracting. Blockchain technology is known to work well in situations with a lot of intermediaries in any transaction.

A consortium of various stakeholders in the ocean-freight market, such as the ship-owner, the charterer, the trader, the terminals, the customs, the suppliers, the receivers, etc. can use a single Blockchain to engage with each other. Such a consortium based Blockchain can assign tokens to its users. New joiners can buy the tokens to gain a stake in the system, and these tokens can be used as a reputation system. The participants can trade value among themselves using these tokens. As with time the system becomes more efficient and more inclusive, the value of the token will rise. This would give a good incentive to the early adopters to join the platforms and accumulate tokens.

The entire end-to-end process can be done through various applications built over the blockchain. For example, as depicted in figure 27, there can be an application (2) for doing fund transfers which the charterer, the bank and the ship-owner use through a User Interface (2). Or another application to facilitate the document management among other parties. A similar application can be built for identity management of each entity, for creating a marketplace where the charterers and the shipowners can find each other or for trading cargo and any other asset relevant to the ecosystem.

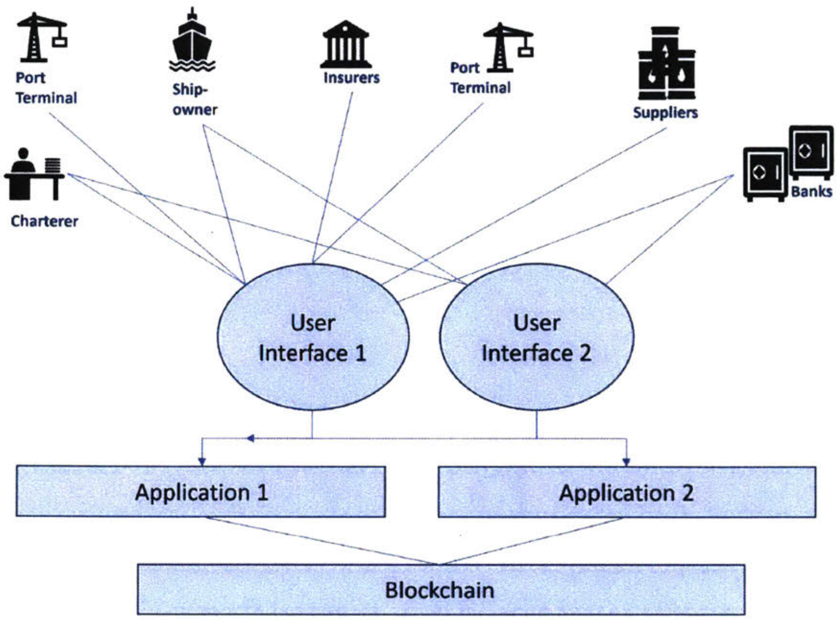


Figure 27: Blockchain for Ocean Freights

Figure 28 shows a possible example of an end-to-end platform for contract and document management. This example shows how in such a process the management of documents, such as a Statement of Facts (SoF), Certificate of Quantity, Bill of Lading, etc. and contracts, such as a Charter Party agreement become unified. First, the ship-owner and the charterer agree on the rates and the terms and conditions of the CP. This understanding defines the formula for calculations of hire, demurrage and other future actions. When an event such as loading or discharging operation happens, the information generated is fed into digital documents. The platform subsequently feeds this information from the digital document to the smart contract. The smart contract can be designed to generate documents such as a Bill of Lading using the information collected from other documents. Calculation of hire and demurrage followed by a fund transfer can also be next steps.

