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Blockchain in the shipping industry: A proposal for the use of blockchain for SMEs in the maritime industry

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Abstract

The main objective of this study is to address one of the significant challenges maritime SMEs, as well as the whole industry, are facing concerning the general necessity to digitize the global supply chain: the lack of transparent information flows between participants and the non-existing documentation standards. This objective includes a proposal of using blockchain technology for data sharing as a solution to counter this challenge.

To understand how a blockchain-based data-sharing platform would succeed and tackle this challenge, TradeLens was selected as a case study. The literature review has addressed the shipping industry as a whole, blockchain technology, and its features and current initiatives that facilitate this technology.

The case study analysis and discussion focused on the architecture, data sharing model, and standards for documentation as well as challenges associated with the solution TradeLens is offering for maritime enterprises. From this analysis, implications for SMEs have been elaborated. Concluding these implications have been validated through interviews with industry experts and strategic decision-makers in maritime SMEs.

Keywords: Blockchain; Maritime Industry; TradeLens; SME; Case Study.

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1. Background

Nowadays, blockchain is being hyped up as the fifth evolution of electronic data processing [1]. In 2008 a developer, using the pseudonym Satoshi Nakamoto, released a white paper in which he described the basic concept of the blockchain, a peer-to-peer electronic cash system [2]. While the basic idea was to establish a system where online payments can be sent without the use of a third party, being completely decentralized, blockchain and bitcoin went to disrupt the concept of money, transfer of value, and the whole financial system. In 2015 The Economist called in their article blockchain "the next big thing" and even compared it to the introduction of the commercial internet [3]. This sparked the enthusiasm of investors, innovators, and technologists worldwide who saw the enormous potential of the digital currency not being controlled by one entity such as governments or banks [4]. However, the disruption did not stop there, Hermann and Prof. Dr.-Ing. Liggesmeyer see the sheer amount of opportunity such technology like blockchain is bringing [5]. Blockchain can improve any contract-related transaction, not only in the financial industry but also in mobility, energy, and identification management.

Moreover, while the digital transformation is covering more aspects of our lives every day, digital innovations decisively initiate essential changes while innovation cycles become shorter [5]. Therefore, to capture the potential of those changes, it is essential to embrace them from an early stage. In a special issue, Beck et al. investigate the impact blockchain has on the business processes of modern organizations [6]. While they mainly focus on the financial industry, they also touch upon the implementation of blockchain and its application, such as tracking shipping containers and pharmaceuticals to recording gambling winnings. This includes blockchain adoption in supply chain management in the maritime industry.

In 1960 container transport was revolutionized through the introduction of the ISO standard 668 by the IMO. It introduced an industry-wide container dimension standard and improved transportation efficiency by reducing coordination costs [7]. In the time of digitization, the maritime industry must undergo a similar transformation. However, being an industry that is heavily reliant on paper-based documentation, information sharing is very inefficient and prone to errors.

Loklindt et al. analyze the challenges of physical document exchange in their conference paper [8]. They aim to set specific guidelines that exploit blockchain technology as a solution for the issue. Eight design principles are imposed: immutability, decentralization, security, privacy, compatibility, scalability, inclusiveness, and territoriality. It leads to four potential approaches for the implementation process.

Wang & Qu aim to clarify the main valuable characteristics for the use of Blockchain in the shipping business, including decentralization, open data, and authenticity of data [9]. Including applications such as smart contracts, fast payments, information sharing, track and trace, and supply chain finance, they are further investigating the implementation of Blockchain in the maritime industry.

Jabbar & Bjørn (2018) introduce an activity on how to implement Blockchain into the shipping domain [11]. They are introducing an infrastructural grind, by which a domain, like shipping, is intersected with new technological infrastructure such as Blockchain. Analyzing their idea of the infrastructural grind will help understand the elements and appropriateness of the consolidation, permeability, and velocity of the implementation of Blockchain. In another paper, Jabbar & Bjørn (2018b) build upon the infrastructural grind and dig deeper into the implementation process of the Blockchain in the shipping domain [12]. It gives further insight into entangled dimensions of the grind and how the dimensions are embedded differently in the supply chain of shipping.

