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The impact of blockchain technology implementation on human resources capabilities development of shipping companies

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ABSTRACT

The research conducted in this thesis was stimulated by the digitalization wave of the "Industry 4.0" that is transforming the shipping industry. The key technological advancement that was of interest in this research is the blockchain technology, which is considered as a disruptive innovative solution for the global shipping industry. The implementation of such a disruptive technology would have an impact on shipping companies' capability building in terms of their human resources. This thesis attempts to add to previous research that focuses on the ways in which blockchain technology implementation in the transactions and documentation processing of port-based companies, namely shipping companies, would affect the capabilities of their personnel. The research methodology used was the deductive reasoning along with a case study of the "Deliver" platform which is a supply chain management platform based on blockchain technology that has been created by the collaboration of "BlockLab" with ABN-AMRO, the Port Authority of Rotterdam, Samsung SDS, Flora Holland and Transfollow. In addition, three individual open-ended semi-structured interviews were conducted with experts from the Port of Rotterdam in order to examine the conceptual framework that emerged through the analysis. The qualitative results of this research illustrate that the capabilities of the human resources of shipping companies will have to be expanded and enriched in order for the companies to efficiently integrate blockchain technology and its applications in their transactions and documentation processing. The required human resource capabilities of shipping companies with respect to the implementation of blockchain solutions in their documentation processing and transactions that were identified in this thesis consist of both generic and industry specific skills for all the workforce, as well as, for the personnel onboard the vessels, supply chain practitioners, managers, lawyers and blockchain software developers in particular. Moreover, this research revealed that it will also be necessary for shipping companies to hire additional workforce, via appropriate recruitment processes, that will have the necessary qualifications, experience and skills related to the implementation and management of blockchain solutions and the enforcement of cyber security measures in order for the blockchain systems that will be incorporated in the existing systems of shipping companies to be effectively protected against cyber risks.

Key words: blockchain technology, human resources, capability development, shipping companies

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CHAPTER 1. INTRODUCTION

This chapter is dedicated to the description of the purpose of this thesis, along with the formation of the research question, and the research relevance, as well as the presentation of the methodology used and the structure of this thesis report.

1.1. "Shipping 4.0" and blockchain technology

The shipping industry is going through a major technological advancement and digitalization, aligned with the "Industry 4.0". That is the main reason why it is called "Shipping 4.0". This technological transition consists of "Cyber physical systems", "Internet of things" and advanced progressed analytics that offer better connectivity between the vessels and the shore, as well as on the vessels, with the use of "Internet of things at sea" and "Internet of services at sea". (Rødseth et al., 2019)

Another facet of this new technological wave is the blockchain technology. Blockchain technology was introduced in 2008 by Satoshi Nakamoto in the form of the Bitcoin cryptocurrency (Rødseth et al., 2019). Blockchain technology is a distributed ledger technology that utilizes cryptography in order to secure the data within the system, through consensus between all the parties that use the technology (Beck et al., 2017). This technology is being implemented within supply chain operations at an increasing rate (Wang et al., 2019). Furthermore, it is implemented in a wide range of services such as financial, public and social services, as well as in risk management, in internet of things (IoT) applications and in its commonly known use as crypto currency (Zheng et al., 2018). Another blockchain application is in economic transactions as a "general purpose digital asset ownership record" (Beck et al., 2017). A transaction is a «*transfer of value between the seller and the buyer*» (Min, 2019).

1.2. Blockchain technology and the port ecosystem

The blockchain technology is considered as a major innovative solution for the global maritime industry in terms of its use for real-time tracking of assets that facilitates the interests of shippers, carriers, insurers, traders, financiers and regulators (Beck et al., 2017).

All these actors, including non-governmental organizations (NGOs) and local communities, are a part of the port ecosystem (Verhoeven, 2010). Ports and supply chains are dependent on these actors and organizations. The Port Authority has a special role in the management of all these stakeholders, since it is connected to their operations. More specifically, a Port Authority is «*the entity which, whether or not in conjunction with other activities, has as its objective under national law or regulation, the administration and management of the port infrastructures, and the co-ordination and control of the activities of the different operators present in the port*» (Verhoeven, 2010). Port Authorities manage the water and land – side sectors of a port and their legal structure has elements of both private and public law.

Shipping companies, that are a part of the port ecosystem and the maritime logistics system that is connected to the global logistics system and contains the transportation of cargo by sea (Papathanasiou, Cole, & Murray) as mentioned above, have as their main activities the management and operation of their fleet of vessels that are conducted via the operations and technical departments. Key activities of the operations department are: ensuring the safe and economic operation of the vessels and a successful collaboration with the other departments of the company, the overall operations of the vessels, port calls orchestration and the arrangement of the communication and cooperation with third parties such as charterers, Port Authorities and agents. As regards the technical department, its main activities include the creation of new building vessel projects, maintenance and repairs of the vessels, ensuring the vessels' seaworthiness and the conduction of surveys by classification societies. (International Maritime Organization)

The implementation of blockchain technology could facilitate the process of the digital exchange of data and documentation of shipping companies. Such documents are compulsory port state reports that could be generated automatically by computers on the vessels. Moreover, there could be an automated integration of updated nautical safety information into the electronic chart information on-board the vessels of the shipping companies, and port state controls of vessel certificates could take place digitally, with no need for physical action by the crew of the vessel or by the port state control officers. Hence, an implementation of blockchain technology would have positive effects on the whole port ecosystem, since a large number of activities of a shipping company's operations and technical departments, as well as, of a Port Authority could be accelerated and, through the automization of these processes, the personnel employed in these entities would be liberated from wearisome administrative

labor. (Rødseth et al., 2019) Finally, Port Authorities are expected to become an enabler and orchestrator of the blockchain network that they are part of and the interoperability of numerous blockchain applications, by connecting various stakeholders, dealing with possible issues and establishing standards for the ports (Oude Weernink et al., 2017).

1.3. Purpose of the research

There are a number of blockchain initiatives in the maritime industry supply chain that are in place already (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019). However, due to the fact that this technology is new and has specific characteristics and functionalities, its implementation would affect shipping companies' capability building in terms of their human resources (Benson- Armer, Otto, Webster, Benkert, & Koch).

Previous research has focused on capability development of shipping companies and its connection to innovation development (Jenssen, 2003; Tsekouras et al., 2011), the drivers and barriers in the application of blockchain technology in the maritime industry and the global maritime supply chain (Keil et al., 2008) and how digital technologies and blockchain applications affect the human resource capabilities of companies in general (Demir, 2019; Coita et al., 2019; Tapscott & Tapscott, 2017). Previous research regarding the potential relationship between blockchain technology and the capability building of shipping companies is limited (Papathanasiou, Cole, & Murray).

1.3.1. Research relevance, main question and methodology

This thesis aims to add to the extant literature by investigating the following key research question:

"How would the implementation of blockchain technology in the transactions and documentation processing of shipping companies affect their human resources capabilities development?"

The research methodology is based on the deductive reasoning. «*Deductive reasoning, or deduction, starts out with a general statement, or hypothesis, and examines the possibilities to reach a specific, logical conclusion, according to California State University»* (Bradford, 2017). This methodology starts from the general, which is the theory, and reaches the specific, which is based on the observations made (Bradford, 2017). Moreover, in order to and serve the purposes of the deductive reasoning and examine the theoretical framework that emerges from the findings of previous research, a case study of the "Deliver" platform developed by "BlockLab" (Port of Rotterdam: News: How Rotterdam is using blockchain to reinvent global trade, 2019), which is established by the Port of Rotterdam in collaboration with the City of Rotterdam and Innovation Quarter (BlockLab: Partners), was selected and three individual open-ended semi-structured (Rowley, 2002) interviews with experts form the Port of Rotterdam were conducted (McIntosh & Morse, 2015).

1.4. Structure of the thesis

This thesis is structured as follows: Chapter 2 includes a description of blockchain technology, its general advantages and its benefits for the maritime industry, issues related to its implementation in businesses in general, but also specifically for the maritime sector, as well as, "smart contracts", their applications, benefits for the shipping industry and issues related to their implementation. In addition, the chapter includes a discussion of the case study, and a description of the main issues, and solutions to these issues, related to the blockchain initiatives in the maritime industry. Moreover, it includes a listing of capability development types and impediments, an elaboration on shipping companies' capability development and its relationship with innovation and blockchain technology implementation, the relationship between human resource capabilities of companies in general and blockchain technology, as well as the proposed conceptual framework. In chapter 3 there is a presentation of the methodology, the research question and the interview characteristics. Chapter 4 is dedicated to the analysis of the qualitative information that was collected via the interviews, the final conceptual framework that emerged via this analysis and the recommendations for the shipping companies and chapter 5 includes the conclusions, limitations and suggestions for further research.

CHAPTER 2. THEORETICAL FRAMEWORK

2.1. Introduction of the theoretical framework

In this chapter there is a description of the blockchain technology mechanism, its overall benefits and more specifically, the benefits it can offer for the maritime industry, as well as, its superiority against other technological solutions. Moreover, there is a presentation of the technical, cyber security and legal issues of the technology in combination with the impediments of the application of blockchain in the shipping industry. The concept of "smart contracts" is explained and there is an elucidation of the benefits, uses and issues that exist in their application in general and in the shipping sector, along with the main concerns and complications regarding the implementation and successful operation of all the maritime blockchain initiatives and potential solutions. In addition, there is an elaboration on the case study that is conducted for the purpose of this research, along with a description of capability development for companies and their significance for the successful operations of a company, based on previous research. Furthermore, there is a listing of the various types of capabilities that a company could build, along with, the main restraints that affect capability building negatively. Also, there is a presentation of an overview of some key previous research findings related to the capability development of shipping companies and its connection to innovations, as well as, the relationship of blockchain technology and human resource capability building of companies in general and more specifically, shipping companies. Finally, the proposed conceptual framework is designed.

2.2. Blockchain technology mechanism

Blockchain technology, as already described in the introduction section, is a distributed ledger technology that utilizes cryptography in order to secure the data within the system, and the key operating mechanism is consensus between all parties that use the technology (Beck et al., 2017). Its basic structure is a chain of "blocks". Each block contains some or all of the current transactions that took place in the system and is incorporated as a permanent database into the blockchain once it is fully completed. All the blocks are connected with each other in a linear chronological order and each block includes a hash of the preceding block. Also, there are the so called "nodes" that represent the computers that are connected to the blockchain

system via a client that validates and transmits the transactions that take place within the system and makes use of the blockchain ledger by automatically downloading a copy of it. The blockchain ledger is public which means that all the users can control whether a transfer originates from the rightful owner. (Foroglou & Tsilidou, 2015) Lastly, blockchain technology ensures secure data storage and exchange via decentralized, peer-to-peer systems (Taylor et al., 2019).

2.3. Blockchain technology benefits

Blockchain technology has been considered as a source of disruptive innovations in the management and business environment (White, 2017). The implementation of such a technology seems to offer significant advantages regarding business processes and products, as well as commercialization activities (White, 2017) since it adds strategic value in business operations and processes in various ways. Blockchain facilitates permissioned commercial applications and cost reductions. (Carson et al., 2018) Moreover, blockchain technology offers the ability to create "smart contracts" (Rødseth et al., 2019). Additionally, several other benefits of blockchain technology are:

- auditability (Beck et al., 2017),
- persistency (Beck et al., 2017),
- anonymity (Beck et al., 2017),
- decentralization (Beck et al., 2017),
- protection of data integrity (Chang et al., 2019),
- resilience against cyber-attacks (Chang et al., 2019),
- distributed information technology (IT) environment (Chang et al., 2019),
- consensus based operation (Chang et al., 2019),
- immutability of history (Chang et al., 2019) and
- customization depending on specific business requirements (Chang et al., 2019).

2.4. Blockchain technology benefits for the maritime industry

Blockchain technology implementation in the maritime industry and the maritime supply chain offers benefits in terms of customs administration and clearance, documentation

digitalization, and security of cross-border trade (Yang, 2019). Furthermore, it enhances the added value of supply chain services and offers a competitive advantage to the companies that implement it (Beck et al., 2017). The value created by the implementation of this technology can be in the form of mutual trust and avoidance of misaligned systems between the user-companies, visibility, data accessibility, validity and safety, as well as network expansion (Oude Weernink et al., 2017), and cost reductions related to documentation processing and exchange, procedural errors, disparities and delays (Diordiiev, 2018). Overall, blockchain implementation in businesses is estimated to reduce around 70% of the costs, in terms of the value gained by companies in the short-term. (Carson et al., 2018) As an example of cost reduction for the shipping industry, the "TradeLens" platform that has been developed by IBM and Maersk (Carson et al., 2018) and is described in Appendix A, is expected to decrease administrative costs by approximately 15% of the value of shipped goods and enable the saving of $1.5 trillion in the global maritime industry (Hellenic Shipping News Worldwide: International Shipping News: Blockchain at sea: How technology is transforming the maritime industry, 2019). Moreover, IBM has invested $200 million and has a workforce of 1,000 employees that are working on blockchain-based internet of things (IoT) (Carson et al., 2018). Maersk had estimated in 2017 that the amount of container shipments transferred via the use of blockchain technology would reach 10 million container boxes per year (Hackius & Petersen, 2017). Therefore, the utilization of blockchain in shipping companies' transactions and documentation processing, as shown above, is important in terms of employment of personnel in the companies that develop blockchain solutions and it can be said that it could contribute to the efficiency of the maritime supply chain.

In addition, with the use of blockchain technology the risk of penalties for customs compliance that are passed-on to the customers is mitigated significantly (Hellenic Shipping News Worldwide: International Shipping News: Blockchain at sea: How technology is transforming the maritime industry, 2019). The utilization of such technology in the maritime supply chain could result in an augmentation of the global GDP by approximately 5% and of the global trade volume by 15% (Tijan et al., 2019). This shows that blockchain implementation in the maritime supply chain could also have a positive impact on global trade.

Furthermore, there is a large number of logistics and operational procedures that are required in order for shipping companies to successfully complete a shipment's

transportation. These procedures are supported by a variety of information systems and other technologies, for example the Enterprise Resource Planning (ERP) (Labarre, 2020) systems and cloud computing. Nevertheless, there is always the need for communication between the shipping companies and collaborating parties. That results in delays and various other drawbacks that have been mentioned. (Papathanasiou, Cole, & Murray)

In addition, an export shipment might require the cooperation of almost 100 parties, the utilization of four different contracts and overall up to 37 documents (Papathanasiou, Cole, & Murray). With regards to container vessels, approximately 50% of these vessels have a delay of more than 12 hours, as regards their scheduled times for the arrival at the port of destination. This delay, in combination with congestion and increased waiting time in ports has a negative impact on the costs of the whole maritime logistics chain. Additionally, global trade costs account for approximately 60%-80% of the total of the operating expenses of maritime companies. The interactions and communication points that include documentation within the maritime supply chain, could reach the number of 200. This documentation includes documents in both electronic and paper form. For instance, in order for a specific cargo to be transferred by one point to another, there is a need for communication and interaction of around 20-30 stakeholders, including shippers and consignees. Traditionally, the communication between the parties is conducted via phone, e-mail or even fax, which creates efficiency problems. (Lambourdiere & Corbin, 2020) Overall, the cost of the trade documentation processing is estimated to be around 15% - 50% of the total costs related to the transfer of the goods (Hackius & Petersen, 2017). Therefore, blockchain utilization for the exchange and processing of documents could contribute to the alleviation of these inefficiencies in the maritime supply chain.

Another application of the blockchain technology that could facilitate the operations of a port is in container handling. More specifically, when a container arrives at a port, it could receive a specific label that includes a cryptographic hash. Via this labeling process, the blockchain system would enable the automatic tracking of all the containers that arrive in the port. In this way, errors and loses related to the information of the container and swindles would be mitigated. With regards to the port services, the automated and independent of the port workforce operation of the blockchain system enables the provision of its services, regardless of delays contributed to human resources issues or natural disasters. Thus, a

significant amount of costs related to economic procedures and operations delays are avoided. (Foroglou & Tsilidou, 2015)

In order for maritime companies to fully reap the benefits of blockchain technology that are mentioned above and incorporate the technology in a way that will enhance the efficiency of their document processing and services, it is important for their human resources that will work on the development of blockchain solutions to have knowledge, experience and the required skills regarding these solutions. More specifically, the IT personnel of the shipping companies will need to be able to integrate solutions like the ERP systems and cloud computing that are being utilized by shipping companies already (Papathanasiou, Cole, & Murray), with blockchain systems and applications. Also, the personnel that is responsible for the daily operations of the shipping companies, as well as managers, will have to be familiar with the blockchain systems and how they are utilized for documentation exchange and transactions.

2.4.1. Blockchain technology advantages over other technological advancements for the maritime industry

Blockchain technology provides more functionalities in comparison with current technologies, some of those functionalities being the facilitation of business-to-business (B2B) and internet of things (IoT) integration. The most valued functionalities with regards to transaction processing are “smart contracts” and the blockchain ledger. In addition, time stamping and data-encrypting and public and private keys are significant functionalities that are not available in the current intermediate supply chain integration services. (Korpela et al., 2017) Furthermore, public blockchains operate without the need for a trusted and neutral intermediary, such as the IMO, which is important for the rapid, secure and trustworthy transactions that take place in the maritime industry, and are considered to be the most secure ones. Nevertheless, there can be various forms of blockchain systems besides public blockchain systems. These could be consortium or private blockchain systems, where consensus is achieved by a specific set of nodes or by a centralized organization. Additionally, it is possible to build the blockchain system in such a way that only a number of specific nodes can conduct transactions, while all nodes are able to read them. (Rødseth et al., 2019) Therefore, it is considered beneficial for the personnel of shipping companies that will develop blockchain systems to be aware and familiar with the various types of blockchain

systems that are available, in order to choose those that respond to the requirements and technological capabilities of the companies.

Taking into consideration all the above-mentioned benefits and advantages that blockchain could offer to shipping companies and other maritime supply chain companies that choose to implement it, it can be concluded that this technology could possibly have a significant impact on the structure of maritime transactions, as well as, on data and documentation processing and exchange. This alterations and improvements will be significantly more discernible in the future, but even so, there is a clear image that digitalization of the shipping sector with the support of this technology could enhance its efficiency, security and the optimization of data related operations.

