

Natalia Wagner

Maritime University of Szczecin
Faculty of Engineering and Transport Economics, Poland
E-mail: n.wagner@am.szczecin.pl

Bogusz Wiśnicki

Maritime University of Szczecin
Faculty of Engineering and Transport Economics, Poland
E-mail: b.wisnicki@am.szczecin.pl

APPLICATION OF BLOCKCHAIN TECHNOLOGY IN MARITIME LOGISTICS

Preliminary communication

UDK: 656.61:005.5]:004.65

JEL classification: M15, O31, O32

Accepted for publishing: October 31, 2019

Abstract

Blockchain technology is mainly implemented in the financial services. However, there are more and more companies from different industries considering the possibility of using this technology. Potential benefits of blockchain are also recognized in logistics management. In sea shipping similar to other transport modes the application of blockchain-based solutions is still a new phenomenon. The paper presents a growing interest in blockchain technology in the area of transport and logistics and in maritime logistics in particular. The main aim of the paper is to classify current and planned applications of blockchain technology in sea shipping. To achieve this goal, two research methods were used: web content analysis and multi-case study. The results show that there are several container shipowners active in the blockchain projects, however, in terms of tonnage, they represent as much as 84% of the world's container fleet. Four main ways of developing blockchain technology in the field of maritime logistics management are distinguished: shipowner's projects, ICT providers' projects, supply chain operators' projects, dedicated consortia projects. The main fields within which blockchain technology is currently tested or already implemented are identified as: contracting and documentation flow (e.g. Bill of Lading), smart contracts, container/cargo track-and-trace, marine insurance, ship register system, bunker tracking system, crew certification system. The results of the paper have some managerial implications. They can help in making strategic decisions by sea shipping companies and maritime logistics operators to decide if it is worth to engage in such projects and choose the best option for themselves.

Keywords: *blockchain, sea shipping, maritime logistics, maritime supply chain management*

1. INTRODUCTION

Blockchain technology offer a new way people and companies exchange value and information over the Internet. The first application of that technology was Bitcoin – a digital asset which works in a distributed data structure based on peer-to-peer network, without the use of any trusted third party (Queiroz, Telles, Bonilla, 2018). Blockchain technology allows the running of small programmes (i.e. smart contracts), which potentially enable trusted automation of contractual relations between trading parties (Hofmann, Strewé and Bosia, 2018). Blockchain technology is

sometimes regarded as a breakthrough achievement that can change the approach to making transactions. Its innovative solutions and expectations regarding the effects are sometimes compared to the scale of changes introduced by the Internet network (Hileman & Rauchs, 2017).

The financial sector remains the most promising application area for blockchain-based tools, however other areas and industries are gradually joining. The five most promising ones that have already invested funds in research and first applications include: financial services, healthcare, land registry, food provenance, automotive (Holden, 2018). It is also among the most important business and technological trends in the area of distribution logistics management (Łapko, Wagner, 2019). The obvious goal of implementing new technology should be to increase the efficiency of maritime logistics processes. Blockchain relates to increased security and speed of transactions and data exchange. Blockchain is a potentially better integration in supply chain management.

The paper collects and analyses the examples of pilots as well as solutions that have been already implemented and classify them in terms of the type of leader and the area of applications in sea shipping. The main aim of the paper is to identify the interest of blockchain-based solutions comparing to other modes of transport and classify areas of testing and implementing blockchain solutions in sea shipping. To achieve that goal three research questions were asked:

RQ1: How big is the interest in blockchain technology in maritime logistics? How it is motivated?

RQ2: Who are the leaders of testing and implementing blockchain-based solutions?

RQ3: What areas in sea shipping have the biggest potential of development blockchain technology?

2. RESEARCH APPROACH

The research method used in this paper falls within the scope of website content analysis and multi-case study. The main research was carried out with the use of two research methods: web content analysis and multi-case study. The first method was used in order to identify the quantity and context of publications dedicated to technology blockchain. The second method allowed for the analysis of several projects devoted to implementation of blockchain technology representative for maritime logistics.