1.1. Motivation

In early 2017, the biggest shipping company in the world, A. P. Møller-Mærsk (Maersk) and IBM, the then-named leader in blockchain technology [13], announced a joint venture to build an industry-wide blockchain for the maritime industry. Later that year, the Global Trade Digitization Platform (GTDP), TradeLens, was launched [14]. The GTDP's primary purpose was to be a secure data solution that facilitates the exchange of documents and increases visibility. For the platform to reach its full potential and develop the wanted network effect, the two companies worked closely with various stakeholders in the ecosystem, like ocean carriers, freight forwarders, ports, and customs authorities [15]. As a result, by the end of 2019, the TradeLens platform publishes more than 2 million events per day and has over 175 organizations in their ecosystems, including major players such as four of the six biggest ocean carriers. Like the

Korean shipping company HMM, other big shipping companies followed, seeing the potential this emergent technology is bearing and built their own blockchain-based solutions [16].

With those efforts in mind being made by big shipping companies, there are still some doubts within the industry. Skeptics believe blockchain is, in the best case, a slightly more reliable way to track data but could also backlash and result in a less efficient way of keeping the data compared to the current central gatekeepers [17]. Furthermore, Gardeners 2019 Hype Cycle, an illustration of the maturity and adoption of technology applications and their potential relevance for solving real business problems and exploiting new opportunities, sees blockchain technology in the so-called Trough of Disillusionment [18]. Meaning the blockchain has not yet reached its full potential in terms of being scalable technically and operationally and still needs five to ten years to have a transformational impact.

For now, only major players adopted this new technology. The customers of the blockchain solutions that are being offered in the maritime industry are mainly large enterprises or their subsidiaries. While previous studies have already explored the blockchain application in the maritime industry, the focus of this study is set on investigating the use of this technology by small and medium-sized enterprises (SME) in the given environment. To understand the inherent uncertainty towards a complete industry-wide implementation of blockchain in the maritime industry, this study will push beyond the current adoption of blockchain.

2. Blockchain in Shipping

The following will provide not only an overview of the challenges blockchain initiatives are trying to address but is also assessing current projects and businesses that are enabling the technology in the maritime context.

In their article, Jensen et al. provide four challenges and their causes in the global supply chain that pushed IBM and Maersk to develop their blockchain initiative, TradeLens [14]. Firstly, each individual organization in the process of shipping is operating its own IT supply chain management system. While there are many different organizations involved in the shipping process, each one of them has its own IT system to track the shipment and the flow of documents. While those systems might have been improved internally, the challenge is associated with the “inefficient flow of inter-organizational, information across supply chain partners” [14]. There are no incentives for the stakeholders of the supply chain to share their digital information, especially since most of such is commercially sensitive.

The authors mention that the absence of standardization for trade documents is another challenge. The discrepancies between supply chain partners about the format and interpretation of those documents result in high costs, uncertainty about lead times, and enable severe security risk to the paper-based documentation. These problems have been known for decades, and the EU, as well as the International Organization for Standardization, have made efforts to provide a framework for container documentation standards. But those projects either failed to attract international interest or only have a few participants who have adopted them even partially.

While shipping is expected to move containers from one location to another, it also involves the moving of around multiple documents that need to be updated by multiple parties. Key documents are the bill of lading, packing lists, certificates of origin, commercial invoices, and export licenses [19]. Again, the digitization of those documents has been done company internally, but the data exchange in between supply chain participants is rarely done. Therefore, the continuous reliance on a multitude of physical documents is a common practice in the shipping industry. IBM has estimated the costs of paper-based documentation to make up to 15% of the total shipping costs [20].

The final challenge mentioned by Jensen et al. is the regulatory requirement of paper documents [14]. Regulations in place require the original document to be signed or stamped to several authorities in short times, up to 15 minutes upon request. The documents are being sent by courier separately while the containers are at sea. If a document is missing or filled out incorrectly, it can delay the shipment's journey. The US Department of Commerce (2018) estimates that the process of documentation, handling, customs clearance, and inland shipping can add over 30 days of delay to the total shipping time .