2.5. Issues related to the implementation of the blockchain technology

There are a number of complications related to the successful implementation of blockchain technology in business-to-business transactions integration. To begin with, there is a need for specific standards related to system interoperability that are currently not available (Korpela et al., 2017). That lack of common standards disables the implementation of the technology in a large scale. Also, the level of the maturity of the technology is low and that results in high switching costs for the companies that choose to implement it. (Carson et al, 2018) On top of all these, the processes of validating the transactions, as well as, creating and transferring of the blocks to all the nodes in the blockchain system demands great computing power (Rødseth et al., 2019).

2.5.1. Blockchain cyber security issues

Another matter that needs to be addressed regarding the application of blockchain is cyber security. Such concerns revolve around network latency, power consumption for the maintenance of the distributed network and data flows of blockchain IoT networks. (Taylor et al., 2019) In addition, it is possible for a certain group of “miners” that create “blocks” in the blockchain system to take control of the blockchain network hash mining rate for illegal and fraudulent purposes. Furthermore, in the case where a blockchain user has a private key that

has been breached, it is not possible for them to regain it, and that results in issues regarding protection of personal identity. (Angelis & Ribeiro da Silva, 2019)

Nevertheless, blockchain technology has a decentralized nature, which means that in order for a cyber actor to hack into a specific block in the blockchain system, they would have to attack all the previous blocks saved in the blockchain history. Therefore, blockchain offers the possibility to create a database of business transactions that cannot be manipulated. (Min, 2019) There are a number of blockchain applications that are being developed in order to deter malicious cyber threats. Previous research refers to the utilization of "smart contracts" and various types of permissioned and permissionless blockchain platforms in order to deter and neutralize cyber threats. (Taylor et al., 2019) Additionally, crypto-currency tokens that are widely decentralized, investable and distributed provide robust security to the blockchain system. More specifically, the development of forensically-friendly crypto currencies that would enable forensic investigation of crypto currency transactions that could potentially involve cybercrime, such as, ransomware software, is considered a vigorous solution against cyber threats. Similarly, the designing of solutions that combine the blockchain technology and hardware would increase the possibility of reduced latency, resulting in less time delays, especially for delay-sensitive applications. (Taylor et al., 2019) Lastly, the last two years, systems have become more mature, scalable and resilient and they are developing fast. These advancements, in combination with the fact that distributed systems are less vulnerable to cyber-attacks, renders them a better choice for supply chain applications that require a high level of availability in terms of security. (Person A, personal interview, June 23, 2020)

Therefore, in order for shipping companies to achieve a successful implementation of the blockchain technology and protect their data and documentation from cyber threats it is crucial that their personnel has the appropriate skills and expertise in order to develop solutions against cyber-attacks and create blockchain systems that are robust and fully secure. This would require specific training of the personnel that creates blockchains and cyber protection solutions or the recruitment of specialists in cyber security matters and blockchain technology. Additionally, expertise with regards to the maintenance of the distributed network and data flows of blockchain systems is considered necessary.

2.5.2. Blockchain legal issues

Regarding legal issues, a distinction between private and public law is required. Private law issues revolve around the utilization of "smart contracts" and are described in the sub-section 2.7.2.1. With regards to public law, the focus is mainly on the utilization of permissionless blockchain systems by parties in order to serve unlawful purposes and exploit pseudonymous participation, so as to avoid matters related to competition law. Additionally, another threat for which there are not any protection measures available yet, is that of fraudulent "miners" who engage in the generation of new blocks within the blockchain system, recklessly and with no intention to act in good faith. In addition, there are specific rules and regulations for each industry, country and union that need to be taken into consideration. (Deloitte Legal, 2018) Lastly, there is a lack of legal standards with regards to the technology specifications (Papathanasiou, Cole, & Murray). Legal standards could be established by a government agency or by a prominent maritime actor for the maritime industry. In that direction, "Standards Australia" created a "road map of priorities" in order to establish a terminology base, in support of the "International Organization for Standardization". However, the majority of the governments worldwide are utilizing a neutral regulatory approach towards blockchain, which means that they neither support nor prohibit the technology. (Carson et al., 2018)

Hence, there is a need for workforce has the appropriate skills and expertise with regards to blockchain solutions and that is aware of the abovementioned cyber risks, in order to develop robust and secure blockchain systems that are apt to the companies' requirements and the specific cyber threats, in collaboration with experts and specialists of the companies' legal departments or advisors in order to tackle legal matters that could arise.

2.6. Issues in the implementation of blockchain technology in the maritime supply chain

There are a number of impediments regarding the feasibility and viability of blockchain applications in maritime supply chain management. These impediments include open architecture specifications, control of access and confidentiality security (Chang et al., 2019). Moreover, the absence of a market standard (Bavassano et al., 2020), the age of the decision-

makers in the industry, the cost of implementing such a technology, the unavailability of relevant investments and the risk aversion mindset, in combination with the low level of diffusion of blockchain technology, are remarkably predominant issues (Gausdal et al., 2018). In addition, blockchain technology may have unparalleled adverse economic and social effects on business practices. Such effects could potentially include a limitation of decision-making freedom by the establishment of uncontrollable and unchangeable record tracks that cannot be modified or dismissed. (Beck et al., 2017) Also, there are issues related to blockchain's complexity, such as security, privacy and scalability, as well as human-centric factors, for example mistypes, programming errors and knowledge deficiencies (Macrinici et al., 2018). Moreover, there is a need for the establishment of world standards that are compatible with the existing systems of the organizations agreed upon by companies, governments, authorities, and other third parties (Farnsworth, 2019), as well as, the provision of certificates by appointed institutes, such as ISO certificates, to the parties that utilize blockchain, in order to ensure that the parties are trustworthy (Oude Weernink et al., 2017).

Furthermore, the maritime supply chain encompasses the transfer of physical goods (Papathanasiou, Cole, & Murray) and, in order to link these goods to a blockchain system in a secure way, IoT and biometrics technologies are required. That poses threats to the cyber security of the blockchain system, because, even though the system itself is robust due to its distributed nature, the good or the IoT censors can be manipulated. An example in the supply chain is the chain of custody certification of goods, such as grains, that would demand for a radio-frequency identification system, in order to augment security. Even so, complete provenance would not be assured. (Carson et al., 2018)

Lastly, certain issues that limit the number of possible applications of blockchain technology in the maritime industry are the following:

- data and transaction validation is only possible when there is online access to the system (Rødseth et al., 2019),
- blockchain has been designed to maintain anonymity of the parties involved (Rødseth et al., 2019),
- blockchain utilizes certain cryptographic algorithms that increase its vulnerability to future quantum computing issues that could jeopardize the integrity of the data in the system (Rødseth et al., 2019) and

- blockchain systems require a significant amount of computing power and internet connection bandwidth (Min, 2019).

All the aforementioned concerns and issues regarding the implementation of blockchain technology in the maritime sector need to be taken into account from maritime actors that choose to integrate blockchain into their transactions and documentation processing. Additionally, it is important that the workforce of these organizations has the required skillset and knowledge on blockchain applications and the integration of other technologies such as IoT, potential technical and cyber issues and how to solve them efficiently and on the implementation of blockchain solutions that fit the companies' technical capabilities.

2.7. "Smart contracts"

A primary and rapidly developing application of the blockchain technology in business is in the form of "smart contracts" (Zheng et al., 2018). "Smart contracts" are a part of "Blockchain 2.0" (Angelis & Ribeiro da Silva, 2019). These contracts are, basically, programs that run within blockchain and are shielded against fraud, bowdlerization and latency (Beck et al., 2017). These programs enable the exchange of assets without third parties having to be involved or aware of the transfer. Moreover, the execution and application of the terms of these contracts is automated. (Presutti, 2018) More specifically, the legal provisions included in the "smart contracts" are integrated and coded via computer programming, and validated via a peer network (Tijan et al., 2019). This means that intermediaries could become obsolete. These contracts offer the possibility of establishing new forms of virtual agreements. (Presutti, 2018) In addition, they provide a high level of customization in transaction procedures (Macrinici et al., 2018).

2.7.1. "Smart contract" benefits and uses for the maritime industry

"Smart contracts" enable the alleviation of information asymmetries that exist in the market (Cong & He, 2019). In addition these contracts can offer benefits in terms of efficiency, compliance and risk alleviation within companies (Min, 2019). "Smart contracts" will enable the simplification of the documentation exchange procedure, thus allowing for time and cost savings, since there will be no need for intermediaries (Papathanasiou, Cole, &

Murray). In addition, "smart contracts" in the shipping industry are expected to include charter-party terms and conditions, along with various other data related to shipping transactions, such as contracts generated by a charterer or ship owner, and to perform automated calculations. Moreover, these contracts are considered to facilitate entry into the shipping services market, therefore enhancing competition. (Diordiiev, 2018)

2.7.2. Development and application issues of "smart contracts"

There are a number of issues concerning "smart contracts", regarding their programmability, the blockchain mechanism, the virtual machine mechanism and the source code level of such contracts (Macrinici et al., 2018). Moreover, there are a large number of deficiencies and restrictions with regard to "smart contract" languages, thus making a number of innovative applications difficult to realize (Zheng et al., 2018). On top of that, the automated function of "smart contracts" disables their manipulation and the prevention of their execution, which is a problem in the case when the contracting parties no longer wish the contract to be executed (Deloitte Legal, 2018).

2.7.2.1. Development and application issues of "smart contracts" in the maritime industry

There are a number of private law issues that revolve around the utilization of "smart contracts". The main issue here is liability in the cases where there have been errors, either deliberate or by mistake, in the code of the "smart contract", that result in it not satisfying the intents of the contracting parties. On top of this, there is a need for the specification of the «*law, jurisdiction, general principles of proper governance, dispute resolution, privacy and the means of digital identity*» (Deloitte Legal, 2018) that will be applied in the contract by the contracting parties, as well as the provision of the contract on paper and the unequivocal identification of the parties in order for the contract to be valid (Deloitte Legal, 2018).

Therefore, taking into consideration all these impediments of the development and execution of "smart contracts", in order for their implementation to be successful, there needs to be a standardization regarding their coding and the language that will be used for their programming, in order to ensure interoperability between the various "smart contracts" in

place. Moreover, it is crucial that all the above-mentioned matters are dealt with at an industry level and that there is a uniformal approach to them. It is critical that the employees of the legal and information technology departments of the shipping companies have knowledge and experience on the development of "smart contracts", as well as, on how to efficiently integrate specific terms and conditions in these contracts. Moreover, an effective collaboration between the two departments would enhance the avoidance of the execution of "smart contracts" that would have a negative economic or operational impact on the companies. It can be concluded from all the information presented in this section that, in order for maritime companies to reap the benefits blockchain technology and "smart contracts" offer, while at the same time effectively dealing with the hindrances that exist, the appropriate set of skills, knowledge, experience and expertise on behalf of their human resources is pivotal.

2.8. Blockchain initiatives in the maritime industry

2.8.1. Introduction of blockchain initiatives in the maritime industry

This section focuses on the blockchain applications and initiatives that exist in the maritime and supply chain sectors. These initiatives pertain to the fields of trade financing procedures, the facilitation of the connection between the various actors of the maritime supply chain, the efficiency of port and cargo tracing operations, the certification, transmutation and exchange of core shipping documents, as well as, the development of blockchain-based "Bills of Lading", the marine insurance sector, the shipbuilding sector, the maritime fuel supply chain, the food supply chain and to business accelerators for the creation of blockchain solutions for the maritime industry. The initiatives are presented in tables in Appendix A.

Also, in this section there is a description of the case study on the "Deliver" platform of the "BlockcLab" (Port of Rotterdam: News: How Rotterdam is using blockchain to reinvent global trade, 2019) and of the main concerns and complications regarding the implementation and successful operation of all the maritime initiatives, along with potential solutions. It is important to present these initiatives and the concerns related to their implementation, since they offer an insight on the reasons and the uses of blockchain technology from maritime actors and the possible capabilities that will be required for the human resources of shipping

companies. The main reasons that led to these blockchain initiatives are the amelioration of efficiency, trustworthiness, transparency, connectivity, security and speed of transactions and data and documentation processing, along with the facilitation of the digital transformation of the maritime supply chain and trade sector.

2.8.2. Case study: the "Deliver" platform

This case study focuses on a specific blockchain initiative in the maritime industry and that is the "Deliver" platform which is developed by "BlockLab" in collaboration with ABN-AMRO, the Port Authorities of Rotterdam, Samsung SDS, (Port of Rotterdam: News: How Rotterdam is using blockchain to reinvent global trade, 2019), Flora Holland and Transfollow (Beije, 2017). The Port of Rotterdam, in collaboration with the City of Rotterdam and Innovation Quarter (BlockLab: Partners), has established its own "BlockLab". This laboratory is a "Smart Industries Field Lab" created to implement blockchain technology. Also, it is integrated in the regional innovation ecosystem of the Port Authority and is a part of the Dutch Blockchain Coalition. Partners of the "BlockLab" are: TU Delft, Rotterdam University of Applied Sciences, Be Scope Solutions, Smart Industry Wolf Pack, Dinalog, CIC and STC Group. (BlockLab: Partners). The conduction of a case study supports the exploratory nature of this research and its aim is to add to the existing theoretical background (Rowley, 2002).

The "Deliver" platform is an open and neutral (Port of Rotterdam: News: How Rotterdam is using blockchain to reinvent global trade, 2019) supply chain management platform based on blockchain technology that has been created by the collaboration of "BlockLab" with ABN-AMRO, the Port Authority of Rotterdam, Samsung SDS, (Port of Rotterdam: News: How Rotterdam is using blockchain to reinvent global trade, 2019), Flora Holland and Transfollow. The main activity of this platform is that it connects the physical receipt of the transported cargo by the receiver with a digital invoice and activates the payment of the invoice of the logistics service provider. (Beije, 2017)

The "Deliver" platform facilitates the visible, efficacious and secure exchange of data. It enables the real-time tracing of orders, shipments and finance and facilitates interoperability. It also enables the saving of significant costs for its users along with an integrated container tracing, where all documentation is automatically saved in the platform's blockchain system

and is visible by all parties. (Port of Rotterdam: News: How Rotterdam is using blockchain to reinvent global trade, 2019) The platform's main goal is to achieve a total, paperless integration of administrative, financial and physical processes integrated in international distribution chains (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019). Moreover, the "Deliver" platform offers a universal connector between all the different platforms that are in place. Another important aim of the platform is to ensure that certain functionalities are provided and that specific validated data are available to the users of the platform. (Person A, personal interview, June 23, 2020)

A real case implementation of the platform took place in July 2019. This transfer involved two containers originating from South Korea that reached Samsung SDS' warehouse in Tilburg, the Netherlands through the Port of Rotterdam (Port of Rotterdam: News: How Rotterdam is using blockchain to reinvent global trade, 2019).

The successful operation of the "Deliver" platform is proof that the appropriate utilization of blockchain technology, in combination with other technological advancements such as the internet of things (IoT) and artificial intelligence (AI) could enable the secure and efficient digitization of supply chain procedures (Port of Rotterdam: News: How Rotterdam is using blockchain to reinvent global trade, 2019). Additionally, it denotes the importance of efficient utilization of blockchain technology by the human resources involved in the platform development and operation, as well as, the partners and clients of the platform.

2.8.3. Concerns regarding blockchain initiatives and possible solutions

Despite the fact that all the initiatives, described in Appendix A and in the case study above, are significant in driving the implementation of blockchain technology in the maritime industry and in maximizing the benefits it can offer, there are still some concerns surrounding them. These concerns mainly encompass competition effects within the industry, in the essence of companies competing for the adoption of these applications (Farnsworth, 2019). More specifically, in order for shipping companies and port systems to offer upgraded and enhanced services to their clients and remain competitive, they are required to participate in the emerging platforms and initiatives. However, the shipping companies that are not willing or are concerned with regards to the sharing of corporate data with competitors and clients,

such as carriage rates, via the blockchain system, might deal with a situation that is threatening to their survival. (Papathanasiou, Cole, & Murray)

Other than that, it has been pointed out by industry experts that all these initiatives are controlled by a small group of entities. Therefore, it is not possible for all the actors in the industry to share and experience the benefits they provide. The ideal environment for the efficient and seamless application of these technologies that would ensure maximum benefits for the industry as a whole would be that in which all actors are interconnected via a single platform, instead of having to choose from a variety of different platforms. (Farnsworth, 2019)

In order for all the initiatives presented in Appendix A to have a successful and fruitful outcome for the whole shipping industry, taking into consideration the encumbrances that are described above, there is a need for specific skills and capabilities of the human resources of the organizations that develop and run them.

More specifically, for the blockchain solutions development and maintenance for the initiatives in all maritime supply chain sectors, required skils could be:

- knowledge and ability to code blockchain systems and "smart contracts",
- familiarity with the blockchain interface and its functionalities and ability to work on it efficiently and implement it based on the company's requirements and the specific requirements of the maritime supply chain sector,
- awareness of cyber risks and experience with cyber protection solutions and measures.

Managers of the maritime supply chain companies and the human resources that are responsible for daily operations and transactions related to maritime and supply chain documentation exchange, validation, processing and certification, such as supply chain practitioners, and that have an immediate contact with the blockchain initiatives in each part of the maritime supply chain, is beneficiary to have skills such as:

- familiarity with the blockchain interface and its functionalities and ability to work on it efficiently and implement it based on the company's requirements and the specific requirements of the maritime supply chain sector,

- ability to integrate operational aspects and specific process requirements with the functionalities of the blockchain solution that is developed by their company or their company is part of.

With respect to the workforce of the legal departments of the companies required skills, with respect to the specific facets of each initiative could be:

- ability to efficiently incorporate legal aspects with regards to contracts, documentation and certificates in blockchain applications in blockchain applications such as “smart contracts”,
- ensure legal compliance with private and cyber security legal issues related to the initiatives.