The web content analysis method was used twice in two different scopes of analysis. Firstly, in a wide range of professional web portals monitoring events on the transport and logistics market, secondly in the portals of the largest container shipowners. In both scopes the interest in blockchain technology was measured by the number of times the key term *blockchain* appeared. The starting point for this analysis is the assumption that the interest in blockchain technology among practitioners and managers could be assessed by the number of publications in industry press and professional web portals devoted to the actual market issues. Managers making decisions about implementing a new solution and investing in technological innovation often make their opinion about expected possible results based on information obtained from professional press, industry web portals and conferences, instead of scientific publications published in prestigious journals. Hence the decision to focus in this paper precisely on information provided for practitioners and managers posted on industry websites.

The selection of container shipping companies for the second scope of the web content analysis is motivated by the fact that they are the best integrated in maritime logistic chains (Wiśnicki, 2018). Standard container units in a great way facilitate this integration. The 100 largest container operators listed in the Alphaliner TOP 100 ranking were included in the tested sample. During the research based on the analysis of websites content, it was verified which shipowners publicly disclosed their involvement in blockchain projects, including blockchain-based tests as well as commercial tools.

The multi-case study method was chosen to analyse projects and tests that use blockchain technology in various areas of maritime logistics. The aim is to identify areas of possible blockchain-based applications not only limited to shipping logistics but covering a wider perspective of shipping industry.

3. BLOCKCHAIN-BASED SOLUTIONS IN MARITIME LOGISTICS

3.1. Popularity of blockchain issues in sea shipping industry

Until March 2019 the number of scientific papers indexed in Scopus database concerning blockchain technology in maritime transport in the business and managerial aspect is 5 and 2 of them were classified as conference papers. The first paper in this field was indexed in 2017. The research papers analyse the attitude toward implementation and possible benefits of blockchain technology expected by managers rather than hard evidence whether or not this technology is effective.

The common research method is an interview conducted among managers. In general, they are interested in blockchain technology and are aware of potential benefits offered by it however there is a high amount of uncertainty, awareness of limitations and lack of understanding how the system could be adopted by the whole industry. The doubts expressed concern mainly required organizational conditions needed for the technology to reach industry-wide adoption which is necessary to harness its full potential (Loklindt et al, 2018; Czachorowski, 2019). Similar doubts of executives reveal research devoted to the strategic aspects of blockchain implementation in supply chains not focusing on the specificity of a particular transport branch but rather on the problems in implementing a disruptive innovation (Dobrovnik, 2018; Wang et al., 2019).

The thematic area covering the professional use of blockchain technology in supply chains indexed in Scopus contained much more research papers (81 of which 38 were conference papers) than papers devoted only to sea shipping. These numbers indicate the initial phase of scientific research, in particular with regard to studying blockchain applications in maritime parts of supply chains.

Internationally recognisable maritime logistics web portals and e-magazines were chosen for assessing the popularity of blockchain technology. Additionally, web-based professional portals representative for land and air transport modes were selected. In twelve portals which were the subject of the research (table 1): the first six are devoted strictly to maritime issues, next four (no 7-10) represent air, road and railway transport, two concentrates on supply chain issues (no 11-12) discussed often from the strategic point of view. Among portals there are web versions of traditional paper magazines (e.g. Lloyd's List, Port Technology International, Polska Gazeta Transportowa). Three most popular Polish e-portals were included in the list (no 6, 10 and 12).

The research shows the number of times the term blockchain has appeared in the title or body of the web article. A time period limit was not settled down. The research was conducted on April 8, 2019 and results are presented in table 1.