In 2014, a team of IT specialists at Maersk, have tracked one shipment of refrigerated goods, avocados, and roses, in this case, on their journey from East Africa to Europe. The goal of this operation was to document the complexity of operational processes and the massive amount of paperwork necessary for an ordinary shipment, and the costs of cross-border trade. They found that about 30 people and organizations were involved, with over 200 interactions between them [22].

The Allianz raised in their annual "Safety and Shipping Review 2021" concerns with regards to cybersecurity risk [23]. While four of the largest shipping companies have become victims of cyber-attacks, further concerns are growing about critical marine infrastructure being targeted for further potential strikes.

2.1. The Blockchain Initiatives

The most prominent example of a blockchain application in the maritime industry is the IBM and Maersk solution, TradeLens. Emerging from their joint Global Trade Digitization (GTD) Initiative, TradeLens was their response to the previously mentioned challenges.

In its early stages, TradeLens was designed to capture and share information about the key events of the shipping containers as well as the providing a network to increase trust and enable encrypted digital copies of trade documents [14]. The blockchain ecosystem is connecting all stakeholders of the supply chain, cargo owners, freight forwarders, inland transportation providers, including rail and trucking, ports and terminals, ocean carriers, customs, and other government authorities [24]. It provides seamless and real-time sharing of cargo details, trade documents, and shipping milestones, ensuring through blockchain technology that critical information is secure, immutable, and auditable. In addition, the open API environment of TradeLens allows third parties to build applications on the platform.

The different features of the solution are divided into three components: the ecosystem, the platform, and the marketplace. Where the ecosystem ensures the sharing and accessing of the data, the platform is the technological foundation of the TradeLens. The marketplace is the final component that allows as an open application and service marketplace third parties to offer their products.

The joint efforts in the application of blockchain of the two giants were not unseen by others in the maritime industry. HMM, the biggest Korean shipping company and eighth biggest in the world, conducted a blockchain technology integrated pilot voyage, together with Samsung SD, to analyze the potential of blockchain implementation in the shipping industry [16]. After finalizing the analysis, HMM announced to continue their efforts on pushing the digital transformation of their company, culminating in the development of cloud-based next-generation IT system "New-GAUS 2020" in 2020 [25]. HMM, plans together with the IT provider, Oracle, to rebuild their Global Advanced & Unified System (GAUS) so that the new IT system can manage the data flow of HMM's vessel operations such as vessel-related information as well as information related to personnel, management, and operations. The proposed system will apply new technologies, including IoT, big data, AI, and blockchain, to provide increased service efficiency and stability of operations.

ZIM, an Israeli shipping company, one of the ten biggest, completed their first pilot testing of a blockchain-backed web-based solution for frictionless digital document exchange called Wave BL [26]. It enables the instant, encrypted, and authenticated transfer of Bill of Ladings and other vital trade documents.

One of the first startups to introduce smart contracts into the logistics industry was ShipChain. The startup built a comprehensive blockchain system that would track and trace the final product from the moment it leaves the factory till it reaches the final customer. The Ethereum blockchain-based system could encompass all modes of freight. All the shipping information was recorded on the blockchain, and smart contracts could be executed depending on the information recorded. Another key feature of the company was the usage of their cryptocurrency, "Ship Token", which was used for the automated settlement of transactions [27]. In late 2020 the company was shut down by the US Securities and Exchange Commission. ShipChain had committed a violation of securities trading laws and could not recover from its sentence [28].

But also, governmental organizations caught interest in blockchain technology. For example, the Danish Maritime authority launched a pilot project to digitize the ship registration process based on blockchain technology. With the support of Deloitte, they developed a blockchain proof-of-concept and aimed at adapting provisions in the Maritime Act and the Mortgage Bill [29,30].

The Belgium startup T-Mining developed a blockchain application for safer and more efficient container handling for ports. The two Benelux ports of Antwerp and Rotterdam are using the method proposed by the company. It replaces the container handling procedure, which involves the usage of PIN codes, which was in the past subject to fraud, and all associated risks and highly inefficient. T-Mining's blockchain solution uses digital tokens for container release rights, making them much safer, more efficient, and faster [31].