2.9. Capability development

Capability building for a company is strategically very important (Benson- Armer, Otto, Webster, Benkert, & Koch), since via this a company can create value, adapt more successfully to dynamic and competitive environments and achieve a high business performance. Moreover, capability development is a path-dependent and time-related procedure during which, a company has insufficient information regarding the ideal investments it has to carry out, and on top of that, the results of these investments are highly uncertain. All these factors enhance the significance of appropriate investments in order for the company to have a successful trajectory and a good overall performance. (Keil et al., 2008)

2.9.1. Types of capabilities

A company has specific tangible and intangible capabilities that it develops over time, through the interactions of its resources (Chang & Rosenzweig, 2009). These capabilities are often related to learning and skills development for the human resources of the company, as well as, operations, marketing (Benson- Armer, Otto, Webster, Benkert, & Koch), research and development (R&D) and business planning, which are known as functional capabilities

(Chang & Rosenzweig, 2009), and the collection of market, technology, competition, upcoming trends and industry related intelligence (Keil et al., 2008).

Moreover there is a distinction between "first-order" and "second-order" capabilities. "First-order" capabilities are:

- successful operation management,
- IT technology applications,
- finance and
- the evolution of the firms' business models.

"Second-order" capabilities are diversification and vertical integration and are founded on the "first order" capabilities. (Cˇirjevskis, 2017)

Another type of capabilities is dynamic capabilities that are defined as «*the capacity of an organization to purposefully create, extend, or modify its resource base*» (Cˇirjevskis, 2017). The development of dynamic capabilities, such as management innovations and the creation of a sustainable competitive advantage, enables the creation of value for companies (Lambourdiere & Corbin, 2020). Dynamic capabilities buildout includes three main stages:

- acknowledgement of alterations in the environment,
- decision to employ dynamic capabilities and
- assets re-composition. (Cˇirjevskis, 2017)

2.9.2. Obstacles in capability building

There are two main hurdles that weaken the manageability of the capability building process. These are:

a) the company's adherence to existing operational processes that stimulates investments for capability developments related to abiding capabilities and
b) the company's attachment to well-known search territories, when it comes to seeking solutions and investments options. (Keil et al., 2008)

These impediments need to be recognized by shipping companies in their efforts to develop blockchain solutions and implement this technology in their transactions and documentation processing, because they could impact their performance negatively. Human resources of the

company that are responsible for blockchain application developments should be able to think "out-of-the-box" and recognize opportunities and threats that come with this innovative technology. Also, shipping companies that utilize blockchain should be mainly based on their "first-order" capabilities, related to IT technology applications in order to develop dynamic capabilities and effectively incorporate blockchain technology in their transactions.

2.10. Capability development of shipping companies

Previous research regarding the capability development of shipping companies and its connection to innovation development has shown some interesting results. Some of the more insightful results are described below.

Process and organizational innovations are significant parts of the development of a dynamic strategy for small shipping companies. Innovations, in general, enable companies to adapt their strategic capabilities in the long run. Moreover, the sophisticated use of technological systems and knowledge centric services is essential for the establishment of an effective innovation strategy, and the creation of new capabilities is firmly linked to the implementation of innovations. (Tsekouras et al., 2011)

Thus, the utilization of an innovative technology such as blockchain would have remarkably positive effects on shipping companies' strategies. Also, it would enable their human resources to develop a new set of capabilities required in order to efficiently manage the changes in the technological and business environment that occur due to this new technological solution.

Innovation capability and the development of inimitable competitive advantages are heavily dependent on the companies' enhancement of competencies and abilities in vertical and horizontal inter-organizational interactions, both within and outside the maritime cluster. Innovations that facilitate economies of scale and the provision of customized services are considered to enable the acquisition of sustainable competitive advantages for the shipping companies. (Jenssen, 2003)

Hence, the utilization of blockchain technology that facilitates co-operation between the maritime supply chain actors and enables the provision of customized services to the shipping companies' clients is important for their competitive performance in the industry.

Moreover, the existence of a research and development department (R&D) within the companies facilitates and enables the integration of disruptive innovations that appear in the market. Therefore, shipping companies that have invested in the creation of an R&D department are capable to utilize the blockchain technology more efficiently and in an easier way. (Papathanasiou, Cole, & Murray)

"Organizational support" (Progoulaki and Theotokas, 2010) is strongly related to the company's culture and strengthens its inimitable, rare and high-valued characteristics and core assets (Progoulaki and Theotokas, 2010). Also, there is a positive relationship between resources, and innovation and logistics service capabilities, as well as between the performance of shipping companies that offer container services and logistics service capabilities. Innovation capabilities and logistics service capabilities are positively correlated. (Yang et al., 2009)

As it can be concluded from the above, previous research focuses on resource and service capabilities that are mostly related to the overall operations and performance of shipping companies and their connection to innovations, in general. Previous research findings support the notion that innovation is beneficial for the development of critical service and resource capabilities of shipping companies, including human resource capabilities. Blockchain technology is considered as a radical innovation for the shipping industry (Beck et al., 2017). Consequently, its application will affect the human resource capability development of shipping companies.

2.11. Human resources capabilities and blockchain implementation

Previous research regarding the effect of digitalization and blockchain on the skills and capabilities of the human resources of companies has shown some interesting results. The main required skills that have been identified are described below.

With regards to the digitalization and new technologies that are being utilized in the corporate environment, the workforce of the companies has to have specific skills and qualifications in order to tackle the competitive challenges of this environment. Digitalization has led to the need for a re-assessment and adjustment of the knowledge, skills and capabilities of the human resources for companies in general. More specifically, these capabilities are related to digital and technology-use skills, learning capabilities, business operations and decision making. Apropos of small and medium-sized enterprises, the implementation of digitalization technologies demands for critical and creative thinking and adaptability of the workforce. (Demir, 2019)

Blockchain technology implementation demands for the development of a new skillset and of additional capabilities (Shaik, 2018). Supply chain practitioners have to develop an open-minded approach towards blockchain technology applications (Min, 2019). With regards to supply chain management processes, the implementation of blockchain technology requires technical expertise and human resources that will underpin and develop the various applications of the technology. More specifically, in respect of the utilization of "smart contracts" in the supply chain processes, the managers of the supply chain companies will be required to employ new decision making and governance processes that serve the purposes of their company and fit the blockchain applications, which in this case are the "smart contracts". (Saberi et al., 2019)

Furthermore, blockchain technology implementation in human resources management of companes in general will require for specific skills of the personnel, namely, the ability to program the blockchain system in such a way that it can verify and control the qualifications, certifications and information of prospective employees (Coita, Abrudan, & Matei, 2019). More specifically, programmers that have skills required in order to develop and maintain the blockchain software and the data incorporated in the system, are considered vital for the successful utilization of the technology. Moreover, managers have to able to efficiently tackle legal responsibilities and issues that might arise, and identify the blockchain solutions that are appropriate for their company in order to maximize the generated value. (Angelis & Ribeiro da Silva, 2019)

The managers of the companies that employ "smart contracts" and lawyers from their legal departments will be required to audit guidelines, to ensure that the "smart contract" software serves the purposes of the contracting parties and acquire knowledge on blockchain

and “smart contracts” issues. By the same token, executives of the companies will be required to collaborate with IT departments of the companies in order to get acquainted with the blockchain functionalities and interface, as well as, its benefits and complications. (Tapscott & Tapscott, 2017)

In addition, the personnel of the companies that will work on the development of the blockchain solutions and systems are expected to:

- comprehend the business results of this technology,
- create solutions that facilitate the connection between the trading parties across the supply chain,
- enable the integration of blockchain systems with the available systems of the company,
- have insights on the available platforms and blockchain architecture design skills in order to critically choose the platform that fits their companies requirements and characteristics,
- have skills and experience with regards to cyber security protection measures, such as, for example, public and private key cryptography skills,
- develop a thorough comprehending and knowledge of blockchain standards and concepts, cyber security threats and system susceptibilities. (Shaik, 2018)

The stakeholders that collaborate in order to provide the transportation services in the shipping industry are usually located in various geographical areas. Also, the human resources of shipping companies consist of shore-based and sea-going personnel. (Nikitakos & Lambrou, 2007) Both the personnel onboard the vessels and the personnel located in the shipping company’s offices on shore are organized based on a hierarchical structure, however the hierarchy onboard the vessels is more strict, since there are officers and rankings. The personnel onboard is required to have multidisciplinary skills, including technical, operational and managerial skills, and not only skills and knowledge on the onboard operations. (Kundu et al., 2007) The personnel ashore and onboard the vessels need to communicate and exchange information effectively in order for the operations of the vessels, as well as, the shipping company in general, to run smoothly and as designed. The management of the shipping company requires the appropriate information related to the commercial operations of the vessel in order to evaluate errors and complete activities related to business intelligence and statistics. The main tasks of managers of the shipping companies revolve around daily

operations and service-related tasks related to competition. (Nikitakos & Lambrou, 2007) Therefore, it is also important for the personnel onboard the vessels of shipping companies to have knowledge and skills related to the utilization and application of blockchain technology for the exchange of shipping related documentation and shipping related transactions that are part of the efficient operation of the shipping company.

With regards to information and communication technologies (ICT) that are being implemented in shipping companies, they require training of the human resources of the companies and personnel that has more experience, knowledge and skills related to these technologies (Nikitakos & Lambrou, 2007). Also, a vast majority (62%) of shipping companies provides the technical support of their network via their own IT departments (Nikitakos & Lambrou, 2007), thus it is beneficial for the IT workforce to have efficient knowledge and experience related to these technologies. Moreover, the decisions related to the implementation of IT solutions in shipping companies are mainly made by IT and general managers. The general manager is the one who ultimately approves the proposals and decisions of the IT manager. Usually, the general manager is also the shipowner. Therefore, the skills, experience and knowledge of the general manager with regards to new technologies, have a significant impact on the efficient adoption and implementation of these technologies. (Nikitakos & Lambrou, 2007) Hence, it is important that the managers and the personnel of shipping companies are familiar, experienced and skilled with regards to the characteristics, functionalities and aspects of new technologies that could be implemented in their company, such as the blockchain technology.

More specifically with regards to blockchain technology, there is a need for technical expertise and appropriate organizational structure of shipping companies (Min, 2019), in order for them to develop and maintain blockchain technology applications. The successful integration of ERP and blockchain systems of shipping companies require specific training and time devoted by the human resources of the companies so that the workforce can be acquainted with this technology and utilize it effectively. (Papathanasiou, Cole, & Murray)

With regards to “Shipping 4.0” and the digitalization process of the shipping industry, the skills of the human resources of shipping companies that is related to maritime logistics infrastructures will have to be adapted (Lambrou & Ota, 2017) and the existing personnel, as well as new personnel, has to go through appropriate training (Oza, 2020). Moreover, there is a need for expertise at all levels of the human resources of shipping companies with regards to

the utilization and management of the "Shipping 4.0" technologies. Additionally, there is a need for expertise with regards to cyber-security measures and risk management, for the workforce of shipping companies. (Lambrou & Ota, 2017)

Collectively from the previous sub-sections of chapter 2, the capability requirements of human resources of shipping companies with regards to blockchain technology application are presented below:

- The human resources that will work on the development of blockchain solutions it is critical to have knowledge, experience and the required skills regarding blockchain programming, its functionalities and interface, in combination with the various solutions and types of blockchain systems that exist, in order to choose those that respond to the requirements and technological capabilities of the companies. More specifically, the IT personnel of the shipping companies will need to be able to integrate solutions like the ERP systems, IoT and cloud computing that are being utilized by shipping companies already, with blockchain systems and applications. Furthermore, in order for shipping companies to achieve a successful implementation of the blockchain technology and protect their data and documentation from cyber threats it is crucial that this personnel has the appropriate skills and expertise in order to develop solutions against cyber-attacks and create blockchain systems that are robust and fully secure. This would require specific training of the personnel that creates blockchains and cyber protection solutions or the recruitment of specialists in cyber security matters and blockchain technology. Additionally, expertise with regards to the maintenance of the distributed network and data flows of blockchain systems, as well as technical issues that are related to the tehnology is considered necessary. Furthermore, knowledge and experience on the development and coding of "smart contracts", as well as, on how to efficiently integrate specific terms and conditions in these contracts is crucial in order to prevent negative economic and operational outcomes.
- Managers of the shipping companies, is critical to get acquainted with the blockchain interface and its functionalities and have the ability to work on it efficiently and implement it based on the company's requirements. In addition, the ability to integrate operational aspects and specific process requirements

with the functionalities of the blockchain solution that is developed by their company is essential.

- The personnel that is responsible for the daily operations of the shipping companies, as well as managers, will have to be familiar with the blockchain systems and how they are utilized for documentation exchange and transactions. Moreover, it is required for them to be able to work on the blockchain interface efficiently and manoeuvre its functionalities. In addition, the ability to integrate operational aspects and specific process requirements with the functionalities of the blockchain solution that is developed by their company, is focal.
- Experts and specialists of the companies' legal departments need to be familiar with the legal implications of blockchain application in transactions and documentation exchange and skilled in order to tackle legal matters that could arise, as well as ensure legal compliance with private and cyber security legal issues related to the initiatives. Moreover, the workforce of the legal department of shipping companies is considered pivotal to have knowledge and experience on the development of "smart contracts", as well as, on how to efficiently integrate specific terms and conditions in these contracts, in order to avoid negative economic or operational impacts on the companies.

The abovementioned human resource capability requirements for the successful implementation of blockchain technology and the digitalization of enterprises that apply to companies in all industries including the maritime industry, and the ones that apply to shipping companies exclusively are presented in the proposed conceptual framework in sub-section 2.12.

2.12. Proposed conceptual framework

The results from previous research presented in the previous sub-section lead to the proposed conceptual framework that is presented in Table 1 below. This framework consists of general skills and training requirements for the human resources of shipping companies that implement blockchain in their transactions and document processing, and specific

capabilities required for the personnel onboard the vessels of the shipping companies, supply chain practitioners, managers, lawyers and blockchain software developers of the companies, as well as additional human resources that are needed.

Table 1. Proposed conceptual framework

Human resources	**Required skills**
All	• digital and technology-utilization skills • appropriate training related to the efficient integration of blockchain with existing systems in the company • the ability to integrate operational aspects and specific process requirements with the functionalities of the blockchain solution • learning capabilities • critical decision making capabilities • creative thinking • adaptability • ability to code the blockchain system in order to facilitate human resources management procedures • experience with the blockchain interface and functionalities
Personnel onboard the vessels	• knowledge and skills related to the utilization and application of blockchain technology for the exchange of shipping related documentation and shipping related transactions
Supply chain practitioners	• open-minded approach towards blockchain technology applications
Managers	• knowledge on blockchain and “smart contracts” advantages and implications • ability to deal with legal responsibilities that are related to blockchain implementation • familiarization with the blockchain functionalities and interface • creation of new decision making and governance processes

	that serve the purposes of the company and fit the blockchain applications, such as “smart contracts”, with regards to supply chain processes • ability to integrate operational aspects and specific process requirements with the functionalities of the blockchain solution
Lawyers	• ability to evaluate templates so as to ensure that the “smart contract” software fulfills the needs of the contracting parties • knowledge and experience on the development of “smart contracts” and on the effective integration of specific terms and conditions in these contracts • knowledge on blockchain and “smart contracts” implications in transactions and documentation exchange in order to tackle legal matters that could arise • assurance of legal compliance with private and cyber security legal issues related to blockchain applications
Blockchain software developers	• ability and knowledge on code building for the development and maintenance of blockchain applications • knowledge and ability with regards to the execution and coding of “smart contracts” and the efficient integration of specific terms and conditions in these contracts • ability to gasp the business results of blockchain technology • ability to create blockchain solutions that facilitate the connection between the trading parties across the supply chain • knowledge and ability to integrate blockchain systems with the current systems of the company such as ERP systems, IoT and cloud computing • awareness and familiarity with existent blockchain platforms • knowledge and comprehending of blockchain technology standards, concepts and vulnerabilities • skills and experience with regards to cyber security protection measures and threats

Additional human resources	• technical expertise and human resources that will underpin and develop the various applications of blockchain technology, with regards to supply chain management processes • expertise at all levels of the human resources of shipping companies with regards to the utilization and management of blockchain technology • expertise and recruitment of specialists in blockchain related cyber security matters and risk management

CHAPTER 3. METHODOLOGY AND RESEARCH QUESTION

3.1. Introduction of the methodology and research question

This section is dedicated to the methodology of the research of the main question and the conceptual framework related to the human resource capabilities a shipping company needs in order to implement blockchain technology efficiently, that is described in sub-section 2.12. Additionally, there is a presentation of the case study that will be utilized as part of the research. The qualitative information required for the investigation of the main research question and the conceptual framework was collected via interviews with experts from the Port of Rotterdam.

3.2. Research method and main question

In order to add to the existing literature, in respect of the human resource capability building of shipping companies that proceed to the implementation of the blockchain technology in their transactions and documentation processing, this thesis seeks to investigate the following research question:

"How would the implementation of blockchain technology in the transactions and documentation processing of shipping companies affect their human resources capabilities development?"

In order to examine the abovementioned research question, an explorative investigation and a qualitative approach is employed. The research methodology is based on the deductive reasoning. «*Deductive reasoning, or deduction, starts out with a general statement, or hypothesis, and examines the possibilities to reach a specific, logical conclusion, according to California State University»* (Bradford, 2017). This methodology starts from the general, which is the theory, and reaches the specific, which is based on the observations made (Bradford, 2017). Therefore, there is a general research question regarding the relationship between human resources capability development of shipping companies and the implementation of blockchain technology in their transactions and documentation processing, followed by specific logical sub-questions related to the consequences of the utilization of such technology. (Bradford, 2017) These sub-questions are incorporated as specific skills and qualifications required for the human resources of shipping companies in the proposed conceptual framework table in sub-section 2.12. Moreover, in order to examine the conceptual framework and serve the purpose of the deductive reasoning methodology, a case study of the "Deliver" platform developed by "BlockLab" (Port of Rotterdam: News: How Rotterdam is using blockchain to reinvent global trade, 2019), which is established by the Port of Rotterdam in collaboration with the City of Rotterdam and Innovation Quarter (BlockLab: Partners) and three individual interviews were conducted with experts from the Port of Rotterdam.