Table 1 The number of occurrences of the term *blockchain* in selected e-portals

No	Branch information portal	The occurrence of the term <i>blockchain</i>
1.	www.worldmaritimenews.com	416
2.	www.marineinsight.com	205
3.	www.lloyd's list.maritimeintelligence.informa.com	307
4.	www.maritimeprofessional.com	1040
5.	www.porttechnology.org	7350
6.	www.gospodarkamorska.pl	86
7.	www.aircargoworld.com	303
8.	www.trucknews.com	70
9.	www.globalrailnews.com	1
10.	www.rynek-kolejowy.pl	2
11.	www.supplychain247.com	19700
12.	www.pgt.pl	2

Source: Own elaboration based on selected e-portals

Topics regarding the application of blockchain technology were often raised and discussed in the maritime media. Some sea shipping portals pay more attention to technology matters than others. Porttechnology.com gained the biggest number of posts because it is focused on technology matters. The number of mentions on general maritime information portals varied between 205 and 1040. Topics related to the use of blockchain were much more popular for sea shipping than for rail or land transport, but very similar to air transport. The biggest disproportion between sea shipping portals in relation to rail transport is observed, where such a reference appeared only once. Similar dependencies are visible in Polish online media, where the marine-focused portal had 86, and the railway portal had only 2 posts. Among the surveyed e-portals most about the use of blockchain technology was written in the media devoted to supply chain management. Many of those articles were about the effects of new technology on flow of documents and information in a strategic sense, not on the physical flow of goods. In this type of approach, the carrier may represent any branch of transport.

In scientific research papers the topic of blockchain-based solutions in maritime logistics is not frequent at all, whereas on the maritime industry information e-portals is quite popular.

Articles published on sea shipping e-portals and in magazines for practitioners in 2018 mainly announced the creation of new consortia, gaining new partners and plans for carrying out tests and experiments. Many new projects were initiated in 2018, so their results are not yet available. If any information about the preliminary results of tests are made public, it is done in a rather modest form. Analysed articles also discussed doubts and concerns expressed by market experts or managers, mainly regarding market architecture and systemic solutions.

3. 2. Shipowners involvement in blockchain technology projects

In the second part of the research, it was checked to what extent container shipowners are interested in participating in tests and commercial solutions based on blockchain technology. Containership operators listed in the Alphaliner TOP 100 ranking involved in blockchain technology project initiatives with information about the fleet capacity and market share is included in table 2.

Table 2 Containership operators engaged in blockchain technology projects

Position in global ranking	Containership operator	Fleet capacity [TEU]	Share in the global container fleet [%]
1	APM-Maersk	4090930	17,9
2	Mediterranean Shipping Company	3358432	14,7
3	COSCO Group	2804882	12,3
4	CMA CGM Group	2661046	11,6
5	Hapag-Lloyd	1671234	7,3
6	ONE (Ocean Network Express)	1533239	6,7
7	Evergreen Line	1236686	5,4
8	Yang Ming Marine Transport Corporation	682318	3,0
9	Hyunday M.M.	436768	1,9
10	PIL (Pacific International Lines)	417793	1,8
11	Zim	315480	1,4
36	Seaboard Marine	36322	0,16
41	Transworld Group	19884	0,09

Source: Own elaboration based on: alphaliner.axsmarine.com/PublicTop100/ and public information obtained from ship owners' websites and sea shipping information portals listed in table 1

The analysis based on shipowners' websites shows that mainly the market leaders are interested in participation in the development and use of blockchain-based tools. It is significant that the first eleven shipowners are engaged in such projects. Beside them, two more shipowners are interested in this type of solutions - Seaboard Marine (rank 36) and Transworld Group (rank 41). The former joined the platform created by APM-Maersk and IBM, while the latter develops its own solution together with other companies of its own capital group. Shipowners active in the blockchain projects, in terms of tonnage, represent as much as 84% of the world's container fleet. This commitment takes various forms.

The pioneer in the field of blockchain-based digital platform designing for global trade is APM-Maersk, which in 2017 together with IBM began work on creating such a solution called Tradelens. Other entities joined the system in the next stages, such as PIL (ranked 10 in table 1), ZIM (ranked 11) and Seaboard Marine (ranked 36). The entities forming the platform belong to various functional areas of the supply chain. These are: beneficial cargo owners, 3PL, inland transport operators, customs/government authorities, ports and terminals, ocean carriers, financial service providers, software developers (Tradelens, 2019). To get as many new members as possible Tradelens convinced them that their goals will also be met by the given platform. In April 2019, more than 100 organizations participated in the Tradelens platform.