3. TradeLens Case

TradeLens is today the biggest global data-sharing platform in the maritime industry [32]. The success of the company and its blockchain solution already had an advantage due to its nature, being the joint venture of two large enterprises, each of which has been a major player in their respective industries. Despite that, TradeLens is offering an innovative yet novel solution to the maritime ecosystem and is therefore still developing and improving. From the early collaboration between Maersk and IBM and the early initiatives, over prototypes and version testing to the final product was developed over a series of iterations. In June 2021, TradeLens announced that Hapag-Lloyd, the biggest German shipping company, and ONE, Japan's biggest shipping company, were joining the network. At this stage, the platform had already processed over 42 million shipments, 2.2 billion events, and more than 20 million documents [33]. Those numbers increased by nearly 50% till today (Feb. 2022), as seen on the platform activity indicator on the TradeLens website (TradeLens, 2022). As discussed throughout this research, the potential of the blockchain solution is massive. Not only the already mentioned benefits of digitizing trade documents and facilitating data exchange, but it also bears the opportunity for digitalization of the whole supply chain processes. The latest addition to TradeLens network, the successful completion of a letter of credit transaction with HSBC, one of the world's largest bank and financial service providers, and Syngenta, a leading agricultural science and technology provider, using the eBL through blockchain technology [34]. This marks a milestone in the digitization of trade finance and a further increase in supply chain efficiency. Syngenta estimated that the use of TradeLens for a shipment from South Korea to Bangladesh saved ten days of lead time for document processing. This proves even further that TradeLens is providing greater efficiency than traditional paper-based document sharing processes that have been at hand. TradeLens has attracted many large enterprises, namely five of the six largest ocean carriers, major terminal operators, customs authorities, and others. The blockchain-based solution has sparked the interest of many participants in the maritime industry, but still, the general adoption is progressing slowly. Jensen et al. have identified two interrelated causes responsible for the hesitation [14]. First, the general reluctance of investing in technology infrastructure, that is, enabling the use of blockchain platforms before there is an ecosystem to connect to, is holding back the commercialization of TradeLens. The addition of new members is increasing the value of the platform, but without members, the value of the network cannot be fully unfolded. The initial IT investments necessary to join TradeLens are therefore discouraging potential participants. This is indeed a well-known problem that communication technology and innovative networks are facing. They will not gain value if a critical mass does not adopt it. The second cause for slow adoption the authors mention in their article is the hesitancy to share sensitive trade documents with a blockchain solution and trusting this technology that these will remain secure. Although blockchain should ensure potential participants the security of their data, the competitive nature of the maritime industry is making stakeholders inherently skeptical of a data-sharing solution that is being suggested by a rival to share sensitive data.

4. Implications

In this part, the insights provided by the interviews will be connected to the findings from the case analysis of TradeLens. First, it will be discussed if the challenges of SMEs in the maritime industry match the ones that are generally associated with the industry as a whole. Second, the general usefulness and the benefits a blockchain solution could offer will be analyzed. And finally, if the blockchain platform that TradeLens is offering will also be feasible for SMEs.

For the first part, the interviewees generally agreed upon the challenges that need to be tackled in the maritime industry for SMEs.

Climate change as a global and industry-overarching megatrend is a challenge that needs to be overcome by everyone. Also, current events like the invasion of Russia in Ukraine have direct effects on the global economy and, therefore, on the shipping industry as well. But another trend mentioned is the general need for digitization. It is necessary to digitize the paper-based processes and streamline the document exchange while ensuring security along the value chain. This is aligned with the challenges TradeLens is mentioning that it wants to tackle. The main purpose of TradeLens is to facilitate document and information exchange throughout the supply chain.

The second part of the analysis discusses the benefits of the implementation of a data-sharing platform. Especially the container industry was mentioned by one of the interviewees as eligible for the implementation of a data-sharing platform due to the business model and the operations that inherent this mode of transportation. However, while there

is an interest in ship owners and shipping companies to facilitate direct contact with the end customer, the introduction of a data-sharing platform has different effects on other businesses along the maritime supply chain. Especially the businesses that have built their business model around the inefficiencies the industry is subject to will become obsolete through the introduction of such technology. Therefore, the widespread introduction of it will meet resistance.