3.3. Interview characteristics

The conduction of interviews facilitates the collection of qualitative data from a relatively small number of people in an efficient and in-depth manner (University Libraries: Research Guides: Topic Guides: Research Methods Guide: Interview Research, 2018). Moreover, interviews are widely utilized in explorative investigations (Fox, 2009). The interviews were individual and were conducted online, via the use of Microsoft Teams software (University Libraries: Research Guides: Topic Guides: Research Methods Guide: Interview Research, 2018). In order to collect the information, audio recording was

implemented, with the permission and consent of the interviewees. The interviews were semi-structured and open-ended. Therefore, the interviewees were free to respond in the way they wished and based on their knowledge on the specific topics. Additionally, all interviewees were asked a similar set of questions based on their knowledge and expertise; therefore the qualitative data that were collected are comparable. (McIntosh & Morse, 2015) The interview of Person B was transcribed post-hoc via the use of the "Amberscript" transcription software from the audio recording (Mallam et al., 2020), while the interview information of Person A and Person C are included as per the interpretation of the interviewer and author of this thesis, after the approval of Person A and Person C. The full text of the interviews, including the questions asked and the answers of the interviewees are incorporated in Appendix B.

The three interviewees were chosen due to the fact that they belong to different collaborative platforms and programs of the Port of Rotterdam Authority, with fairly different operations and goals, and on the basis of their familiarity with the characteristics of the case study conducted in this thesis, namely the "Deliver" platform, as they revealed also via the interviews, and on the relationship between the human resource capability development of shipping companies and blockchain implementation that is being investigated in this thesis. More specifically, Person A is part of the "BlockLab" team that has developed the "Deliver" platform, so they have direct knowledge about the platform, Person B is part of the "Smart Port" team, which is a non-profit partnership between the Port of Rotterdam Authority, Deltalinqs, the Municipality of Rotterdam, the Erasmus University, Delft University of Technology, TNO and Deltares, with a goal of supporting innovations in the port of Rotterdam (Smart Port: About SmartPort) and has a more indirect familiarity with the platform and Person C is part of the Rotterdam Port Authority and also has indirect insights on the platform. However, in order to deal with potential bias in the interviews, the interview information included in the analysis of this thesis was corresponding to the respective questions asked and based on the actual answers given by the interviewees. In addition, the in-depth nature of the interviews allowed for a collection of information related to the insight and perspective of the interviewees and a decrease in the possibility of misinterpretation of the data collected. (Hofisi et al., 2014)

After the completion of the interviews, the information collected was summarized in order to evaluate the conceptual framework included in Table 1, in sub-section 2.12. The

interview characteristics along with the positions and the organizations of the interviewees are included in Table 12, in Appendix B.

CHAPTER 4. ANALYSIS

4.1. Introduction of the analysis

This chapter is dedicated to the analysis of the qualitative information gained via the interviews that were conducted for the research purpose of this thesis, and the recommendations for the shipping companies. The three interviewees were all familiar with the "Deliver" platform of the "BlockLab" even though only Person A is part of the "BlockLab" team. The overall opinions and insights of the interviewees regarding the main research question and proposed conceptual framework, presented in section 2.12., were insightful and overall homogeneous.

4.2. Evaluation of proposed framework for the case study

There are different types of clients that utilize the "Deliver" platform. Person A categorized them as "producers" and "consumers". The "producers" are, basically, companies that provide services on the platform. "Producers" do not necessarily have to build their own technology since their services can be structured on any kind of technology. These services include applications that provide certain benefits to the users of the platform, such as the provision of a digital CMR (Contrat de Transport International de Merchandises par Route) (Global Negotiator: Dictionary of International Trade: CMR Transport document) or a digital "Bill of Lading". These companies are in principal tech companies that build software, and usually already have a software solution in place. The key capability they need is to be able to achieve the technological integration of their solution with the "Deliver" system. The "Deliver" platform is similar to an application store, where anybody can place and offer their applications and anyone who is interested can obtain an application via the platform.

The "consumers" are the users of the services that are developed by the "producers". "Consumers" utilize the provided functionalities and validated data. Person A revealed that the "consumers" consist of companies that are in different levels of digital maturity. These

companies could be large international companies, such as Samsung, that only require certain parts of the network because, for instance, they do not have specific functionalities in their system or they do not have access to that particular data provided by the platform for a particular port. They could also be companies that are smaller in size compared to Samsung, but still have a considerable size and are in need of a platform, so as to fully digitize their supply chain.

Consequently, the companies that utilize the "Deliver" platform so as to provide blockchain solutions require a specific set of skills of their personnel in order to achieve a successful integration of their solution with the "Deliver" system. The companies that use the platform in order to acquire the services provided in it require certain aspects of the network, specific functionalities of the blockchain system and certain data. In addition, they are in need of specific skills and qualifications of their human resources in order to optimize and digitalize their supply chain, and elevate their level of digital maturity.

4.3. Evaluation of proposed skills for all human resources

Overall, the overall responses of the interviewees were contradicting. With regards to digital and technology-utilization skills, the ability to integrate operational aspects and specific process requirements with the functionalities of the blockchain solution, experience with the blockchain interface and functionalities, learning capabilities and adaptability, Person A and Person C revealed that blockchain application in the transactions of shipping companies will not require an alteration in existing skills of the workforce or additional training, since for a large number of users, knowing what the blockchain engine actually is, is not particularly necessary. Person A described blockchain technology application as similar to the internet access via multiple devices such as laptops and cellphones, which is made possible by TCP/IP, which is basically an online protocol for internet communication. The interviewee added that users of the internet do not have a thorough knowledge on how it actually works, but they use it to communicate and send e-mails. Similarly, Person C expressed that the personnel will be able to learn how to use the blockchain interface the same way they do with a new computer or software. Therefore, this information is partially aligned with the findings of the previous research that is summarized in the proposed conceptual framework with regards to the adaptability of the skills of all the personnel of shipping companies in order to

utilize blockchain technology, but they do not indicate the requirement for training and development of the specific skills mentioned earlier in this paragraph.

In contrast, Person B revealed that a lot of training will be required for the human resources of the companies that implement blockchain technology in their transactions, because it is a new technology. Therefore, due to the fact that the opinions of the three interviewees are contradicting, it is difficult to state whether the use of the blockchain interface and its functionalities will definitely require new training regarding digital and technology-utilization skills, the ability to integrate operational aspects and specific process requirements with the functionalities of the blockchain solution and new learning capabilities of the human resources of shipping companies in order to be able to work on the blockchain systems effectively, that are expected based on the literature. It could be partially said that adaptability of their skills could be developed further with regards to the utilization of the functionalities of blockchain technology, as expected in the literature.

None of the interviewees mentioned appropriate training related to the efficient integration of blockchain with existing systems in the company, critical decision making capabilities and creative thinking as important capabilities that the human resources of shipping companies need to develop in order to successfully integrate blockchain technology within their transactions and documentation processing. Therefore, it is not possible to conclude whether these skills that have been founded in previous literature (Papathanasiou, Cole & Murray; Demir, 2019) will surely be required.

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Only Person C emphasized on the necessity of blockchain technology implementation in human resource management for shipping companies with a large number of vessels and personnel, both onboard the vessels and shore-based. Blockchain technology would enable the assurance of the compliancy of the vessel and the people on board with the laws and regulations of the country they are visiting, along with the dissemination and exchange of management and training information. Hence, it cannot be concluded that human resources will definitely be required to develop the ability to code the blockchain system in order to facilitate human resources management procedures as anticipated in the literature (Coita, Abrudan, & Matei, 2019), since it is only mentioned by one of the interviewees.

4.4. Evaluation of proposed skills for the personnel onboard the vessels

With regards to knowledge and skills related to the utilization and application of blockchain technology for the exchange of shipping related documentation and shipping related transactions that are part of the efficient operation of the shipping company (Kundu et al., 2007; Nikitakos & Lambrou, 2007), Person C stated that the personnel on board the vessels will not work on the development of blockchain solutions; they will only use the blockchain system. Thus, they will not have to go through specific training or have to acquire new skills that are related to blockchain solutions development. The interviewee highlighted the importance of blockchain technology for the connection between the shore and the vessels. It seems that the main change that blockchain will bring is that instead of having to exchange e-mails, the two objects, meaning the vessel and the shore center, will interact with each other through a secure connection. For instance, the current process is that when a vessel enters the port area, the captain of the vessel has to present the medical declaration of crew members to the Port Authority in paper form or via e-mail. With digital systems, the vessel will be able to lock automatically into the port system and send all data and documents via blockchain. Also, the medical report of a crew member will be inserted automatically in their declaration of health via digital systems like the blockchain system. In this case, the captain will not need new skills. Neither will the rest of the crew on board the vessel.

Blockchain implementation in data processing, and not only in transactions, in combination with other technologies such as IoT could offer significant benefits in terms of man-hours, limitations minimization and carrying out inspections by distance, as mentioned by Person C. Person C elaborated that in situations where the captain of a vessel that is sailing to Rotterdam, for example, does not have the appropriate certificates and qualifications in order to enter this port area, because of a delay in their delivery or due to the lack of appropriate training, via blockchain technology, the vessel will automatically inform the captain and the company that some members of the crew are not qualified sufficiently to perform their tasks. Blockchain would enable the exchange of such information at any time, between vessels and Port Authorities and then, with respect to the law implemented at each Port Authority, the possibility of the vessels entering the respective ports would be defined. Blockchain systems could be developed in the future in such a way that all local restrictions are included in the systems in order to ensure that the arrival of a vessel will comply with all local regulations and recommendations. In that way, blockchain technology implementation would ensure that

everybody on board is compliant with the laws and regulations of the local authorities, and in the case where that is not true, the blockchain system would give a signal that there are issues regarding that. Moreover, Person C added that physical inspections on these matters would not be mandatory anymore, which would result in time efficiency of the vessel operations in the port of destination or the area where it would sail through, and ensure reliability of voyage plans, since possible interruptions by port authorities or other authorities would be minimized. Such secured blockchain systems would also benefit Port Authorities, since via their implementation, it would be guaranteed that all vessels entering the ports would have the appropriate documentation available.

Despite the fact that, based on the insights from Person C, the workforce on board the vessels of shipping companies will not have to develop new skills with regards to blockchain solutions implementation and development for the exchange of shipping related documentation and shipping related transactions as mentioned in literature, it is not possible to state this in an absolute manner since it is not supported by the other two interviewees as well. However, it can be said that the personnel onboard the vessels could employ its already existing skills in order to utilize the blockchain technology for documentation related processes.

4.5. Evaluation of proposed skills for supply chain practitioners

Person A was the only interviewee that elaborated on the capabilities of supply chain practitioners. Person A supported that supply chain practitioners will need to be able to comprehend information technology, work with big amounts of data and be quite knowledgeable about the tools and various ways of manipulation of data, and, on top of these, they will be required to perform analyses and do their own modeling. Additionally, Person A contributed that the supply chain person will be the one that will represent the main flows within the supply chain, which include the information flow, the physical flow and the financial flow. Also, Person A added that it is important for supply chain practitioners to have the necessary knowledge in order to be successful in managing all these flows. However, the interviewee did not mention the open-minded approach towards blockchain technology applications that is stated in literature (Min, 2019), so it cannot be said that this finding of

previous literature is supported by the information from the interviews, since it is not mentioned by any of the interviewees.

4.6. Evaluation of proposed skills for managers

With regards to "smart contracts" related human resource capabilities it can be discerned that the development and execution of a "smart contract" is complicated, basically due to the fact that the contract is extremely complex to reproduce in code, which makes it very difficult to implement in practice. Person A emphasized on the need for specific skills related to the ability of a person to understand computer code and the functions of a "smart contract", since "smart contracts" are written in computer code. The process of building and utilizing a "smart contract" for a company is similar to the process of signing an employment or purchase contract or a contract with a client, where specialists from the legal, procurement and human resources department are required for the successful completion of these procedures.

However, Person C indicated that, provided that in the future blockchain technology has become commonly and widely utilized in everyday transactions and data exchange, there will also be a standard "smart contract" that will replace all other types of contracts. Then, the generation of a "smart contract" will be effortless in comparison with a normal contract that is being utilized in the current procedures, since it will be possible for a party to copy or utilize the standard "smart contract" by adjusting it to their specific prerequisites.

Thus, it can be discerned that until there is a standard "smart contract" that can be generated easily and re-produced by shipping companies, specific skills and knowledge will be required for the creation of such a contract. However, based on the insights from Person A the skills required for managers with regards to "smart contracts" could be mainly focused on the understanding and knowledge on coding and on the functionalities of "smart contracts" as part of the blockchain solutions implemented in the company's transactions and documentation processing. Also, similarly to the procedure followed by shipping companies with regards to any type of contracts, an effective collaboration between various departments, such as legal, human resources and IT are considered beneficial for the successful employment of "smart contracts".

The skills and abilities of managers detected in previous literature with regards to "smart contracts" and blockchain application that are included in the proposed conceptual framework of this research, namely knowledge on blockchain and "smart contracts" advantages and implications, ability to deal with legal responsibilities that are related to blockchain implementation, familiarization with the blockchain functionalities and interface, new decision making and governance processes that serve the purposes of their company and fit the blockchain applications, such as "smart contracts", with regards to supply chain processes and ability to integrate operational aspects and specific process requirements with the functionalities of the blockchain solution, are not supported by the information from the interviews.

4.7. Evaluation of proposed skills for lawyers

Even if "smart contracts" are widely used in the future, lawyers and "smart contract" developers will still be necessary for the creation of these contracts. Regarding the responsibilities and skills of a lawyer, Person C pointed that the main complication a "smart contract" might create is that, due to the fact that legal jurisdictions are national and vary in each country around the world, a "smart contract" developed in the Netherlands, for example, might differ remarkably from a "smart contract" created in Indonesia.

Therefore, the lawyers that are a part of the personnel of the legal department of shipping companies is highly possible that they will need to develop the skills related to the ability to evaluate templates so as to ensure that the "smart contract" software fulfills the needs of the contracting parties and includes the specific terms and conditions required in shipping transactions, and is in accordance with the local and national laws of the contracting parties. In addition, since they will most probably be co-operating with the employees that will develop "smart contracts", it would be beneficial to acquire knowledge on blockchain and "smart contracts" implications and functionalities with regards to documentation exchange, in order to tackle legal matters that could arise. So these expected skills based on the literature (Tapscott & Tapscott, 2017) are partially underpinned since they are supported by the insights of one of the interviewees. Nevertheless, the ability to ensure legal compliance with private and cyber security legal issues related to blockchain applications that is referred to in literature is not validated by the interview information, therefore it cannot be inferred that they will be required.

4.8. Evaluation of proposed skills for blockchain software developers

With regards to the development of blockchain software, all of the interviewees suggested that training and new skills will be required for the human resources of the companies that choose to incorporate it in their transactions, because it is a new technology and it is also quite difficult to develop a blockchain ledger. Pertaining to that, Person C supported that a specific skillset and a significant amount of time would be required in the initial development of a "smart contracts" since it is a new type of contract.

Moreover, another issue is the trustworthiness of the workforce that will work on the development of "smart contracts". Person B noted that it is important for a company that develops such a contract for its own use or that outsources it from another company, to be certain that it serves its purposes. In case there are coding errors or mismanagement of the contract, the company that employs it could endure financial losses or there could also be cybercrime incidents.

Furthermore, Person B highlighted the importance of the ability of the industry actors to recognize that blockchain is not a solution for everything, and that they need to use it in a way that will effectively contribute to their operations. A more common understanding of how it can be used has to been established in order for the technology to scale. In the same wavelength, Person A emphasized that in order to make the most out of blockchain, there is also the need for an integration of other technologies, such as the internet of things (IoT) and artificial intelligence (AI). Nonetheless, in order to for companies to maximize the utilization of the functions and capabilities of the new technologies mentioned earlier, they have to combine them in a way that is functional.

With regards to cyber security matters, the complexity of some of the applications that were implemented in the early stages of blockchain technology, in combination with the maturity of the technology led to some significant implications. Person A connected these issues to the fact that the creators of software would build applications on top of the blockchain infrastructure without considering error handling and the ways in which users could utilize these applications. That resulted in vulnerabilities in the systems.

All the interviewees revealed that blockchain systems applied in transactions and document processing should be effectively secured against cybercrime, despite the fact that blockchain technology is a distributed ledger that is more difficult to be attacked by cyber actors. Person C mentioned that this could be possible by keeping the blockchain systems out of the internet network. However, blockchain technology is based on connectivity between parties which makes it difficult to completely disconnect it from the internet. Even if an organization utilizes it for internal processes, the advantages and functions it offers would be limited. Therefore, Person C persisted that cyber risks should not impede digitalization. Without digitalization and solutions like the blockchain technology, companies would return to paperwork processes that were applied in the past, where hacking was not possible. However, these processes would require two or three times more workforce. Possible solutions to cyber threats mentioned by Person C are digital counter-hackers, and blockchain development companies are already working on protection measures against ethical hackers.

Hence, it can be concluded from the above that there will be a need for training and acquisition of some of the skills required for the human resources of the companies that will develop blockchain solutions, based on literature expectations. These skills are:

- ability and knowledge on code building for the development and maintainance of blockchain applications,
- ability to gasp the business results of blockchain technology,
- knowledge and ability to integrate blockchain systems with the current systems of the company, such as ERP systems, IoT and cloud computing
- knowledge and comprehending of blockchain technology standards, concepts and vulnerabilities, and
- skills and experience with regards to cyber security protection measures and threats.

As regards knowledge and ability on the execution and coding of “smart contracts” and on how to efficiently integrate specific terms and conditions in these contracts, the ability to create blockchain applications solutions that facilitate the connection between the trading parties across the supply chain and awareness and familiarity with existent blockchain platforms that are mentioned in the literature, the information from the interviewees do not confirm these required human resources capabilities.

4.9. Additional human resources requirements for the shipping companies

All the interviewees revealed that there will be a need for the recruitment of additional personnel, in order for the shipping companies to integrate blockchain technology into their transactions and documentation processing efficiently. More specifically, Person A contributed that specialists who have experience with regards to the functions of the computer code required for the development of "smart contracts", will be essential for the successful creation and execution of these contracts. On top of that, Person B stressed that there will be a need for additional workforce in order for the shipping companies to develop all the blockchain solutions required for their transactions and document processing procedures, while Person C added that more personnel will be required in order to create solutions that secure the companies' systems against ethical based hacking and cybercrime.