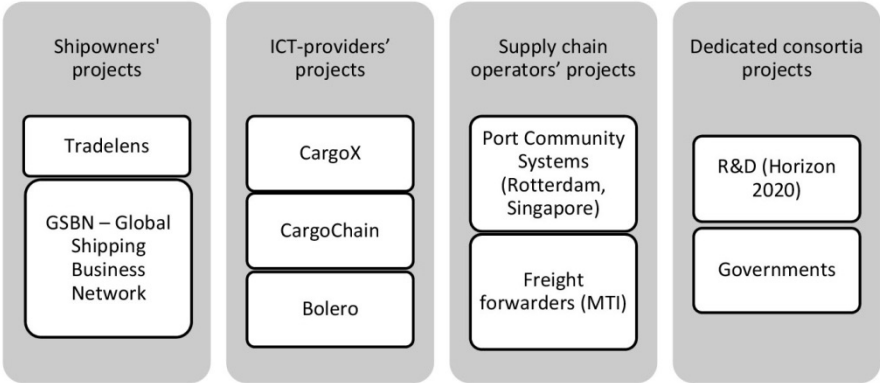
During the construction and testing phase, Tradelens was associated only with one container operator with the largest market potential. This probably raised some concerns among other ship operators regarding the neutrality of this solution. Therefore, the remaining giants in the container market have not decided to join Tradelens but formed the alternative consortium instead. The Global Shipping Business Network (GSBN) was established in November 2018 and is only in the design phase. The consortium includes: CMA CGM, COSCO Shipping Lines, Evergreen Marine, OOCL, Yang Ming, DP World (port operator), Hutchison Ports (port operator), PSA International Pte Ltd, Shanghai International Port, CargoSmart (solution provider). The biggest difference between Tradelens and GSBN approach is the beginning phase of the platform development process. Tradelens was created by one shipowner, and subsequent entities are joining the solution. In contrast, GSBN is not intended to be associated with a single shipowner, but

with a larger number of initiators. The consortium insists that collaboration is the main way of introducing innovation and digital transformation to the supply chain (Baker, 2018).

In addition to the crucial role of container operators in blockchain-based maritime logistics projects, the involvement of ICT companies, ports and different entities participating in the supply chain should be noticed. On the maritime market there are several examples of such different size and scope projects. An example can be Silsal pilot project which in June 2018 tested the capabilities of the blockchain technology to exchange, identify and acknowledge cargo documents and certificates between Abu Dhabi Ports and the Port of Antwerp. The plans are to offer a tool to the trade community as a complementary tool to Maqta Port Community System which is presently in use in Abu Dhabi Ports (MSC, 2018). Another example of successful test can be a pilot made by ocean carrier APL, Kuehne&Nagel, AB InBev and Accenture. Its aim was to eliminate the need for printed shipping documents and create efficiencies and cost savings for the freight and logistics industry (Todd, 2018).

Authors of this paper analysed partners and the scope of current projects, which allowed to prepare their initial classification. Blockchain technology in the field of maritime logistics management can be initiated in various ways, it can distinguished (figure 1):

- shipowner’s projects,
- ICT providers’ projects,
- supply chain operators’ projects,
- dedicated consortia projects.



Source: author’s own.

Figure 1 Initiators of main Blockchain technology projects for maritime market. Classification with examples

Shipowners initiated projects aimed to create universal tool for global container shipping market. This category examples are Tradelens - the tool Maersk is behind, and much wider GSBN consortium. Ibrahim Gokcen, chief digital officer at Maersk, said: “The projects we are doing and with IBM aim at exploring a disruptive technology such as blockchain to solve real customer problems and create new innovative business models for the entire industry” (Groenfeldt, 2017). Consortia always include a technology vendor. In the tool development process more and more participants performing various functions in the supply chain are invited to join a platform.

Projects created by ICT providers aimed to develop “neutral” platform not decisively controlled by any of the entities that use their services. This may be the biggest advantage and most desirable trait that will determine platforms being widely adopted. On the other hand, if the platforms created by ICT companies (often start-ups) are not joined by the market leaders, then it’s

very hard to achieve the market share that guarantee commercial success. The examples of such blockchain-based platforms are: CargoChain, CargoX, Bolero International.