The final analysis part addresses the actual implementation of TradeLens in shipping SMEs. While the interviews gave great insight into the interest in implementing the solution offered by TradeLens, one could see that SMEs are especially dependent on their customers' implementation. The big shipping enterprises like Hapag-Lloyd and Maersk, which are already customers of TradeLens, are fully integrated companies. Meaning they are not taking care of a single part of the maritime supply chain but have either subsidiaries that are facilitating the pre-and post-shipping processes or doing those themselves. Therefore, it is easier to integrate such data-sharing platforms into their business model.

Summing up the discussion of the interviews and the findings of the case study, TradeLens could offer great benefits to SMEs in the maritime industry. On the one hand, TradeLens is offering operational improvements by reducing paper-based documentation and streamlining the information flows in the maritime industry. Further, security is ensured throughout the documentation. The platform is promoting standards for documentation, which results in less fraudulent and error-prone behavior. Concerns about the data security of the shared information are not only dismissed using blockchain technology, but also the permissioning model supports the controlled sharing between the various parties that are operating along the global supply chain. While the fully integrated large enterprises have already made a step ahead by implementing the TradeLens blockchain solution SMEs are still dependent as a second-mover on the implementation decision of their customers and other stakeholders. This will likely be overcome with a general industry-wide adaptation of blockchain-based data-sharing platforms. As five of the six largest ocean carriers that use the TradeLens solution make up to over two-thirds of the container shipping market, it will only be a matter of time until an industry-wide adoption [35]. Further, the interviewees mentioned some genuine interest after the TradeLens had been proposed to them.

Reverting to the research questions to understand the why and how of blockchain implementation for maritime SMEs, the case analysis gives great insight. From the challenges identified and the validation through the interviews, the general need for digitization in the maritime industry is a key point for SMEs as well. The solution TradeLens is offering is tackling the lack of information flows and documentation structure and is providing the participants with a framework for data sharing. This results in increased operational efficiency, transparency throughout the global supply chain, and reduced costs.

5. Limitations & Future Works

The theoretical nature of the chosen methodology bears the first limitation of this research. Case-based research has the potential to be subject to researcher-induced bias throughout the data collection and the analysis [36]. As mentioned in the methodology chapter, the statistical generalizability is very restricted in the case study approach [37] and therefore, the study does not aim to fully explain every possible aspect of the shipping industry and its stakeholders. Even though practical implications from the case have been drawn and the suggestive actions and investments have been brought forward, they might be subject to missing development of practical application of TradeLens in the given context and the respective significant testing methodology.

Another limitation is the sample group of interviewees. Even though all of them are experts in the chosen field and context, with enough expertise to judge the current situation as well as they have an overview of the industry, they still might be biased to their personal view and therefore, due to the tiny number of experts used to discuss the implication might be biased too.

Despite the limitations of this study, the implications drawn from this case with the combination of the interviews with industry experts not only built a theoretical framework for the implementation of blockchain in SMEs in the maritime industry but also arose some genuine interest in the topic by the questioned interviewees. While the interviewees have heard of the TradeLens blockchain solution and its general purpose, they have not considered its implementation due to the lack of specific knowledge about TradeLens and blockchain applications for the maritime industry. Especially when mentioning the benefits of the solution to the digitization challenge in the industry, the interviewees expressed their interest in TradeLens.

Therefore, future works could dive into two different directions. First, since the number of interviewees was small and insignificant, a questionnaire could be carried out to a greater sample of strategic decision-makers in maritime SMEs. This would help to understand if the interest expressed by the interviewed subjects could be generalized to the industries subgroup. Further, practical implementation in a maritime SME of the proposed solution with field research testing could analyze if the proposed benefits are practical.

Due to the novelty of this blockchain-based platform, TradeLens is continuously evolving and is already disrupting the landscape of the maritime industry. It will likely change the way of data and information exchange and the global supply chain collaboration. Furthermore, the proliferation of this platform and its competitors will open several opportunities for further research in different fields, like asset management, operations, and the industry's economics.