These insights are in accordance with literature expectations. The only requirement for additional workforce based on literature findings that is not supported by the interview information is related to the implementation of blockchain technology in supply chain management processes (Saberi et al., 2019).

4.10. Additional information from the interviews

Regarding the development of an electronic "Bill of Lading", in April of 2019, "BlockLab" conducted a technical "proof of concept", and begun making it known to the market. Person A elaborated that large companies such as Alibaba, Amazon and Microsoft have already become a part of the electronic "Bill of Lading" initiative of the "BlockLab". Moreover, Person A added that there is, already, a number of electronic "Bills of Lading" that are being utilized. "BlockLab" focuses on a very specific issue related to the "Bill of Lading" and that is the fact that the "Bill of Lading" is also a title of ownership of the cargo. It is a document of title that one can use as collateral of finance. In Dutch law it is stated clearly that one can only use the "Bill of Lading" as collateral when it is in paper form. This means that a digital document is not accepted and recognized as collateral. In order to circumvent that impediment, "BlockLab" created a project to develop an electronic "Bill of Lading" that can be utilized as a way to transfer title and as collateral. This, however, requires changes not only

in the Dutch law, but also in many jurisdictions around the world. “BlockLab” is conducting this project in collaboration with a Singaporean entity and, if it is successful, then a large number of jurisdictions in the world will have to make alterations in their laws regarding this part. “BlockLab” is working on achieving this law amendment to allow the transfer of ownership via a digital document that can be used as collateral. Person A highlighted that this procedure will take one or two years, since the electronic “Bill of Lading” cannot be used yet, but “BlockLab” is developing it in order to demonstrate its superiority against existing solutions. With respect to such legal matters related, also, to the utilization of electronic “Bills of Lading”, Person C expressed that blockchain technology will not cause the amendment of laws. On the contrary, it will enable the implementation of the various laws that exist. Thus, it can be inferred from the above, that blockchain implementation, as already found in the theoretical framework, has legal implications that will affect its uses and applications in the maritime industry in order to better facilitate the abovementioned processes.

Overall, despite the number of solutions and applications of blockchain that are being developed, a number of activities will not be moved to the blockchain technology. Person A explained that the reason for this is that in a large number of cases it does not make sense and, on top of that, companies have invested heavily in existent applications, most of which are functioning quite well. Person B added that in order to be proved that blockchain technology applications in the industry work efficiently; there is a need for a critical mass and scale in the applications. Hence, the human resources of shipping companies have to be critical when choosing to incorporate a blockchain solution as part of the company’s system, so as to ensure maximum benefits for their company and avoid additional costs for a technological solution that will possibly not improve the efficiency and will not serve the goals of the company.

4.11. Final conceptual framework

The final conceptual framework included in Table 2 below, incorporates the information collected via the three interviews with the experts from the Port of Rotterdam with regards to the case study of the “Deliver” platform, as well as, general insights that confirmed the expected human resource capability requirements for the personnel of shipping companies that choose to utilize blockchain technology in their transactions and documentation processing. The most relevant skills required for the human resources and more specifically

for the personnel onboard the vessels, supply chain practitioners, managers, lawyers and blockchain software developers of the companies, are presented along with the need for specific additional human resources as well as the insights and human resources requirements for the companies that were added based on the interviewees comments.

Table 2. Final conceptual framework

Human resources	Required skills
All	• adaptability of the skills of all the personnel with regards to the utilization of the functionalities of blockchain technology
Personnel onboard the vessels	• adaptation of already existing skills in order to utilize the blockchain technology for documentation related processes
Supply chain practitioners	• familiarity with the blockchain functionalities and the way in which blockchain technology can be used in order to digitalize the supply chain processes efficiently • understanding of the facets of information technology • ability to work with big amounts of data • knowledge and experience with various tools and ways of data manipulation • ability to perform analyses • modeling skills • knowledge with regards to the management of the information, the physical and the financial flow of the supply chain
Managers	• understanding and knowledge on coding and on the functionalities of "smart contracts" as part of the blockchain solutions implemented in the company's transactions and documentation processing • effective collaboration with various departments of the shipping company, such as legal, human resources and IT for the successful employment of "smart contracts"

Lawyers	• ability to evaluate templates so as to ensure that the "smart contract" software fulfills the needs of the contracting parties • knowledge and experience on the development of "smart contracts" and on the effective integration of specific terms and conditions in these contracts • knowledge on blockchain and "smart contracts" implications in transactions and documentation exchange in order to tackle legal matters that could arise
Blockchain software developers	• ability and knowledge on code building for the development and maintenance of blockchain applications • ability to gasp the business results of blockchain technology • knowledge and ability to integrate blockchain systems with the current systems of the company, such as ERP systems, IoT and cloud computing • knowledge and comprehending of blockchain technology standards, concepts and vulnerabilities • skills and experience with regards to cyber security protection measures and threats
Additional human resources	• expertise at all levels of the human resources of shipping companies with regards to the utilization and management of blockchain technology • expertise and specialists in blockchain related cyber security matters and risk management

4.12. Recommendations for shipping companies

The final conceptual model includes the necessary skills and training requirements for the human resources of companies in general and for shipping companies that utilize the "Deliver" platform, in order to effectively integrate and apply the blockchain technology in their documentation processing and their transactions. It would be wise for these companies to ensure that their human resources have these skills acquired via appropriate training and

certification, as well as, experience with the blockchain technology functionalities, platforms, applications and structure. Additionally, there will be a necessity for the recruitment of human resources that are qualified and experienced in the utilization and management of blockchain technology, as well as cyber security issues and protection measures. That way, the companies will have the opportunity to reap the economic and efficiency benefits of this technology.

CHAPTER 5. CONCLUSION AND LIMITATIONS

In this section there is an elaboration of the concluding remarks, and the limitations of the research conducted for this thesis, along with suggestions for further research.

5.1. Concluding remarks

The research conducted in this thesis was stimulated by the digitalization wave of the "Industry 4.0" that is transforming the shipping industry (Rødseth et al., 2019). The key technological advancement that was of interest in this research is the blockchain technology, which is considered as a disruptive innovative solution for the global shipping industry (Beck et al., 2017). This was discernible by the large number of initiatives that have been created within the maritime supply chain ecosystem and are described in this thesis report. Nevertheless, the implementation of such a disruptive technology will have an impact on shipping companies' capability building in terms of their human resources (Benson- Armer, Otto, Webster, Benkert, & Koch). Essentially, previous research regarding the ways in which blockchain technology implementation in the transactions and documentation processing of shipping companies would affect the skills and learning capabilities of their personnel is limited. In consequence, this thesis attempts to add to previous research on that matter.

The research methodology employed is the deductive reasoning (Bradford, 2017). In addition, a case study was conducted for the purpose of this study, namely the "Deliver" platform which is a supply chain management platform based on blockchain technology that has been created by the collaboration of "BlockLab" with ABN-AMRO, the Port Authority of Rotterdam, Samsung SDS, (Port of Rotterdam: News: How Rotterdam is using blockchain to

reinvent global trade, 2019), Flora Holland and Transfollow (Beije, 2017). The conduction of a case study supports the exploratory nature of this research and its aim to add to the existing theoretical background (Rowley, 2002). Research papers, articles, reports and press releases were used in order to collect the information for the case study, the maritime blockchain initiatives, the applications, advantages and disadvantages of the blockchain technology, as well as the connection between innovation and blockchain implementation, and capability development of shipping companies. Furthermore, in order to examine the proposed conceptual framework that emerged through the analysis of the abovementioned aspects, three individual open-ended semi-structured interviews were conducted with experts from the Port of Rotterdam.

The research conducted in this thesis identified the capability requirements for the human resources of shipping companies that integrate blockchain technology in their transactions and documentation processing for the entirety of the personnel of the companies, as well as for specific professional positions within the companies as follows:

- All workforce: adaptability of their skills with regards to the utilization of the functionalities of blockchain technology,
- Personnel onboard the vessels: adaptation of already existing skills in order to utilize the blockchain technology for documentation related processes,
- Supply chain practitioners: familiarity with the blockchain functionalities and the way in which blockchain technology can be used in order to digitalize the supply chain processes efficiently, understanding of the facets of information technology, ability to work with big amounts of data, knowledge and experience with various tools and ways of data manipulation, ability to perform analyses, modeling skills and knowledge with regards to the management of the information, the physical and the financial flow of the supply chain,
- Managers: understanding and knowledge on coding and on the functionalities of "smart contracts" as part of the blockchain solutions implemented in the company's transactions and documentation processing and effective collaboration with various departments of the shipping company, such as legal, human resources and IT for the successful employment of "smart contracts",
- Lawyers: ability to evaluate templates so as to ensure that the "smart contract" software fulfills the needs of the contracting parties, knowledge and experience

on the development of “smart contracts” and on the effective integration of specific terms and conditions in these contracts and knowledge on blockchain and “smart contracts” implications in transactions and documentation exchange in order to tackle legal matters that could arise,

- Blockchain software developers: ability and knowledge on code building for the development and maintenance of blockchain applications, ability to gasp the business results of blockchain technology, knowledge and ability to integrate blockchain systems with the current systems of the company, such as ERP systems, IoT and cloud computing, knowledge and comprehending of blockchain technology standards, concepts and vulnerabilities, skills and experience with regards to cyber security protection measures and threats.

Moreover, via this research it is demonstrated that there is a necessity for the recruitment of experts and specialists with knowledge on the management and implementation of blockchain technology, as well as blockchain related cyber security matters and risk management.

Some of the requirements in terms of capabilities of the human resources with regards to blockchain implementation mentioned above have a generic application in all industries that utilize the technology. More specifically, for small and medium-sized enterprises that utilize digitalization technologies the adaptability of the workforce is critical (Demir, 2019). As regards the managers of the companies that employ “smart contracts”, they will be required to collaborate with IT departments of the companies in order to get acquainted with the “smart contracts” and blockchain functionalities and interface, as well as, its benefits and complications (Tapscott & Tapscott, 2017). Additionally, lawyers from the legal departments of companies that utilize blockchain and “smart contracts” will be required to audit guidelines, to ensure that the “smart contract” software serves the purposes of the contracting parties and acquire knowledge on blockchain and “smart contracts” implications (Tapscott & Tapscott, 2017). Furthermore, programmers that have skills required in order to develop and maintain the blockchain software and the data incorporated in the system, are considered vital for the successful utilization of the technology in all companies regardless of the industry that the company belongs to (Angelis & Ribeiro da Silva, 2019). Finally, the workforce of the all companies, irrespective of their sector, that will work on the development of the blockchain solutions and systems are expected to comprehend the business results of this technology, enable the integration of blockchain systems with the available systems of the company, have

skills and experience with regards to cyber security protection measures, such as, for example, public and private key cryptography skills and develop a thorough comprehending and knowledge of blockchain standards and concepts, cyber security threats and system susceptibilities (Shaik, 2018).

Hence, the required human resource capabilities of shipping companies with respect to the implementation of blockchain solutions in their documentation processing and transactions consist of both generic and industry specific skills that are mentioned above. That means that the companies will have to dedicate monetary resources and time in the training of their personnel and facilitate the process of required skills acquisition of their human resources via workshops or other forms of knowledge sharing, provided by professionals and experts. Moreover, this research revealed that it will also be necessary for shipping companies to hire additional workforce, via appropriate recruitment processes, such as personal interviews, certifications validation and cooperation with experts that are familiar with the requirements for the implementation of blockchain technology, that will have the necessary qualifications, experience and skills related to the implementation and management of blockchain solutions and the enforcement of cyber security measures in order for the blockchain systems that will be incorporated in the existing systems of shipping companies to be effectively protected against cyber risks.

5.2. Limitations and suggestions for further research

Albeit this research has been conducted to the best of the knowledge of the author, there are still some points that could be improved and enhanced. In this section, there is an elaboration of the limitations of this thesis and the recommendations for further research.

To begin with, regarding the case study, the fact that it is only one and it is focused on the Port of Rotterdam makes it harder to generalize about the specific capabilities that will be required for the human resources of the shipping companies that choose to implement the blockchain technology in their transaction and documentation processes. However, the interviewees were all familiar with the initiative that was selected as a case study and that it is why it was considered a very good fit for analysis. Nevertheless, a few more case studies related to some of the initiatives included in this thesis report would probably provide a better overview on the matter. Similarly, the number of the interviews could have been larger,

despite the fact that their quality was sufficient and the author was able to ask critical and essential questions to the interviewees. Nonetheless, it was not possible to conduct interviews with experts from shipping companies, due to the corona crisis that affected their work regimes and schedules.

The abovementioned limitations provide opportunities for further research. A suggestion for further research would be to conduct case studies related to a variety of the initiatives from each part of the maritime supply chain that have been described in this report. Moreover, further research could utilize a larger number of interviews with experts from several organizations and companies in the maritime industry in order to collect qualitative data that illustrate in a more specific fashion the impact of blockchain technology implementation on the capabilities of the human resources of shipping companies.

REFERENCES

Academic literature

Angelis, J., & Ribeiro da Silva, E. (2019). Blockchain adoption: A value driver perspective. *Business Horizons, 62*, pp. 307-314.

Bavassano, G., Ferrari, C., & Tei, A. (2020). Blockchain: How shipping industry is dealing with the ultimate technological leap. *Research in Transportation Business & Management*.

Beck, R., Avital, M., Rossi, M., & Bennett Thatcher, J. (2017, November 15). Blockchain Technology in Business and Information Systems Research. *Business & Information Systems Engineering, 59*(6), pp. 381-384.

C˘irjevskis, A. (2017). Unbundling dynamic capabilities in successful Asian-Pacific shipping companies. *JOURNAL OF ASIA BUSINESS STUDIES, 11*(2), pp. 113-134.

Chang, S.-J., & Rosenzweig, P. (2009, July 15). Subsidiary Capability Development In Multinational Enterprises: An Empirical Investigation. *Advances in International Management*, pp. 93-121.

Chang, Y., Iakovou, E., & Shi, W. (2019). Blockchain in global supply chains and cross border trade: a critical synthesis of the state-of-the-art, challenges and opportunities. *International Journal of Production Research*, pp. 1-18.

Coita, D., Abrudan, M., & Matei, M. (2019). Effects of the Blockchain Technology on Human Resources and Marketing: An Exploratory Study. In A. Kavoura, E. Kefallonitis, & A. Giovanis (Eds.), *Strategic Innovative Marketing and Tourism: 7th ICSIMAT, Athenian Riviera, Greece, 2018* (pp. 683-691). Athens, Greece: Springer.

Cong, L., & He, Z. (2019). Blockchain Disruption and Smart Contracts. *The Review of Financial Studies, 32*(5), pp. 1754-1797.

Demir, A. (2019). Digital skills, organizational behavior and transformation of human resources: A review. *Ecoforum, 8*(1(18)), pp. 6.

Diordiiev, V. (2018). Blockchain technology and its impact on financial and shipping services. *Economics. Ecology. Socium, 2*(1), pp. 51-63.

Foroglou, G., & Tsilidou, A.-L. (2015). *Further applications of the blockchain.* Conference paper, University of Macedonia, Finance and Accounting.

Fox, N. (2009). *Using Interviews in a Research Project.* Resource pack, The NIHR RDS for the East Midlands / Yorkshire & the Humber.

Ghezeljeh, T., & Emami, A. (2009). Grounded theory: methodology and philosophical perspective. *Nurse Researcher*(1), pp. 15-23.

Hackius, Niels & Petersen, Moritz (2017). *Blockchain in logistics and supply chain: Trick or treat?*. In: Kersten, Wolfgang Blecker, Thorsten Ringle, Christian M. (Ed.), *Digitalization in Supply Chain Management and Logistics: Smart and Digital Solutions for an Industry 4.0 Environment. Proceedings of the Hamburg International Conference of Logistics (HICL)*, Vol. 23, ISBN 978-3-7450-4328-0, epubli GmbH, Berlin, pp. 3-18, http://dx.doi.org/10.15480/882.1444

Hofisi, C., Hofisi, M., & Mago, S. (2014, July). Critiquing Interviewing as a Data Collection Method. *Mediterranean Journal of Social Sciences, 5*(16), pp. 60-64.

Jenssen, J. . (2003). Innovation, capabilities and competitive advantage in Norwegian shipping. *Maritime Policy & Management, 30*(2), pp. 93-106.

Korpela, K., Hallikas, J., & Dahlberg, T. (2017). Digital Supply Chain Transformation toward Blockchain Integration. *Proceedings of the 50th Hawaii International Conference on System Sciences*, pp. 4182-4191.

Kundu, S., Malhan, D., & Kumar, P. (2007). Human resource management practices in Shipping Companies: A study. *Delhi Business Review, 8*(1), pp. 75-88.

Kuo, S.-Y., Lin, P.-C., & Lu, C.-S. (2017). The effects of dynamic capabilities, service capabilities, competitive advantage, and organizational performance in container shipping. *Transportation Research Part A, 95*, pp. 356-371.

Lambourdiere, E., & Corbin, E. (2020). Blockchain and maritime supply-chain performance: dynamic capabilities perspective. *Worldwide Hospitality and Tourism Themes, 12*(1), pp. 24-34.

Lambrou, M., & Ota, M. (2017). *Shipping 4.0: Technology Stack and Digital Innovation Challenges.* Conference paper, IAME.

Lu, C.-S. (2007, May). Evaluating Key Resources and Capabilities for Liner Shipping Services. *Transport Reviews, 27*(3), pp. 285-310.

Macrinici, D., Cartofeanu, C., & Gao, S. (2018, October). Smart contract applications within blockchain technology: A systematic mapping study. *Telematics and Informatics, 35*, pp. 2337-2354.

Mallam, S., Nazir, S., & Sharma, A. (2020). The human element in future Maritime Operations - perceived impact of autonomous shipping. *Ergonomics, 63*(3), pp. 334-345.

McIntosh, M., & Morse, J. (2015). Situating and Constructing Diversity in Semi-Structured Interviews. *Global Qualitative Nursing Research*, pp. 1-12.

Min, H. (2019). Blockchain technology for enhancing supply chain resilience. *Business Horizons*, pp. 35-45.