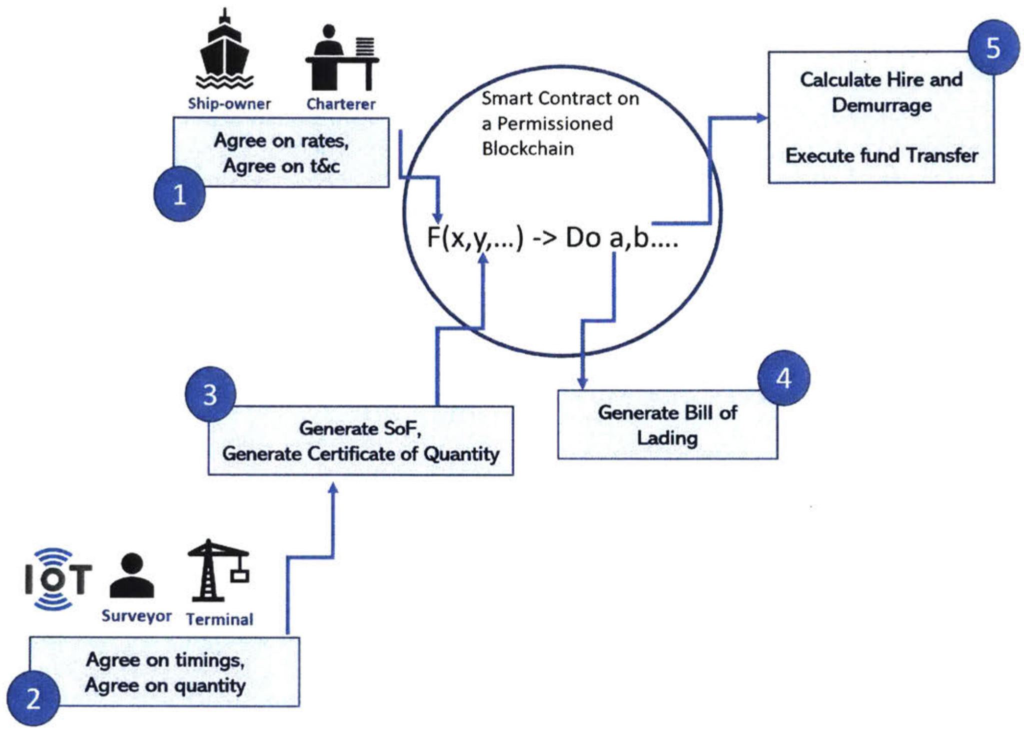


Figure 28: Blockchain-based contract and document management system

The benefits

With an ecosystem built like this and used by all stake-holders all the benefits mentioned in previous sections can be realized. Starting from a platform where the charterer and the shipowner find each other, to an end-to-end document management solution, the system has a potential to eventually obliterate all middlemen, including the brokers and the banks.

The challenges

In the absence of a strong link between offline and online events, asymmetric information and moral hazard will still be an issue in these ecosystems. In this context, Internet of Things devices are instrumental in expanding the set of contracts that can be automated on a blockchain because they can be used to record real-world information (e.g. through sensors, GPS devices etc.) and substitute labor intensive verification with affordable hardware (Catalini, 2017).

4.6 Legal aspects of Blockchain-based contracts

Contracts are a legal document. Two contracting parties depend on a trusted third party to resolve any dispute they might have in the future. The Charter Party agreement is the primary legal document for the carriage of goods through the sea. As such international carriage involves stakeholders from several different legal jurisdictions, it is imperative for the Charter Party agreement to be very clear and effective in dispute resolution from the outset. There are two ways in which this concern is addressed at the moment. The two contracting parties agree in advance about which legal system will be used if they end up with a dispute. This is documented in the agreement. The English Law has been the most popular so far. Alternatively, or at times, additionally, the two parties also include an arbitration clause in the Charter Party agreement. Arbitration refers to a way to resolve disputes outside the existing legal system of courts wherein one or more individuals, called "arbitrators" take decisions to resolve the dispute. If the Arbitration Clause is included in a particular agreement, the decision of the arbitrators is legally binding and enforceable in a court. Choosing arbitration over litigation helps the contracting parties save a lot of time and hassles, especially when they reside in different countries.

As we move from the existing contracting system to a future of Blockchain-based smart contracting practices, the mechanism for dispute resolution needs investigation. Decentralized public Blockchain-based applications such as Bitcoin tend to have no dependence on any trusted third party for dispute resolution. They are built on the premise that in a decentralized system such disputes would never arise. For example, the Bitcoin system assumes that any transaction that goes on the Blockchain would have never made it to the Blockchain had there been a valid reason for that transaction to be disputed. However, in permissioned Blockchain-based applications, there is some degree of centralized control to handle fraud and disputes.

Irrespective of the type of platform used, two contracting parties have the responsibility of agreeing to a dispute resolution system as a part of the contracting process. The below table (*adopted from the MAS.S62* *course at MIT; instructors- Neha Narula, Tadge Dryja & Joseph Bonneau*) compares a traditional contract to a smart contract.

	Traditional	**Smart**
Specification	Natural Language + "legalese"	Code
Assent	Signatures	Digital Signatures
Dispute resolution	Judges, Arbitrators	Decentralized platform, Arbitrators
Nullification	By judges	---
Payment	As specified	Built-in
Escrow	Trusted third party	Built-in

Table 6: Legal aspects of traditional Vs smart contracts

As the table shows, the Arbitration clause can be included in the smart contract based Charter Party agreements. In a Blockchain-based system, the Arbitrators will have to assume the role of an oracle. In Blockchain terminology, the term oracle refers to and individual or an entity third party that has been entrusted with finding, verifying and submitting real-world occurrences to a smart contract. So, effectively, the arbitrators will become a participating node with a pre-defined role and power which they may exercise if the smart contract is triggered by a conflict.