Appendix A. Case Study Approach

A case study approach has been chosen for this research following through the proposed guidance by Yin [37]. A wide range of information has been collected including sources provided by TradeLens, academic papers and two semi-structured interviews have been conducted with strategic industry decision makers.

References

[1] Laurence, Tiana. (2019) Blockchain for dummies, 2nd ed. John Wiley & Sons, Ltd.
[2] Nakamoto Satoshi. (2018) Bitcoin: A Peer-to-Peer Electronic Cash System.
[3] The Economist. (2015). The next big thing. https://www.economist.com/special-report/2015/05/07/the-next-big-thing
[4] Back, Adam. (2017). Announcing Blockstream Satellite. https://blog.blockstream.com/en-announcing-blockstream-satellite/.
[5] Hermann, Sascha, & Prof. Dr.-Ing. Liggesmeyer, Peter. (2018). Blockchain – Eine Technologie mit disruptivem Charakter – Potenziale und Herausforderungen. Gesellschaft Für Informatik, 1.0, 37.
[6] Beck, Roman, Avital, Michel, Rossi, Matti, & Thatcher, Jason B. (2017). Blockchain Technology in Business and Information Systems Research. Business and Information Systems Engineering, 59(6), 381–384. https://doi.org/10.1007/s12599-017-0505-1
[7] Li, Ling, & Zhou, Honggeng (2021). A survey of blockchain with applications in maritime and shipping industry. Information Systems and E-Business Management, 19(3), 789–807.
[8] Loklindt, Christopher, Moeller, Marc-Philip, & Kinra, Aseem (2018). How Blockchain Could Be Implemented for Exchanging Documentation in the Shipping Industry BT - Dynamics in Logistics (M. Freitag, H. Kotzab, & J. Pannek (eds.); pp. 194–198). Springer International Publishing
[9] Wang, Shuaian, & Qu, Xiaobo. (2019). Blockchain Applications in Shipping, Transportation, Logistics, and Supply Chain BT - Smart Transportation Systems 2019 (X. Qu, L. Zhen, R. J. Howlett, & L. C. Jain (eds.); pp. 225–231). Springer Singapore.
[10] Jabbar, Karim, & Bjørn, Pernille. (2018). Infrastructural grind: Introducing blockchain technology in the shipping domain. Proceedings of the International ACM Conference on Supporting Group Work, 297–308.
[11] Jabbar, Karim, & Bjørn, Pernille. (2018). Permeability, Interoperability, and Velocity: Entangled Dimensions of Infrastructural Grind at the Intersection of Blockchain and Shipping. ACM Transactions on Social Computing, 1(3), 1–22. https://doi.org/10.1145/3288800
[12] Jabbar K, Bjørn P. Permeability, Interoperability, and Velocity: Entangled Dimensions of Infrastructural Grind at the Intersection of Blockchain and Shipping. ACM Transactions on Social Computing 2018;1:1–22.
[13] Juniper Research. (2017). IBM Ranked Number One Blockchain Technology Leader. https://www.juniperresearch.com/press/ibm-ranked-no-1-blockchain-technology-leader
[14] Jensen, Thomas, Hedman, Jonas, & Henningsson, Stefan. (2019). How TradeLens delivers business value with blockchain technology. MIS Quarterly Executive, 18(4), 221–243.
[15] IBM. (2017). Maersk and IBM Unveil First Industry-Wide Cross-Border Supply Chain Solution on Blockchain. PR Newswire. https://newsroom.ibm.com/2017-03-05-Maersk-and-IBM-Unveil-First-Industry-Wide-Cross-Border-Supply-Chain-Solution-on-Blockchain
[16] Braden, Dustin. (2017). HMM aims for full blockchain adoption by year-end. https://www.joc.com/maritime-news/container-lines/hyundai-merchant-marine/hmm-aims-full-blockchain-adoption-year-end_20170907.html
[17] Popper, Nathaniel, & Lohr, Steve. (2017, March 17). Blockchain: A Better Way to Track Pork Chops, Bonds, Bad Peanut Butter? New York Times. https://www.nytimes.com/2017/03/04/business/dealbook/blockchain-ibm-bitcoin.html
[18] Rimol, Meghan, & Goasduff, Laurence. (2019). Gartner 2019 Hype Cycle Shows Most Blockchain Technologies Are Still Five to 10 Years Away From Transformational Impact. Gartner. https://www.gartner.com/en/newsroom/press-releases/2019-10-08-gartner-2019-hype-cycle-shows-most-blockchain-technologies-are-still-five-to-10-years-away-from-transformational-impact
[19] Jensen, Thomas, Vatrapu, Ravi, & Bjørn-Andersen, Niels. (2018). Avocados crossing borders: The problem of runaway objects and the solution of a shipping information pipeline for improving international trade. Information Systems Journal, 28(2), 408–438. https://doi.org/10.1111/isj.12146
[20] Groenfeldt, Tom. (2017). IBM And Maersk Apply Blockchain To Container Shipping. Forbes. https://www.forbes.com/sites/tomgroenfeldt/2017/03/05/ibm-and-maersk-apply-blockchain-to-container-shipping/
[21] ACE Department of Commerce. (2018). Cost-Risk Topic - Shipping. https://acetool.commerce.gov/cost-risk-topic/shipping
[22] Bajpai, Prableen. (2017). How IBM And Maersk Will Use The Blockchain To Change The Shipping Industry. Nasdaq. https://www.nasdaq.com/articles/how-ibm-and-maersk-will-use-blockchain-change-shipping-industry-2017-03-06
[23] Allianz. (2021). Safety & Shipping Review 2021.
[24] TradeLens. (2020). Solution Brief - Edition 3.