Nærland, K., Beck, R., Müller-Bloch, C., & Palmund, S. (2017). *Blockchain to Rule the Waves - Nascent Design Principles for Reducing Risk and Uncertainty in Decentralized Environments.* Research paper, European Blockchain Center.

Nikitakos, N., & Lambrou, M. (2007). Maritime Transport: The Greek Paradigm: Chapter 12: Digital Shipping: The Greek Experience. *Research in Transportation Economics, 21*, pp. 383-417.

Oude Weernink, M., van den Engh, W., Francisconi, M., & Thorborg, F. (2017). *The Blockchain Potential for Port Logistics.* Research paper, SmartPort and the Port of Rotterdam Authority.

Oza, P. (2020, April). Tackling challenges in commercial shipping through technology. *ISF Institute of Research and Education (IIRE) Journal of Maritime Research and Development (IJMRD), 4*(1), pp. 15.

Papathanasiou, A., Cole, R., & Murray, P. (n.d.). The (non-)application of blockchain technology in the Greek shipping. *European Management Journal*.

Progoulaki, M., & Theotokas, I. (2010). Human resource management and competitive advantage: An application of resource-based view in the shipping industry. *Marine Policy, 34*, pp. 575-582.

Rowley, J. (2002). Using Case Studies in Research. *Management Research News, 25*(1), pp. 16-27.

Rødseth, Ø., Meland, P., Frøystad, C., & Drugan, O. (2019). *PKI vs. Blockchain when Securing Maritime Operations.* Paper, Norwegian Research Council.

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research, 57*(7), pp. 2117-2135.

Strauss, A., & Corbin, J. (1994). Grounded Theory Methodology: An overview. In A. Strauss, J. Corbin, N. Denzin, & Y. Lincoln (Edt.), *Handbook of qualitative research* (pp. 273-285). Sage Publications, Inc.

Tapscott, D., & Tapscott, A. (2017). How Blockchain Will Change Organizations. *MITSLOAN MANAGEMENT REVIEW, 58*(2), pp. 9-14.

Taylor, P., Dargahi, T., Dehghantanha, A., Parizi, R., & Choo, K.-K. (2019, February 19). A systematic literature review of blockchain cyber security. *Digital Communications and Networks, 5*, pp. 1-10.

Tijan, E., Aksentijevi´c, S., Ivani´c, K., & Jardas, M. (2019). Blockchain Technology Implementation in Logistics. *Sustainability, 11*(1185), pp. 13.

Tsekouras, G., Poulis, E., & Poulis, K. (2011). Innovation and dynamic capabilities in a traditional service sector. *Baltic Journal of Management, 6*(3), pp. 320-341.

Verhoeven, P. (2010). A review of Port Authority functions: towards a renaissance? *Maritime Policy & Management, 37*(3), pp. 247-270.

White, G. (2017). Future applications of blockchain in business and management: A Delphi study. *Strategic Change, 26*(5), pp. 439-451.

Yang, C.-C., Marlow, P., & Lu, C.-S. (2009, November). Assessing resources, logistics service capabilities, innovation capabilities and the performance of container shipping services in Taiwan. *International Journal of Production Economics, 122*(1), pp. 4-20.

Yang, C.-S. (2019, October). Maritime shipping digitalization: Blockchain-based technology applications, future improvements, and intention to use. *Transportation Research Part E, 131*, pp. 108-117.

Zheng, Z., Xie, S., Dai, H.-N., Chen, X., & Wang, H. (2018, October). Blockchain challenges and opportunities: a survey. *International Journal of Web and Grid Services, 14*(4), pp. 352-375.

Other sources

Beije, A. (2017, September 21). *BlockLab: Blockchain and its practical use in logistics: Some real developments*. Retrieved on July 2, 2020, from BlockLab: https://www.blocklab.nl/logistic-development/

Benson- Armer, R., Otto, S.-S., Webster, G., Benkert, C., & Koch, T. (n.d.). *McKinsey & Company: Organization: Our Insignts: Building capabilities for performance.* Retrieved on March 28, 2020, from McKinsey & Company: https://www.mckinsey.com/business-functions/organization/our-insights/building-capabilities-for-performance

BlockLab: About us: BlockLab Team. (n.d.). Retrieved on June 25, 2020, from BlockLab: https://www.BlockLab.nl/about/

BlockLab: Blockchain for Energy and Logistics: What we do? (n.d.). Retrieved on July 2, 2020, from BlockLab: https://www.blocklab.nl/

BlockLab: Partners. (n.d.). Retrieved on July 2, 2020, from BlockLab: https://www.blocklab.nl/partners/

Bradford, A. (2017, July 25). *LIVESCIENCE: HOME: REFERENCES: Deductive Reasoning vs. Inductive Reasoning*. Retrieved on March 28, 2019, from LIVESCIENCE: https://www.livescience.com/21569-deduction-vs-induction.html

Carson, B., Romanelli, G., Walsh, P., & Zhumaev, A. (2018). *Blockchain beyond the hype: What is the strategic business value?* Research, McKinsey & Company, Digital McKinsey, pp. 2, 6, 7, 8 and 10.

Consensys: Blockchain in finance: Komgo: Blockchain Case Study for Commodity Trade Finance. (n.d.). Retrieved on July 2, 2020, from Consensys: https://consensys.net/blockchain-use-cases/finance/komgo/

Deloitte Legal. (2018). *Blockchain: Legal implications, questions, opportunities and risks*, pp. 11 & 12.

Farnsworth, A. (2019, January 9). *Wartsila: Innovation: Blockchain – The case for digitalising shipping*. Retrieved on June 10, 2020, from Wartsila: https://www.wartsila.com/twentyfour7/innovation/blockchain-the-case-for-digitalising-shipping

Galvin, D. (2017). *IBM and Walmart: Blockchain for Food Safety.* IBM Corporation, pp. 3, 12 & 15.

Global Negotiator: Dictionary of International Trade: CMR Transport document. (n.d.). Retrieved on June 25, 2020, from Global Negotiator: International Contracts & Documents ready to use: https://www.globalnegotiator.com/international-trade/dictionary/cmr-transport-document/

Hellenic Shipping News Worldwide: International Shipping News: Blockchain at sea: How technology is transforming the maritime industry. (2019, March 8). Retrieved on June 10, 2020, from Hellenic Shipping News Worldwide: https://www.hellenicshippingnews.com/blockchain-at-sea-how-technology-is-transforming-the-maritime-industry/

Hwee Hwee, T. (2018, October 4). *The Straits Times: Business: Companies & Markets: Pacific International Lines, IBM in blockchain trial to create electronic bill of lading*. Retrieved on June 10, 2020, from The Straits Times: https://www.straitstimes.com/business/companies-markets/pacific-international-lines-ibm-in-blockchain-trial-to-create-electronic

International Maritime Organization. (n.d.). *Module 3: From Management to Operation.* IMO Train the Trainer Course, International Maritime Organization, pp 4, 7, 9 & 10.

Labarre, O. (2020, July 7). *Investopedia: Business Essentials: Enterprise Resource Planning (ERP)*. (S. Anderson, Editor) Retrieved ON July 21, 2020, from Investopedia: https://www.investopedia.com/terms/e/erp.asp

MarcoPolo: About. (n.d.). Retrieved on July 2, 2020, from MarcoPolo: https://www.marcopolo.finance/about/

Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018. (2019, December 26). Retrieved on June 10, 2020, from Marine Insight: https://www.marineinsight.com/know-more/7-major-blockchain-technology-developments-in-maritime-industry-in-2018/

Port of Antwerp: News: Smart port with blockchain. (2017, December 20). Retrieved on June 10, 2020, from Port of Antwerp: https://www.portofantwerp.com/en/news/smart-port-blockchain

Port of Rotterdam: News: How Rotterdam is using blockchain to reinvent global trade. (2019, September 12). Retrieved on June 10, 2020, from Port of Rotterdam: https://www.portofrotterdam.com/en/news-and-press-releases/how-rotterdam-is-using-blockchain-to-reinvent-global-trade

Presutti, L. (2018, May 21). *CYBERLAWS: Blockchain technology: challenges and legal issues*. Retrieved on June 10, 2020, from CYBERLAWS: https://www.cyberlaws.it/2018/blockchain-technology-challenges-legal-issues/

Shaik, K. (2018, March 1). *IBM: Blockchain Pulse: IBM Blockchain Blog: Blockchain education: The top 10 blockchain skills you need to develop*. Retrived on July 14, 2020, from IBM: https://www.ibm.com/blogs/blockchain/2018/03/the-top-10-blockchain-skills-you-need-to-develop/

Smart Port: About SmartPort. (n.d.). Retrieved on June 25, 2020, from Smart Port: https://smart-port.nl/en/about-smartport-2/

TradeLens: Platform: A Smarter Way to Engage in Trade. (2020). Retrieved on May 25, 2020, from TRADELENS: https://www.TradeLens.com/platform

TRADELENS: PLATFORM: A SMARTER WAY TO ENGAGE IN TRADE. (2020). Retrieved on May 25, 2020, from TRADELENS: https://www.TradeLens.com/platform

University Libraries: Research Guides: Topic Guides: Research Methods Guide: Interview Research. (2018, September 21). Retrieved on July 18, 2020, from Virginia Tech University Libraries: https://guides.lib.vt.edu/researchmethods/interviews

Vakt: About us: Strategic collaborations: Our core principles. (n.d.). Retrieved on July 2, 2020, from Vakt: https://www.vakt.com/about-us/

Vakt: Post Trade Management Platform: Our story: Our investors. (n.d.). Retrieved on July 2, 2020, from Vakt: https://www.vakt.com/

Vakt: Technology. (n.d.). Retrieved on July 2, 2020, from Vakt: https://www.vakt.com/technology/

APPENDIX A - BLOCKCHAIN INITITIVES IN THE MARITIME INDUSTRY

Table 3. Trade financing initiatives

Trade financing				
Initiatives/ Application	**Description and main goals**	**Founding and supporting entities**	**Users and members**	**Technology base**
"Komgo" platform	Optimization, security and trustworthiness of trade financing transactions and documentation processing, compliancy with Anti-Money Laundering (AML) regulations (Consensys: Blockchain in finance: Komgo: Blockchain Case Study for Commodity Trade Finance).	The platform is connected to the "Vakt" platform (Consensys: Blockchain in finance: Komgo: Blockchain Case Study for Commodity Trade Finance).	Various entities, such as banks, commodity traders, carriers, oil companies, energy companies and inspection companies, some of which are: some of its members are ABN-AMRO, BNP Paribas, Credit Agricole, Citi, Gunvor, ING, Koch Supply & Trading, Macquarie, Mercuria, MUFG Bank, Natixis, Rabobank, SGS, Shell and Societe Generale (Consensys: Blockchain in finance: Komgo: Blockchain Case Study for Commodity Trade Finance).	JP Morgan's Quorum, Ethereum platform, documentation transfer system based on distributed ledger technology called "Kite" (Consensys: Blockchain in finance: Komgo: Blockchain Case Study for Commodity Trade Finance).
"Vakt" platform	Post trade physical management platform aimed at achieving a cyber secure, efficient and trustworthy trading ecosystem (Vakt: About us: Strategic	Deloitte, ThoughtWorks and the "Komgo" platform (Vakt: About us: Strategic collaborations:	ABN- AMRO, BP, Chevron, Equinor, Gunvor, ING bank, Koch Industries Inc., Mercuria Energy Group Ltd, Reliance Industries Limited, Shell, Societe Generale and Total (Vakt: Post Trade Management Platform: Our story: Our investors).	A private permissioned distributed ledger (Vakt: Technology).

	collaborations: Our core principles).	Our core principles).		
"Marco polo" platform	Part of the "Marco Polo" network which is a trade and working capital finance network and its main goal is the enhancement of network effects for its members (MarcoPolo: About).	TradeIX and R3 in collaboration with a large number of major financial institutions and some of their clients (MarcoPolo: About).	Some main investors: ING bank, Bank of America, Bangkok Bank, BNP Paribas, Danske Bank, Accenture, Microsoft, Pole Star, Vesuvius, KSB, Daimler, Durr, Oracle and Mitsui & Co (MarcoPolo: About).	Open distributed blockchain-based platform (MarcoPolo: About).
Mercuria's initiative for trade (2017)	Trading and shipping business of Mercuria (Opensea.pro: How can the shipping industry take advantage of the blockchain technology?).	Mercuria, ING and Societe Generale (Opensea.pro: How can the shipping industry take advantage of the blockchain technology?).	Mainly Mercuria which is a shipping and trading conglomerate (Opensea.pro: How can the shipping industry take advantage of the blockchain technology?).	Blockchain technology (Opensea.pro: How can the shipping industry take advantage of the blockchain technology?).

Table 4. Initiatives aimed at facilitating connection between the actors of the maritime supply chain

Facilitators of connection between the actors of the maritime supply chain				
Initiative/ Application	**Description and main goals**	**Founding and supporting entities**	**Users and members**	**Technology base**
Global Shipping Business Network (GSBN) (2019)	This network is an open digital platform provides a digital baseline in order to link all stakeholders and allow collaboration that promotes innovation and digital transformation in the supply chain. (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019). Another objective of this network is to enable the digitization and automation of documentation procedures related to "dangerous goods", which is a category of goods classified as hazardous that are subject to a specific range of regulatory aspects (Farnsworth, 2019).	CMA CGM, COSCO SHIPPING Lines, Evergreen Marine, OOCL, Yang Ming, terminal operators DP World, Hutchison Ports, PSA International Pte Ltd, Shanghai International Port and software solutions provider CargoSmart signed a formal statement of intent for a Memorandum of Understanding (MOU) to create GSBN (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Carriers, terminal operators, customs agencies, shippers and logistics service providers. (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Open digital platform built on distributed ledger technology (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).

"Silsal" platform	Its goal is to offer a smooth and secure connection between various stakeholders across the trade community (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Maqta Gateway, which is a subsidiary of Abu Dhabi Ports (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Various stakeholders across the trade community (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	This technology amalgamates blockchain technology and unique digital user identities (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).

Table 5. Port operations and cargo tracing and transferring initiatives

Port operations and cargo tracing and transferring				
Initiative/ Application	**Description and main goals**	**Founding and supporting entities**	**Users and members**	**Technology base**
"Smart port"	Pilot program focused on blockchain implementation in the container handling in the Port of Antwerp, in order to increase the efficiency and security of container handling process (Diordiiev, 2018). This pilot program is part of the plan of a five-pronged program developed by the city of Antwerp within its efforts to become a European leader for the Internet of Things (IoT) (Port of Antwerp: News: Smart port with blockchain, 2017).	The Port of Antwerp in collaboration with "T-Mining", which is an Antwerp start-up (Port of Antwerp: News: Smart port with blockchain, 2017).	Mainly the Port of Antwerp (Diordiiev, 2018).	Blockchain technology (Port of Antwerp: News: Smart port with blockchain, 2017).

Pacific International Lines' blockchain initiative for cargo tracing	Blockchain-based supply chain platform that enables tracking and tracing of cargo. The founding companies evaluated it by tracking cargo that travelled from Chongqing to Singapore via the Southern Transport Corridor. (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Pacific International Lines (Pte) Ltd ("PIL"), PSA International ("PSA") and IBM Singapore ("IBM") signed a Memorandum of Understanding (MOU) in order to develop innovations that are founded on the blockchain technology (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Maritime supply chain actors (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Blockchain technology (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).
Shipment transfer via the "Ethereum blockchain" (2018)	In March 2018, there was a successful trial of a shipment transferred based on a smart contract via the "Ethereum blockchain". That specific shipment included two 40-foot high cube container boxes sailing from Malaysia to Brazil. During the process there were a number of TEU tokens that were held as booking deposit on blockchain, which were later efficiently returned to the users that owned them, after the receipt of port EDI message on a textile shipment. (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019)	This deployment was conducted by 300cubits (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	300cubits (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Ethereum blockchain (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).

Table 6. Initiatives related to the certification, transmutation and exchange of core shipping documents

Certification, transmutation and exchange of core shipping documents				
Initiative/ Application	**Description and main goals**	**Founding and supporting entities**	**Users and members**	**Technology base**
Pilot blockchain-based seafarer certification system	The main goals of this pilot project are to accelerate and smoothen procedures and avoid mishaps due to lack of verification for safety documentation, access to verified safety, training certifications of seafarers and due to certificate management that is based on papers (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Maritime Blockchain Labs (MBL), which was founded by blockchain technology, governance experts Blockchain Labs for Open Collaboration (BLOC) and the Lloyd's Register Foundation and its mission is to investigate the implementation of blockchain technology in the domain of safety of critical infrastructure and to propel novel business models for the international maritime industry (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	International maritime industry actors (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Blockchain technology (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).
"TradeLens" platform	The main goal of this platform is to provide the key actors of the international maritime supply chain with the ability to exchange data and documents in real time and in a secure manner (Carson et al., 2018).	Maersk and IBM (Tradelens: Platform: A Smarter Way to Engage in Trade, 2020).	IBM and Maersk announced that 94 organizations are actively participating or have agreed to participate on the "TradeLens" platform (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019). These organizations comprise of port and terminal operators internationally, customs authorities, brokers, cargo owners, freight forwarders, as well as transportation and logistics companies (Farnsworth, 2019).	It is a blockchain-based platform that is built on open standards (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).
"Design Science Research project"	This project is aimed at creating and assessing an information technology product which enables the transmutation of core shipping documents, such as the "Bill of Lading", into smart contracts in order to alleviate the transactional risk and uncertainty that exists within maritime supply chains (Nærland et al., 2017).	The "Design Science Research project" was developed by the "European Blockchain Center" in cooperation with Maersk, a major international shipping company (Nærland et al., 2017).	Maritime supply chain actors (Nærland et al., 2017).	Blockchain technology (Nærland et al., 2017).