Supply chain operators' projects partners are initiated by main actors serving the door-to-door maritime logistics services, e.g. port and intermodal operators, freight forwarders. Container operators are included in projects to the extent that results from their role in the supply chain. The example of such a platform is Calista – a tool created, among others, by the port in Singapore.

Last category of dedicated consortia projects is not unambiguous to define. Shipowners are not always the initiators, but they play very important role in the proof of concept stage. Project tests and experiments are conducted by consortia incorporating research institutions, governmental institutions, digital technology developers, ports and other market entities. Their main aim is to test a solution in particular conditions not to develop an industry-wide tool.

Regardless of the way blockchain-based technologies are developed and implemented in the maritime logistics, the concerns expressed by the managers are similar. The most important are (Baker, 2019a, 2019b):

- lack of standards of interoperability between rival platforms which would enable them to integrate,
- lack of critical mass, which would be measured not only with number of shipping operators, but also other entities which cooperate with them in supply chains,
- lack of jurisdiction. It is not known how a dispute would be settled.

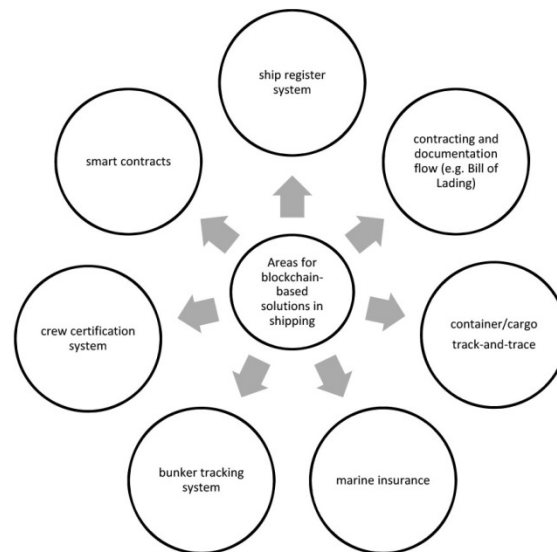
One of the biggest obstacles that can cause too little interest of entities in using blockchain technology tools is the lack of interoperability and common standards between applications. However, there are some signals on the market that indicate taking steps to counteract this practice. A new association – Digital Container Shipping Association (DCSA) was established in April 2019 by four funding members: A.P. Moller-Maersk, Hapag-Lloyd, Mediterranean Shipping Company and Ocean Network Express. Its aim is to promote common information technology standards across the container shipping industry (Hapag-Lloyd, 2019). The initiators recognize the need for a neutral body acting in favour of all participants in the maritime logistics. They claim to work for digitalisation, standardisation and interoperability in the sea shipping industry. The association was created for all IT solutions, not only for blockchain.

There are also other examples of initiatives which aim to encourage the use and adoption of blockchain-based solutions and develop industry standards. Another example of association from transport market is BITA - Blockchain In Transport Alliance. Also World Economic Forum (WEF) noticed that blockchain technology could bring transparency to the fragmented supply chain industry. WEF announced a new initiative *Redesigning Trust with Blockchain in the Supply Chain* to ensure blockchain technology is deployed in an "interoperable, responsible and inclusive way". Among the participants there are for example: APM-Maersk, Port of Rotterdam or Port of Los Angeles (World Economic Forum, 2019).

It turns out that although all entities see the need for integration and standardization, not only several similar platforms are created, but also many associations and initiatives that are to harmonize the rules of cooperation on the market.

3.3. Areas of blockchain technology applications in maritime industry

Support from blockchain technology for maritime industry does not only cover the creation of ICT solutions allowing efficient supply chain management, facilitating paperless documents flow in particular. Different areas of maritime business are also included in the process of implementing up-to-day information technologies. Figure 2 presents the main fields within which blockchain technology is currently tested or already implemented.



Source: author's own.