The process of law-making by Governments has always been a follower instead of a leader. Changes in our society and markets prompt the legislators to come up with new rules. In the context of contracting, until a few decades ago emails or another form of digital data were not considered valid by several courts in the world. But as the technology evolved, so did the legal system and now not just email but several other forms of digital communication are considered valid for an argument in the courts. There are some states in the US leading this adoption of Blockchain and smart contracts into the legal system. For example, the state of Tenesse has already passed a bill recognizing Blockchain based smart contracts for electronic transactions. However, it will still take a lot of time for this to become a globally acceptable phenomenon. Till the time the legal system adapts, arbitration is expected to help the growth of smart contracts. However, nullification of the contract remains a question, open for further investigation and discussion.

5. CONCLUSION

We started with a motivation to find technological solutions for making the process of carriage of goods through sea more efficient. Narrowing down the scope, we focused on the contracting process for hiring a liquid-bulk tanker for transporting goods such as oil and on the technology side, we focused on one of the most popular emerging technology – Blockchains. In chapter 1 we mapped the entire contracting process, starting from the time a ship-owner and charterer start looking for each other to the time the cargo is transferred, and the hire is paid. We broke down the entire process into multiple steps to understand the problems and challenges in detail. We carried out a survey and conducted interviews to consolidate our understanding of the industry and its inefficiencies further. Our survey revealed that it might take from as little as 15 to as many as 163 days for the entire end-to-end process to complete. Through another survey, we noted that need to be constantly online, monitoring and adapting to market trends and lacking information about the counterparties were some of the major pain points for most of the respondents. The entire contracting process suffered from lack of trust among various stakeholders, with various trust establishing agents such as brokers and the banks making the entire process more time and cost expensive. Then, we discussed Blockchain technology and smart contracts, and we explored how they can be applied to improve the contracting process.

Our analysis showed that for some stages of the contracting process, for example, the stage when the ship-owner and the charterer are negotiating the terms and conditions of the Charter Party agreement, use of any technology is hardly going to lead to improvements in near future. However, there are stages in the process, such as the final stage when the cargo has been discharged and the calculation of demurrage and payment of hire and demurrage needs to be done, using Blockchain-based tools can lead to huge savings and improvements. Management of documents such as the Bill of Lading was noted as another Blockchain-based application that may lead to big savings in time and cost. We discussed the challenges such new applications will face in each stage separately and then in the final section of chapter 4 we concluded that and end-to-end solution that ties up all the different processes, beginning from a marketplace to a documents management and contract management tool will lead to easier and more effective adoption. Such a Blockchain for shipping will end up re-engineering the entire contracting process by tokenizing various real and digital assets involved and providing a trustless platform for exchanging them.

Blockchain is a very fast evolving technology. Upcoming inventions in interoperability and layer 2 applications are expected to improve scalability and latency of Blockchain applications and make them cheaper and more convenient to adopt. For future research, in addition to the advancements in Blockchain technology, Natural Language Processing (NLP) Artificial Intelligence solutions for contract management looks promising. This is another fast evolving space which can have a huge impact on the way any legal document is created and managed. Negotiations over the terms and conditions of a Charter Party agreements if automated with the use of NLP algorithms will lead to savings in time.

The contracting process involves several stakeholders with each having a unique set of concerns and incentives. Blockchain technology shows the potential of streamlining the interactions among these stakeholders. The success of any such Blockchain- based solution depends on active participation from all of these stakeholders. Getting one company to use such platform in isolation will not help leverage the potential of Blockchains. Hence, it is recommended that the industry builds a consortium with representation from different stakeholders to further study and invest in the development of Blockchain applications acceptable to all parties.

6. APPENDIX

6.1 Glossary

Artificial Intelligence(AI): This refers to the technology which empowers computers to make intelligent decisions based on cognitive functions which are typically associated with humans.

BBB (Before Breaking Bulk): It is a clause which when inserted in a Charter Party agreement implies that the hire for the carriage of cargo needs to be paid to the ship-owner by the charterer before the ship commences discharging of the cargo at the discharge port.

Bill of Lading: A bill of lading (BL) is a document issued by a carrier (or his agent) to acknowledge receipt of cargo for shipment. It is a conclusive receipt, i.e. an acknowledgement that the goods have been loaded; it evidences the terms of the contract of carriage, and it serves as a document of title to the goods.

Bitcoin: Bitcoin is a digital currency (also called crypto-currency), invented by Satoshi Nakamomto in 2009. It runs on a peer-to-peer computer network and is not backed by any country's central bank or government.

Blockchain: Blockchain refers to the distributed ledger technology which allows cryptographically secured decentralized storage of data backed by a consensus mechanism (such as a proof-of-work) to ensure that there is a single source of truth and the record of the data is immutable. Blockchains can be public, which anybody with a certain computing power is allowed to join or permissioned, which is private to a group of individuals and one needs the permission of this group to join as a node.