"CargoX Smart Bill of Lading"	It is a "Bill of Lading" in a smart contract form. The first application of the "CargoX Smart Bill of Lading" that incorporates the blockchain technology took place in August 2018 at the Port of Koper, in Slovenia, where this smart contract was used in order to successfully manage a container shipment. This particular "Bill of Lading" was issued electronically and sent via an extremely secure and reliable public blockchain network. The process was really fast, taking into account that it only took a few minutes where it would normally have taken days or even weeks. In addition to this, the possibilities of loss, theft or damage to this "Bill of Lading" were diminished to zero. (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).			Blockchain technology (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).
Pacific International Lines' electronic "Bill of Lading"	The "Bill of Lading" has legal and commercial nature, provides evidence for the contract of carriage, receipt of goods and ownership of goods and it is used as a reference for banks to extend trade financing. Habitually, the "Bill of Lading" is mailed between the contracting parties. The whole process has handling costs and presents risks such as fraud and loss of the document. Therefore the use of blockchain offers significant benefits regarding transparency and eliminating the abovementioned risks. (Hwee Hwee, 2018)	Pacific International Lines (PIL) in co-operation with IBM and with the support of the Maritime and Port Authority of Singapore (MPA), the Singapore Shipping Association, the Infocomm Media Development Authority, the Singapore Customs and the Bank of China's Singapore unit . (Hwee Hwee, 2018).	Maritime actors (Hwee Hwee, 2018).	Blockchain technology. (Hwee Hwee, 2018).

Table 7. Marine insurance initiatives

Marine insurance				
Initiative/ Application	**Description and main goals**	**Founding and supporting entities**	**Users and members**	**Technology base**
EY's AND Guardtime's blockchain platform for the marine insurance sector	Its goal is to enhance blockhain benefits through an end-to-end use across the maritime industry for marine insurance (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Ernst & Young (EY) and Guardtime in collaboration with A.P. Møller-Maersk A/S, ACORD, Microsoft, MS Amlin, Willis Towers Watson and XL Catlin (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Maritime industry actors (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Blockchain platform based on Microsoft Azure global cloud technology (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).

Table 8. Initiatives in the shipbuilding sector

Shipbuilding sector				
Initiative/ Application	**Description and main goals**	**Founding and supporting entities**	**Users and members**	**Technology base**
Lloyd's Register's and Hyundai Heavy's Industries blockchain initiatives for shipbuilding	Collaboration project launched in September 2019 aimed at investigating the value of blockchain technology applications in shipbuilding. Lloyd's Register also launched its own prototype blockchain-based Class register, which constitutes the first demonstrator that has the ability to register ships into Class utilizing blockchain technology (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Lloyd's Register in collaboration with Hyundai Heavy Industries (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019) .	Shipbuilding maritime actors (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Blockchain technology (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).
Shipbuilding "Approval Letter"	The "Approval Letter" is utilized in the ship-building procedure. The current procedure of an "Approval Letter" is consecutive and requires evaluation of documents such as designs of the vessel, many communicationpoints and storage of documents from both the shipyard and the company that is responsible for the construction of the vessel. Its main issue is the defective synchronization and lock mechanisms of data, documents and remarks. Moreover, during audits from third party companies involved in the construction of the vessel, such as ship owners' subcontractors, the company has to give access to the necessary resources, including human resources, and infrastructure, thus making the whole process costly and complex. With this initiative, DNV GL investigated how the implementation of blockchain technology would affect the way it offers third-party services to its clients and improve the process of the "Approval Letter". Moreover, the aim of its use is to enhance trust between class societies and other actors in the maritime industry, since no private intellectual property data are saved in the blockchain system. (Rødseth et al., 2019)	DNV GL (Rødseth et al., 2019).	DNV GL, class societies and other actors in the maritime industry (Rødseth et al., 2019).	Blockchain technology (Rødseth et al., 2019).

Table 9. Maritime fuel supply chain initiatives

Maritime fuel supply chain				
Initiative/ Application	**Description and main goals**	**Founding and supporting entities**	**Users and members**	**Technology base**
Maritime Blockchain Labs's (MBL) blockchain project for the maritime fuel supply chain	This project is focused on fuel information that is important for the operations of the maritime sector. Also, in 2019 Maritime Blockchain Labs (MBL) launched in 2019 its first demonstrator project. This project is basically a fuel provenance register, set to provide valid fuel information related to its origin, journey and characteristics, and undergo extended commercial development. Also, MBL established a consortium in order to enhance traceability, transparency, compliance and governance in the maritime fuel supply chain. (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019)	Maritime Blockchain Labs (MBL), which is a subsidiary of Blockchain Labs for Open Collaboration (BLOC) and a consortium including Lloyd's Register, Precious Shipping, Bostomar, BIMCO, International Bunker Industry Association (IBIA) and GoodFuels (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Maritime supply chain actors (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Blockchain technology (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).

Table 10. Food supply chain initiatives

Food supply chain				
Initiative/ Application	**Description and main goals**	**Founding and supporting entities**	**Users and members**	**Technology base**
Port of Antwerp's blockchain-powered pilot program for the food supply chain automation	This pilot program enables the seamless transfer of documents, such as certificates of origin and phytosanitary certificates with the use of smart contracts. The main aim of this program is to ensure the safety of fruit and vegetables and denotes the important role of the Port of Antwerp in digitalizing and innovating in order to provide secure and automate processes to enhance the food chain. (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019)	The Port of Antwerp in collaboration with Belfruco, Enzafruit, PortApp, 1-Stop and T&G Global (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	The Port of Antwerp and food supply chain actors (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).	Blockchain technology (Marine Insight: Know more: 7 Major Blockchain Technology Developments In Maritime Industry In 2018, 2019).
IBM's and WALMART's blockchain solution for food supply chain provenance	The main goal of this solution is to secure food supply chain provenance (Galvin, IBM and Walmart: Blockchain for Food Safety, 2017). The main benefits it aims are: faster transactions, cost reductions in terms of overheads and intermediaries, risk mitigation in terms of cyber crime and fraud and enhanced trust between the supply chain parties via record keeping and common procedures (Galvin, IBM and Walmart: Blockchain for Food Safety, 2017). Moreover, the utilization of blockchain technology, will facilitate tracking and transparency of operations and food supplies throughout the supply chain, the provision of complete, correct and necessary data among the supply chain actors and a more seamless cooperation between the parties (Galvin, IBM and Walmart: Blockchain for Food Safety, 2017).	IBM and Walmart (Galvin, IBM and Walmart: Blockchain for Food Safety, 2017).	Food supply chain actors (Galvin, IBM and Walmart: Blockchain for Food Safety, 2017).	Blockchain technology (Galvin, IBM and Walmart: Blockchain for Food Safety, 2017).

Table 11. Business accelerator for blockchain solutions

Business accelerator for blockchain solutions				
Initiative/ Application	**Description and main goals**	**Founding and supporting entities**	**Users and members**	**Technology base**
Wärtsilä's business accelerator program	This business accelerator program was launched in Turku, Finland in August 2018, in order to assist the growth of new partnerships that will foster blockchain solutions for the maritime industry (Famsworth, 2019).	Wärtsilä in collaboration with Royal Caribbean and other innovative start-ups and maritime companies (Famsworth, 2019).	Maritime industry actors (Famsworth, 2019).	Blockchain technology (Famsworth, 2019).

APPENDIX B – INTERVIEWS

Interview information

Table 12. Interview information

Date of the interview	Form of interview	Duration and Method of Recording	Referenced name of the interviewee in the text	Position of the interviewee	Organization
23-06-2020	Individual	55 minutes, audio recorded	Person A	Logistics solutions	"BlockLab"
24-06-2020	Individual	20 minutes, audio recorded	Person B	Project developer for the "Roadmap Smart Logistics"	"Smart Port", which is a non-profit partnership between the Port of Rotterdam Authority, Deltalinqs, the Municipality of Rotterdam, the Erasmus University, Delft University of Technology, TNO and Deltares, with a goal of supporting innovations in the port of Rotterdam.. (Smart Port: About SmartPort)
02-07-2020	Individual	66 minutes, audio recorded	Person C	Program manager	Rotterdam Port Authority

Sources: The interviews and the websites of the organizations mentioned in the table

Text of the interview with Person A

Question 1.: ***Would you like to talk a bit about yourself?***

Answer: «*I am co-founder of "BlockLab" and co-author of a book on blockchain and supply chain management together with two professors from the University of Southern California*». The greatest challenge for the port of Rotterdam is the switch to sustainable energy sources, since it is a port industrial complex and requires reliable energy infrastructure. One of the disadvantages of sustainable energy is that it is either propelled by wind or generated by using solar energy. Also, via the transition to sustainable energy sources, the Port of Rotterdam becomes significantly less dependent on the existent coal and gas power plants. "BlockLab" is 100% owned by the Port of Rotterdam. "BlockLab" focuses on developing blockchain solutions to the energy transition challenge and for logistics.

Question 2.: ***Could you describe what "BlockLab" does as a main activity?***

Answer: "BlockLab" is not an IT company, since it does not create software and does not aim at selling it to millions of users. The main activity of the team that runs the "BlockLab" is to detect a particular problem related to logistics or energy transition and then identify whether blockchain could be a possible solution to this problem. Then the "BlockLab" team strives to build a consortium capable of tackling this problem. They come up with a solution which is not a full-scale IT solution; rather it is more like a proof of concept. In order to test whether the solution they have envisaged actually works in practice, they run a number of pilot programs. They make alterations and further developments based on the comments and the feedback they obtain from the pilot programs and once these additional developments are completed, they incorporate the blockchain-based solution into a separate entity. That entity becomes a "spin-out" company, with its own management structure, independent of the "BlockLab". In some cases, "BlockLab" has an advisory role for these companies, but most of the time it is not involved with them and the respective solution anymore.

Question 3.: ***Do you have any contacts with companies that have already, for example, implemented blockchain, so you have an insight on how they have used it, what capabilities they needed afterwards or maybe what they are planning on developing in the future?***

Answer: The "BlockLab" team is currently working on the development of two solutions that are very close to the market needs. The team has a solid knowledge with regards to the needs and requirements of companies, in order for them to implement the blockchain software in a successful way. There are different types of clients. One type is the "producers" that are, basically, companies that provide services on the "Deliver" platform. "Producers" do not necessarily have to build their own technology since their services can be structured on any kind of technology. These services include applications that provide certain benefits to the users of the platform. Such services are digital CMR or digital "Bill of Lading". The main goal of the platform is to ensure that certain functionalities are provided and that specific validated data are available to the users of the platform. These companies are in principal tech companies that build software, and most of the time they already have a software solution in place. The key capability they need is to be able to achieve the technological integration of their solution with the "Deliver" system. The "Deliver" platform is actually like an application store, where anybody can place and offer their applications and anyone who is interested can obtain an application via the platform. The users of the services that are developed by the "producers" are called "consumers". "Consumers" utilize the provided functionalities and validated data. "Consumers" consist of companies that are in different levels of digital maturity. These companies could be large international companies, such as Samsung, that only require certain parts of the network because, for instance, they do not have specific functionalities in their system or they do not have access to particular data provided by the platform for a particular port. They could also be companies that are smaller in size compared to Samsung, but still have a considerable size and are in need of a platform so as to fully digitize their supply chain. Capabilities are very diverse within the whole ecosystem of the "BlockLab" platform.

Question 4.: ***Regarding the supply chain, do you or someone else that you work with, or for example the companies, see the blockchain technology being implemented in some other parts of the supply chain, besides the ones that is already being implemented in, in the near or further future?***

Answer: With regards to the implementations of blockchain in other parts of the supply chain, there are initiatives in the areas of trade finance and commodity trading which are proximately related to the supply chain. In these areas there is a lot of paperwork, as well as an unequivocal need for privacy in transactions, especially in commodity trading, and in the administration section which deals with prices and client information. There are already two platforms running, namely "Komgo" and "Vakt", which are mainly trade finance solutions. The GSBN network is similar to the "TradeLens" platform and is aimed primarily at the maritime supply chain. Moreover, there are the "Marco Polo" and "WeTrade" platforms, which are focused at providing trade finance and supporting the financial flows of international trade. Another area of the supply chain where blockchain is applied is for provenance, in order to ensure the origin of the goods transported within the supply chain. Walmart in collaboration with IBM have worked on creating solutions in this part of the supply chain operations.

Question 5.: ***Regarding the capacity and the scalability of blockchain technology for the transactions is there anything you could add to that or are there any challenges related to that?***

Answer: "BlockLab" focuses on a specific type of clients. The "BlockLab" team initially approaches major clients that already have structured their supply chain in a well-functioning order. Most of the time, these clients have already set up an organization and invested in IT systems, their operations are fairly streamlined and they have a very good overview of the supply chain. Based on its collaborations and operations up-till now, the "BlockLab" team has observed that companies that are considerably large, but not as large as Unilever for example, strain to optimize their supply chain. The reason for that is that their level of digital maturity is remarkably low. A large number of companies still manage their supply chains using excel sheets and e-mails and are interested in adopting new digital solutions, such as blockchain, IoT and artificial intelligence (AI), because their digital

maturity is low. The lack of digital maturity of the clients is another challenge for "Blockclab".

Another challenge is that there are serious competitors on the same platform and there are issues related to the competition aspect. "BlockLab" has established an open network where entrance for the competitors of its founding entities, which are ABN Amro, Samsung and the Port of Rotterdam, is made possible, since its goal is not to become a closed community. Another challenge is that of the profitability of the provider of the platform. An easy and straightforward solution to that is that, since the provider of the platform has a large number of data gathered in the platform, they could sell them and make profits out of it. Becoming a data trading platform is not the goal of "BlockLab". The "BlockLab" team believes that data should be owned and available for the use of their owner, so they applied blockchain in such a way that they can guarantee that data is not stored in a central place, and that the actual users of the "Deliver" platform are able to have access to the data. Another challenge is that of the efficient co-operation between a port, a bank and an electronics manufacturer, taking into consideration that these entities have different cultural, technical and corporate backgrounds. For the reason that blockchain is a considerably new technology, a number of its functions and aspects are not fully mature yet and there is always some doubt and uncertainty regarding whether the technology will work properly and scale, whether it is secure enough, whether it is possible for it to be implemented rapidly and how clients perceive distributed technology in general, mainly due to the low level of digital maturity of the companies. The "BlockLab" team fully believes in the current capabilities of blockchain technology and in the blockchain solutions the team has developed.

Question 6.: ***What about interoperability between the systems?***

Answer: Interoperability issues are connected to the lack of standardization, not only in the blockchain implementation, but also in the implementation of legacy systems, and are important for clients. The "Deliver" platform is developed in order to tackle this problem and offers a universal connector between all the different platforms that are in place. Despite the number of solutions and applications of blockchain that are being developed, a number of activities will not be moved to the blockchain technology. That is mainly due to the fact that in a large number of cases it does not make sense and, on top of that, companies have invested heavily in existent applications, most of which are functioning quite well.

Question 7.: ***Regarding cyber security, have you come across any kind of problems or incidents related to that or?***

Answer: One of the reasons why blockchain is more secure as technology is because of its distributed nature. Successfully attacking the blockchain system is, in general, more difficult than attacking a centralized system, because the blockchain system contains copies of the users' data and applications that run in various servers across the globe. In order to take out the whole blockchain network, one has to take out more than just one single server, because it is a distributed ledger that is much more resilient than a classical client-server system that has a unique central database located in only on one single place, where all the data is also streamed towards. The complexity of some of the applications that were implemented in the early stages of blockchain, in combination with the maturity of the technology resulted in some significant problems. Most of these issues were related to the fact that the creators of software would build applications on top of the blockchain infrastructure without considering error handling and the ways in which users could make use of these applications. That resulted in vulnerabilities in the systems, an example of which is the DAO hack. The last two years, systems have become more mature, scalable and resilient and they are developing rapidly. These advancements, in combination with the fact that distributed systems are more secure against cyber-attacks, renders them a better choice for supply chain solutions that require a high level of availability in terms of security.

Question 8.: ***Since in order for someone to be able to use the blockchain technology, they have to have certain knowledge and skills, are there going to be any specific requirements regarding these capabilities for the companies and their personnel or is there going to be a need for new personnel?***

Answer: All communication on the internet via multiple devices, such as laptops and cellphones, is made possible by TCP/IP, which is an online protocol for internet communication. Users do not have a thorough knowledge on know how it actually works, but they use it to communicate, and send e-mails for example. In the early adaptation of blockchain people were interested in how it works, but nowadays companies are much more interested in using it as a solution to their problems that cannot be solved with other kinds of

technology. For a large number of users knowing what the blockchain engine actually is not necessary. In supply chain management, practitioners have to be able to comprehend IT, work with large amounts of data and be very knowledgeable about how to manipulate data, what kind of tools to use for that, and, on top of that, be able to perform analyses and their own modeling. In supply chain management, practitioners should have a thorough comprehending of the financial side of the supply chain and gradually the supply chain person will be the one that will represent the main flows within the supply chain, which include the information flow, the physical flow and the financial flow. The key challenge is providing supply chain personnel with the required knowledge in order for them to be successful on managing all these flows.

Question 9.: ***The fact that it is easy for us to use technology, as you said, could mean that the blockchain interface is easy to work on, but does this also apply to "smart contracts", since they are more complicated to use and create?***

Answer: Regarding "smart contracts", despite the term given to them, they are neither contracts nor particularly smart. In reality an actual implementation of these contracts is very far away, basically due to the fact that this contract is highly complex to reproduce in code, which makes it very difficult to use in practice. Additionally, it is hard for someone to understand the functions of a "smart contract". There is a need for specific knowledge in order for someone to be able to comprehend "smart contracts". The process of building and utilizing a "smart contract" for a company is similar to the process of signing an employment or purchase contract or a contract with a client, where specialists from the legal, procurement or human resources department are required for the successful completion of these procedures. The only difference is that "smart contracts" are written in computer code, which means that there is a need for a different kind of knowledge. There is also a need for specialists that are able to explain to the person that creates the contract, what the computer code does. If one develops a good quality code, it is important for them to include comments on their code explaining each of its functions. The ability to understand computer code is supremely useful in this case.