Figure 2 Maritime industry areas in which blockchain technology is developed

One of the applications is the blockchain platform for the insurance sector. The first such platform is called Insurwave and was developed in collaboration of APM-Maersk, Ernst&Young (EY) and their partners (blockchain company Guardtime, Microsoft Azure, broker Willis Towers Watson and insurers MS Amlin and XL Catlin). The aim of the platform is to integrate information from clients, brokers, insurers and third parties with insurance contracts in a standardised, secure and transparent format (Faulkner, 2017). As in the case of applications in maritime logistics, here also the involvement of the largest container shipowner allows testing the solutions immediately on a large scale. The platform was launched in 2018 and is supposed to support more than half a million automated ledger transactions and help manage risk for over 1000 commercial vessels in the first year of its activity (EY, 2018).

Another pilot solution for sea shipping industry is the blockchain-based seafarer certification system. The demonstrator project is funded by the Lloyd's Register Foundation through a consortium called Maritime Blockchain Labs. The aim of the tested tool is to help tackle a number of seafarer documentation issues. It is mainly in interest of crew agencies, shipowners, training and education entities, regulatory bodies and seafarers themselves (Clayton, 2018).

The subject that has been also tested within blockchain technology pilots is bunker tracking. In this type of projects, the Maritime Blockchain Labs works in cooperation with shipowners such as NYK and CMA CGM and Port of Rotterdam. Biofuel was used. The aim of conducted demonstrations was to test the ability of end-to-end traceability of marine bunkering transactions from storage to the vessel's fuel tank, thereby providing assurance to shipowners and charterers (MBL, 2018).

The next area in which the blockchain tests are carried out is a ship register. The first classification society that decided to make such an attempt has very long tradition and is well known on the maritime market. Lloyd's Register of Shipping announced the launch of prototype blockchain-enabled class register in September 2018. The idea is that the blockchain-based ship register in a form of a platform provides trusted and up-to-date information on ships, which enables more efficient execution of many transactions on the market, such as financing, insurance and payments (Lloyd's Register, 2018).

Another example of blockchain-based digital platform is shipowner.io which is created for financing assets in the sea shipping industry. This tool is a little bit different than other solutions because it runs on tokens and use Ethereum smart-contracts governed eco-system. It claims to be an offer for everyone who would like to invest in maritime assets (Shipowner.io, 2018). Very similar idea has been developed by Value on Chain start-up, which created a platform built on blockchain that will enable investing in sea shipping assets. For shipowners it means lower costs than a traditional IPO and flexibility to offer part of one ship to the investment community, rather than enter the entire company to the stock exchange (Lowry, 2018).

4. CONCLUSIONS

Based on the analysis of the state and perspectives of blockchain technology implementation in maritime logistics management conclusions can be formulated that allow for the answer to previously formulated research questions.

Shipping company management toward the widespread use of digitization and future technologies is one of the most important challenges faced by the maritime industry. The implementation of blockchain technology in maritime logistics is still in the early stages. Currently, we can talk about single implementations and some preparations to establish a market standard. There is a great interest in this technology of containership shipowners, much bigger in comparison with operators and carriers representing other branches of transport. This disproportion of operators' approaches can result in the diversity in the whole supply chains.

Motivations of leaders and members of project consortia testing blockchain technology seem different and are not always possible to determine. One of the significant motivations seems to be the desire to improve the competitive position on the market and the company's image. The implementation of blockchain technology is undoubtedly a common trend and is positively perceived by customers of carriers and logistic operators.

Containership operators are the leaders or key partners of most consortia implementing technologies in maritime logistics. It is determined by their role in the supply chain. Among the leaders of project teams are also ICT providers and operators of intermodal supply chains. Implemented solutions, although tested on a smaller scale, ultimately have a global reach and an unlimited number of users.

The analysed projects are currently at the stage of technology development, testing in small scale real-market conditions or expanding the group of project participants. Blockchain development potential depends on meeting specific technical requirements (level of process digitization) and on openness for transparency connected with IT systems (common databases and share of smart contracts). The fastest implementations in the entire supply chain are possible in case of ownership links between entities operating on a given market, for example in the form of alliances and sub-market holdings.