Brokers: Brokers are the middlemen between the ship-owner and the charterer. They help them find each other and subsequently execute an agreement.

Cargo documents: These refer to a set of certificates and reports generated during each port operation (loading and discharging) to record the details of the cargo, its stowage on the ship, and other activities performed. These are created by the onboard crew and the Cargo Surveyor. They each create their own set of documents and then sign each other's documents to show acceptance of the details mentioned in those documents.

Cargo Terminal: Cargo terminals are part of a sea-port, at times independently managed by private entities which store cargo temporarily and are responsible for loading and discharging of the cargo on/from ships.

Certificate of Quality, Quantity and Origin: This refers to the certificate or a set of certificates with details about technical specifications, quantity and origin of the cargo being loaded. It is provided by the consigner or the loading terminal, through an appropriate authority (such as an accredited laboratory). This information can be issued in a single certificate or three separate certificates.

Charter Party: A charter party is an agreement signed between the ship-owner and the charterer to carry the cargo. All terms and conditions of the carriage are recorded in this agreement. The agreement gives the charterer an authority over the operation of the ship for either a certain period of time or for a certain voyage.

Charterer: A charterer is either an independent company or a sub-division within a trading firm which takes the responsibility of managing logistics of the cargo.

Classification Society: Classification societies are independent organizations that establish and maintain technical standards for the construction and operation of ships and offshore structures.

Consignors: These are the entities who are buying the cargo. The cargo is shipped to them. They are also called Receivers.

Demurrage: If the ship is not able to complete operations within the agreed laytime, the extra hours are converted to dollar value (based on an agreed rate as mentioned in the charter party) which is called Demurrage. If the operations have been delayed for no fault of the ship-owner (for example, slow rate of loading provided by the terminal), then the owner is entitled to be compensated by the charterer.

Dispatch: If the ship completes the operations in less number of hours than defined as the laytime then the ship-owner pays dispatch to the charterer of a vessel. In the liquid bulk tanker market dispatch is normally not used in practice.

Flag State: Flag State is the Government of the country where a particular ship is registered. The ship is expected to follow all rules of the particular country at all times.

IoT: The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Laycan: This refers to the earliest date at which the laydays can commence and the date after which the charter can be cancelled if the vessel has not by then arrived.

Laydays: represent the time at which a ship must reach the charterer for cargo operations. If a particular ship is not able to reach the charterer in the defined laydays, it may lead to a penalty/fine or cancellation of the charter party agreement by the charterer.

Laytime: This is the amount of time allowed to a ship in a voyage charter for loading and unloading of cargo at a port.

Letter of Indemnity: A letter of indemnity (LOI) is a letter guaranteeing contractual provisions will be met, otherwise financial reparations will be made. The principle behind an LOI is the guarantee that losses will not be suffered if certain provisions of a contract are not met.

Port Agents: These are local agents at the loading/discharging ports, appointed by the charterer to handle the operations of the ship. They are responsible for contacting the local port authorities, terminals, customs, etc. to ensure the ship arrives and departs on time.

Ports Authority: This refers to the sea-port which facilitates the navigation, arrival, berthing and departure of the ships.

Receivers: These are the entities who are buying the cargo. The cargo is shipped to them. They are also called Consigners.

Ship-owner: The individual or company which owns the ship, also referred to as a carrier. The owner is responsible for ensuring that the ship remains in a seaworthy condition at all times. The crew onboard a ship are the representative of the ship-owner and the Master.

Smart Contracts: A smart contract is a Blockchain-based computer protocol which digitally facilitates a contract allowing the performance of credible transactions without third parties. These transactions are trackable, irreversible and can be triggered by a pre-defined event.

Statement of Facts: Sometimes also called a "time-sheet" is a cargo document which contains all timings necessary for the calculation of hire, demurrage, dispatch, etc.

Statement of facts: This is a document with a record of all the events relevant to the shipment operations with their time of occurrence. It is also referred to as a Time-sheet. Each involved party prepares their statement of facts and get it signed by the other involved parties to record their acceptance of those facts.

Suppliers: These are the producers of the good who are selling the cargo.

Surveyor: These are the cargo surveyors who board the ship at loading/discharging ports to observe the operations as an independent third party.

Time Charter Party: charter party refers to the agreements signed between the ship-owner and the charterer for a single voyage from one port to another.

Trader: A trader is an independent merchant who Sells cargo in one location and buys from another to capture the spread.

Trustless: This refers to a system wherein the interacting party do not necessarily need to trust each other to facilitate a transaction. The system ensures the accuracy of the information, and hence there is no need for trust or a trusted third party to exist.

Voyage Charter Party: Voyage charter party refers to the agreements signed between the ship-owner and the charterer for a single voyage from one port to another.

6.2 References

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