Question 10.: ***Would you like to add something regarding the legal aspect of blockchain technology implementation, since blockchain is still not accepted in many jurisdictions as a way to conduct transactions or create contracts and as you also mentioned there is no uniformal standardization? Has this created any specific problems that you might have come across up-till now? More specifically with regards to public and private law issues?***

Answer: The "BlockLab" team has come across such issues. There is, already, a number of electronic "Bills of Lading" that are being utilized. "BlockLab" focuses on a very specific issue related to the "Bill of Lading" and that is the fact that the "Bill of Lading" is a title of ownership of the cargo. It is a document of title that one can use as collateral of finance. In Dutch law it is stated clearly that one can only use the "Bill of Lading" as collateral when it is in paper form. This means that a digital document is not accepted and recognized as collateral. In order to circumvent that impediment, "BlockLab" has come up with a project to develop an electronic "Bill of Lading" that can be utilized in order to transfer title and as collateral. This, however, requires changes not only in the Dutch law, but also in many jurisdictions around the world. "BlockLab" is conducting this project in collaboration with a Singaporean entity and, if it is successful, a large number of the jurisdictions in the world will have to make alterations in their laws regarding this part. "BlockLab" is working on achieving this law amendment to allow the transfer of ownership via a digital document that can be used as collateral. That is something that is going to require one or two years, since the electronic "Bill of Lading" cannot be used yet, but "BlockLab" is developing it in order to demonstrate its superiority against existing solutions.

Question 11.: ***What is your opinion on blockchain and its future in the industry?***

Answer: Blockchain is going to be a backbone technology for the future digitization of the supply chains. In order to fully utilize blockchain, there is also the need for an integration of other technologies, such as the internet of things (IoT) and artificial intelligence (AI), and all these technologies together will revolutionize logistics within the next 10 years. Regarding the electronic "Bill of Lading", in April of 2019, "BlockLab" conducted a technical proof of concept, and begun making it known to the market. Large companies such as Alibaba, Amazon and Microsoft have already become a part of the electronic "Bill of Lading" initiative. In the next 10 years there will be a tremendous change in technology, in the way it

is being implemented and in the way by which supply chains will be executed. The industry has been inefficient in its operations and as a result of that there is a lot of overcapacity. In tracking, for instance, around 30%-40% of the trucks drive around empty, while the average loading rate is around 60%-65%. The situation in the shipping industry is quite similar, because maritime companies strive to optimize their own operations and rarely consider collaborating, sharing data and working closely with their competitors in order for their services to be more efficient and so as to decrease overcapacity. That situation is now changing. There will be a reduction in the amount of vessels required to ship the same or slightly less volumes of containers, because the industry will become more efficient. This will create opportunities in terms of the logistics service providers becoming more able to take on different tasks, such as becoming a financier of cargo or a contract manufacturer on behalf of their customers. That is where the supply chains are moving towards and blockchain is an important technology that supports this change. However, and in order to make the most of the new technologies mentioned earlier, one needs to combine them in a way that is functional. The companies that can accomplish that in the best way possible are going to have a very good position in the next 10 years.

Text of the interview with Person B

Question 1.: ***So, it's [blockchain technology] been implemented in a few parts of the maritime supply chain. Already there are a few initiatives regarding the food chain or some other initiatives such as "TradeLens" and the "Deliver" of the "BlockLab" of the Port of Rotterdam. I would like to ask you if you have any insights on whether that [initiatives] could be extended to other parts of the supply chain, too, like not the already implemented ones.***

Answer: "To be honest, I don't have that much insight in that. I could imagine that initiatives, like "TradeLens", will not only be related to maritime transport since Maersk is involved and Maersk is also active in other parts of the transport chain. I can imagine that it also extends to other parts of the supply chain. But to be honest, I don't have direct insight in how those kinds of things are developing."

Question 2.: ***Would you like to share with me what your knowledge is on that [blockchain]?***

Answer: “Well, a few years back, I had been involved to some extent, to some research on what blockchain is and how it could contribute to the ports. So I know that there are some initiatives. And I also supervised a few students who did their theses on blockchain. But in general I think it's a technology which you can use it to some extent, but it's not the answer for all problems. A few years back, everyone said, "well, blockchain can help, it can help fix it", but it's not as easy like this. And so there were very high expectations and back then if I would have put blockchain somewhere on your product, then everyone wanted to finance or support you because blockchain was it. But now after these high expectations, you have a sort of a drop down of interest maybe because now is the moment that you need to deliver new services and show that it can work. But in general, I think for a lot of services, you don't even need to know that blockchain as a technology is used because you have just an interface, which is probably just the same as you have right now on your Internet browser. So as long as it can service your needs, it can be very helpful. But on the other hand, it is also still in its sort of infancy period. We also don't know yet what it can do and how it is going to be implemented. Sure, there are a few examples, but yeah, it's still difficult to do that in a larger scale. I would say. And the most important element why blockchain was promoted is that it was trustworthy because you could trust the blockchain. But then, there are still sort of periods in which people need to get that trust, right? You can say that you can trust it, but are you really going to trust it? So that's, I think, a big step that needs to be taken still in order to get sufficient business for blockchain products. And I think that the "TradeLens" and "Deliver", those are very important initiatives and then that can be very helpful. I would say. But, yeah, I don't know exactly how this is already progressing. I had some insights or I heard some things about IBM primarily promoted "TradeLens" because it's sort of their technology and Maersk is involved. But they also made it a bit more difficult for other shipping lines to step in, right? Because, are you going to work with a competitor? Well, I know, as I understand correctly already, a few other shipping lines that did. So maybe that has already overcome that problem. So, yeah. It probably needs a bit more, I would say, volume, mass, you need a critical mass in order to really show that things work. And I don't know if it's already there yet.”

Question 3.: ***So I'm guessing since you've already said that it's kind of an easy interface to use [blockchain technology interface], because I'm mainly focused on whether there are going to be needed new skillsets for the personnel that uses them and not so much for the system itself, but mainly also for the use of "smart contracts" where you need to be able to code them and there are, of course, some specific terms that you need to include. So, I was really curious about whether there's going to be a need for more specific training, let's say, for the personnel in order to be able to implement the technology.***

Answer: "There probably needs to be a lot of training because it's a new technology. It's also quite difficult, as I understood, to build the blockchain. So the question is will we have enough people to develop all those kinds of blockchains? And then also, do we trust the people? Because if you develop or let another company develop a "smart contract", is that contract exactly doing what you want, right? So, if there is a bug in it, some way or another, then you could lose a lot of money maybe, or the money is going to the wrong organization. Or I can imagine that there can also be a lot of cybercrime with this kind of things if it's not managed well. So those kinds of things are very important issues I would say."

Question 4.: ***Also regarding cyber security and all these matters. Although people say that it's quite safe because it's a distributed ledger, so in order to attack the whole system, you need to attack multiple servers. So that kind of makes it more difficult. However, I found something that's mentioned as "miners", that they create false blocks. They do not act in good faith and they could probably create some damage in the system.***

Answer: "Yeah, I agree with that, right? But if there's a criminal… You have sort of hacks, right? This type of hacking, probably. But you could also say that that's what sometimes is done within the port terminals, with customs, for example, if you have criminals. Yeah, if you want to I don't know if this is the right word. But if you pressure people to... For example, I could say, well, you need to help me with this. So there's a criminal putting pressure because they're saying, I know where you live, and this and that and if you don't help me, I can either inform the police or I will make sure that you lose your job or whatever. So you're pressurized to help this criminal, right? And you see that sometimes with customs to make sure that drugs is being imported or not detected. I could imagine that if a criminal knows that you are

working on a “smart contract”, that the criminal might also say, well, “OK, maybe five percent of the money you need to direct to me if this contract is accepted”, something like that. So there are ways of putting people under pressure to make sure that money is going to the wrong direction. Let's say it like that. So there are probably different ways on how to do that. But I can imagine that that's also cybercrime. But it can be something that needs to be taken into account let's say it like that.”

Question 5.: ***So, you've already also mentioned quite a few challenges that are there regarding the blockchain and also trust and all those things. So what would your opinion be on whether this is going to be fully implemented in the near future or there are just going to be a few minor initiatives that will exist?***

Answer: “I think it needs time. So, I think it will be implemented on a large scale if it's proved to really work and it's manageable. Then I think it can really contribute to the maritime sector or the logistics sector. So I'm sure that still a lot of companies are developing things and focusing on how it can help their company or their business. So I can imagine that it will be implemented to a larger extent than we currently see right now, because clearly there are advantages in using the blockchain. But I think it's also important to recognize that blockchain is not a solution for everything and that you really need to use it in a way that it really can contribute something and not just because you can use the blockchain. And then I think that needs to sort of settle down on how this is used in the best way. And then if we have a bit more common understanding of how it can be used, then like, for example, with the internet twenty years ago, we also didn't expect that this was all possible with it. So, sure there were some ideas about webshops, but we probably couldn't have guessed that it would influence logistics, for example, in such a big way. On how we do business and how we buy things online and all that. So there are many, many ways of how you can do business or improve business through the Internet and by having services or software through the Internet. In 10 years probably we couldn't have imagined that we would be doing banking maybe via the blockchain without physical banks, for example. But probably that's going to happen. But we don't know that yet, at least. It's not that a lot of people know that probably.”

Text of the interview with Person C

Question 1.: ***Remarks on blockchain technology regarding the required infrastructure and implementation in the future.***

Answer: A concern regarding the successful implementation of blockchain in the future is whether the required number of secure databases, along with data and computing centers are available all around the world. If all financial transactions and information exchange are conducted via the blockchain there will be a need for a large number of computing systems that will process all the data and the energy demand will be high. This will also result in high costs. In the near future, meaning 5-10 years from now, there will be more possibilities for blockchain applications in secure transport procedures.

Based on research conducted a few years ago related to the frequency of communication required in the transportation process of a box, the number of contact points that included transaction papers was found to exceed 37. With the use of blockchain technology, the delivery of the goods or materials from party to party in the transport chain and the consequent payments, could be carried out in a smooth and fast way.

Nevertheless, there are a large number of restrictions, such as document standardization, where, for instance a shipment could have three or four different transport numbers, dependent on the countries, transfer points and supply chain parties it passes through until it reaches its final destination. Blockchain could be an enabler and facilitator of digitalization and standardization of transport and logistics processes.

Additionally, blockchain can offer similar benefits to the shipping industry. That could be the case of blockchain utilization where all the documentation related to port and transport procedures, as well as vessel organization and operations is managed via this technology system. In this case, every time there is a new crew member employed all their certificates and qualifications would be inserted in the blockchain system of the vessel. This way, inspections would be conducted much more rapidly and easily, since all required documentation and certificates of the vessel and its crew would be connected to the vessel via the blockchain system. Blockchain could be utilized on a high level where all documentation is processed and exchanged via this system and would ensure a secure data management for the shipping sector.

The vessels could sail around the globe and every port they reach would connect digitally via the blockchain to them and all information would be incorporated in a secure blockchain system. That introduces a completely different way of thinking with regards to data management. The current process for captains on vessels, in order to keep records of information and exchange it with the shipping companies or other interested parties, is based on paperwork and communication via emails. Via blockchain, such time-consuming and ineffective procedures would be replaced by direct interaction between the vessel and the technology of the party that is interested in particular information of the vessel and its crew.

Blockchain implementation in data processing, and not only in transactions, in combination with other technologies such as IoT could offer significant benefits in terms of man-hours, limitations minimization and carrying out inspections by distance. Blockchain offers cyber and data security, reliability, integrity, confidentiality and trustworthiness. It could ensure that parties receive the correct information from the correct source.

Question 2.: ***Will there be a requirement for a specific kind of training for the personnel in order to utilize blockchain, in combination with the other technologies mentioned, efficiently or for specialists in the technology?***

Answer: Blockchain application will not require an alteration in existing skills of the workforce. In order for blockchain to function successfully, what will be required is a connection between the shore and the vessel, via the use of appropriate technology. What will change is that, instead of having to exchange e-mails, the two objects will interact with each other through a secure connection. Blockchain implementation will decrease a significant amount of work of the personnel. For instance, the current process is that when a vessel enters the port area, the captain has to present the medical declaration to the Port Authority in paper form or via e-mail. With digital systems, the vessel will be able to lock automatically into the port system and send all data and documents via blockchain. In this case, the captain will not need new skills. Also, the medical report of a crew member will be inserted automatically in their declaration of health via digital systems. Blockchain will not have a large impact regarding human resources in training. The personnel will be able to learn how to use it the same way they do with a new computer or software, for example.

However, there might be a need for the recruitment of workforce that has experience and skills in blockchain solutions development. The personnel on board the vessels will not work on the development of blockchain solutions, they will only use it, so they will not have to go through specific training or have to acquire new skills.

Question 3.: ***Does this (the answer regarding the need for new skills, training and additional personnel) apply also to "smart contracts", because one needs to be able to know how to create a "smart contract" and enable all the specific terms needed in the contract? Will there be a need for collaboration of experts from the legal and IT department that will create the "smart contracts"?***

Answer: The first "smart contract" that would be developed would require a significant amount of time since it is a new type of contract. However, when "smart contracts" are widely used in the future, lawyers and "smart contract" developers will still be necessary for the creation of a "smart contract". Notwithstanding, provided that in the future blockchain technology has become commonly and widely utilized in everyday transactions and data exchange, there will also be a standard "smart contract" that will replace all other types of contracts. Then, the generation of a "smart contract" will be effortless in comparison with a normal contract that is being utilized in the current procedures.

Even so, new skills of the human resources are considered essential. Regarding the responsibilities of a lawyer, the main complications that a "smart contract" might create is that, due to the fact that legal jurisdictions are national and vary in each country around the world, a "smart contract" developed in the Netherlands, for example, might differ remarkably from a "smart contract" created in Indonesia. In terms of the skillset required, they are mostly related to the initial development of "smart contracts", considered that when there is a standard "smart contract" applied it in the future, it will be possible for a party to copy or utilize that by adjusting it to their specific prerequisites.

Question 4.: ***What about legal and juridical matters, related to, for example, the electronic "Bill of Lading" which has to be in paper form since it is a title of ownership***?

Answer: In the execution of certain contracts when a party from the Netherlands buys something in China, for instance, it is juristically in their possession when it reaches the Port of Rotterdam. So when the shipment arrives at the port of destination, then is when the formal exchange of the goods actually occurs, according to the law. There are also situations where, a party purchases goods in Brazil, for example, and they become their possession instantly, so the only thing they have to do is to arrange the transportation of the goods. Sometimes the transportation is arranged by the party that sends the cargo and it is their responsibility until it arrives at the port of destination and sometimes the party that purchases the cargo is responsible for organizing the transport.

Blockchain might be a solution that will facilitate transportation procedures. Regardless of the systems utilized for the process, via blockchain the payments take place at the moment that is specified by law. Blockchain technology will not cause the amendment of laws. On the contrary, it will enable the implementation of the various laws that exist. In situations, where the captain of a vessel that is sailing to Rotterdam, for example, does not have the appropriate certificates and qualifications in order to enter this port area, because of a delay in their delivery or due to the lack of appropriate training, via blockchain technology, the vessel will automatically inform the captain and the company that some members of the crew are not qualified sufficiently to perform their tasks. Blockchain would enable the exchange of such information at any time, between vessels and Port Authorities and then, with respect to the law implemented at each Port Authority, the possibility of the vessels entering the respective ports would be defined. Blockchain systems could be developed in the future in such way that all local restrictions are included in the systems in order to ensure that the arrival of a vessel will comply with all local regulations and recommendations. That would also facilitate the tasks and duties of Port Authorities in the future, as regards inspections and Port Authority regulations. A large number of solutions could be developed without the utilization of blockchain technology, but they would be less secure.

Question 5.: ***With regards to the scalability of blockchain technology, is it possible for the technology implementation to further expand in the future, when there is also the appropriate infrastructure available?***

Answer: The "Bill of Lading" will still be required in the future even if there are fully autonomous vessels that interact with shore offices and Port Authorities. The only difference could be that it will be available in a digital form on board the vessels. In the future, there could be, for instance, 4G or 5G data connectivity of the vessel that would enable the exchange of large amounts of data, including the "Bill of Lading" and the information and documentation of the crew onboard the vessel, with the port of destination. In this situation, when the vessel would enter a specific geographical area, only the use of geofencing for clearance and exchange of the data would be required.

Question 6.: ***What kind of future capabilities will be needed for the companies that implement the blockchain technology?***

Answer: Another application for blockchain technology that would be necessary for shipping companies with a large number of vessels and personnel both onboard the vessels and shore-based, is in human resource management and the assurance of the compliancy of the vessel and the people on board with the laws and regulations of the country they are visiting.

In that way blockchain would: 1) ensure that everybody on board is compliant with the laws and regulations of the local authorities, and in the case where that is not true, the blockchain system would give a signal that there are issues regarding that, 2) physical inspections on these matters would not be required anymore, which would result in time efficiency of the vessel operations in the port of destination or the area where it would sail through, and ensure reliability of voyage plans, since possible interruptions by port authorities or other authorities would be minimized. Such secured blockchain systems would also benefit Port Authorities, since via their implementation, it would be guaranteed that all vessels entering the ports would have the appropriate documentation available. There would be benefits for the human resources, goods, containers and boxes, as well as for logistics services.

Question 7.: ***Regarding cyber security, despite the security of the blockchain systems as distributed ledgers, there are still possibilities for cyber crime, so is it secure enough?***

Answer: Systems that are critical for the mission of an organization should be effectively secured against cyber crime by for example, remaining out of the internet society. Blockchain technology is based on connectivity between parties which makes it difficult to completely disconnect it from the internet. Even if an organization utilizes it for internal processes, the advantages and functions it offers would be limited. Blockchain adds a security layer in information sharing, however the entities that implement is should be effectively protected against cyber crime. Cyber threats will always exist. If digitalization comes to a standstill and companies return to paperwork processes that were applied before digitalization, where hacking was not possible, that would result in the need for two or three times more workforce to perform their operations successfully. Possible solutions to cyber threats are digital counter-hackers and blockchain development companies are already working on protection measures against ethical hackers. There is a possibility that more personnel will be required in order to create solutions that secure the companies' systems against ethical based hacking and cybercrime.

Question 8.: ***Is there anything more that you would like to add?***

Answer: Back in 2015 blockchain wasn't discussed as a solution, platforms, hubs and track and trace systems were considered as solutions regarding the decrease in the number of communication points in the transfer of goods. The main benefits for companies that would drive them to explore blockchain and invest in it, are the possibility of creating a compliancy rate on all their operations, as well as, the dissemination and exchange of management and training information.