[25] HMM. (2019). Develop “New-GAUS 2020” in Earnest. https://www.hmm21.com/cms/company/engn/introduce/prcenter/news/1205771_18539.jsp
[26] Wave BL. (2017). ZIM’s Groundbreaking Blockchain-Based Bill of Lading.
[27] Kückelhaus, Dr. Markus, & Chung, Gina. (2018). Blockchain in Logistics. In DHL Customer Solutions & Innovation. https://doi.org/10.26140/anie-2019-0803-0057
[28] Kingston, John. (2020). Logistics provider ShipChain, which built on blockchain, shutting down after big payment to SEC. Freight Waves. https://www.freightwaves.com/news/logistics-provider-shipchain-which-built-on-blockchain-shutting-down-after-big-payment-to-sec
[29] Chambers, Sam. (2017). Denmark trials blockchain to register ships. Splash247. https://splash247.com/denmark-trials-blockchain-register-ships/
[30] Offshore Energy. (2019). Digitalization of Danish Ship Register Closer to Reality. https://www.offshore-energy.biz/digitalization-of-danish-ship-register-closer-to-reality/
[31] Loohuis, K. (2020). Benelux ports use blockchain in major efficiency drive. CompterWeekly.
[32] Louw-Reimer, J., Nielsen, J. L. M., Bjørn-Andersen, N., & Kouwenhoven, N. (2021). Boosting the Effectiveness of Containerised Supply Chains: A Case Study of TradeLens. In M. Lind, M. Michaelides, R. Ward, & R. T. Watson (Eds.), Maritime Informatics: Additional Perspectives and Applications (pp. 95–115). Springer. https://doi.org/https://doi.org/10.1007/978-3-030-72785-7_6
[33] TradeLens. (202). HAPAG-LLOYD AND OCEAN NETWORK EXPRESS COMPLETE TRADELENS INTEGRATION. TradeLens Press Release.
[34] TradeLens. (2022). SYNGENTA AND HSBC COMPLETE PAPERLESS TRADE FINANCE TRANSACTION ON THE TRADELENS PLATFORM. TradeLens Press Release.
[35] Statistisches Bundesamt. (2022). Marktanteile der Top 10 Container-Reedereien weltweit.
[36] Grafton, J., & Mundy, J. (2017). Relational contracting and the myth of trust: Control in a co-opetitive setting. Management Accounting Research, 36(August 2016), 24–42. https://doi.org/10.1016/j.mar.2016.07.008
[37] Yin, R. K. (2018). Case study research and applications: Design and methods. In Journal of Hospitality & Tourism Research (Vol. 53, Issue 5). https://doi.org/10.1177/109634809702100108