REFERENCES

- Baker, J., (2018). Leading carriers launch new blockchain platform. *Lloyd's List*, 06.11.2018
- Baker, J., (2019a). Blockchain faces hurdles before widespread adoption. *Lloyd's List*, 11.03.2019
- Baker, J., (2019b). Standards will be key to success of blockchain in shipping. *Lloyd's List*, 08.02.2019
- Clayton, R., (2018). Industry partners eye blockchain records for seafarer certification. *Lloyd's List*, 11.12.2018
- Czachorowski, K., Solesvik, M., Kondratenko, Y. (2019). The Application of Blockchain Technology in the Maritime Industry. In: Kharchenko, V., Kondratenko, Y., Kacprzyk, J. (eds.) *Green IT Engineering: Social, Business and Industrial Applications. Studies in Systems, Decision and Control*, vol 171. Springer, Cham, 561 – 577

- Dobrovnik, M., Herold, D.M., Fürst, E., Kummer, S. (2018). Blockchain for and in Logistics: What to Adopt and Where to Start. *Logistics*, 2, 18.
- Ernst & Young. (2018). World's first blockchain platform for marine insurance now in commercial use, 25 May 2018, https://www.ey.com/en_gl/news/2018/05/world-s-first-blockchain-platform-for-marine-insurance-now-in-co [accessed 18.03.2019]
- Faulkner, M., Marine insurance blockchain platform launched. *Lloyd's List*, 06.09.2017
- Groenfeldt, T., (2017), IBM and Maersk Apply Blockchain to Container Shipping. *Forbes*, 05.03.2017.
- Hapag-Lloyd. (2018). Corporate Development, presentation at Capital Markets Day, Hamburg, 21.11.2018, www.hapag-lloyd.com [15.02.2019]
- Hapag-Lloyd. (2019). Digital Container Shipping Association established, <https://www.hapag-lloyd.com/en/press/releases/2019/04/digital-container-shipping-association-established.html> [accessed 14.05.2019]
- Hileman, G., Rauchs, M. (2017). Global Blockchain Benchmarking Study, University of Cambridge Judge Business School
- Hofmann, E., Strewe, U. M., Bosia, N. (2018). Supply Chain Finance and Blockchain Technology. The Case of Reverse Securitisation, Springer
- Holden, W., (2018) 5 Industries That Will Fuel The Blockchain Boom, Juniper Research White Paper, <https://www.juniperresearch.com/document-library/white-papers/5-industries-that-will-fuel-the-blockchain-boom> [accessed 20.02.2019]
- Łapko, A., Wagner, N. (2019). Distribution logistics. Trends, challenges, examples, CeDeWu, Warszawa [in Polish]
- Lloyd's Register. (2018). Classification register updated for the digital age, <https://www.lr.org/en/latest-news/classification-for-the-digital-age/> [accessed 01.03.2019]
- Locklindt, C., Moeller, MP., Kinra, A. (2018). How Blockchain Could be Implemented for Exchanging Documentation in the Shipping Industry, In: Freitag M., Kotzab H., Pannek J. (eds.) *Dynamics in Logistics. LDIC 2018. Lecture Notes in Logistics*. Springer, Cham
- Lowry, N. (2018). First shipping blockchain 'IPO 2.0' forecast for 2019, *Lloyd's List*, 15.03.2019
- MBL. (2018). GoodFuel Marine and BLOC Announce World's First Bunker Delivery Using Blockchain Technology, Marine Blockchain Labs, www.maritimeblockchainlabs.com/ [accessed 12.03.2019]
- MSC. (2018). MSC embarks on another innovative project to test the capability of blockchain technologies in the container shipping sector, <https://www.msc.com/rou/news/2018-october/msc-and-abu-dhabi-ports-explore-international-bloc> [accessed 20.02.2019]
- Nightingale, L. (2018). Major box carriers unite to drive digital harmonisation. *Lloyd's List*, 14 Nov 2018
- Queiroz, M.M., Telles, R., Bonilla, S.H., (2018). Blockchain and supply chain management integration: a systematic review of the literature. *Supply Chain Management: An International Journal*, <https://doi.org/10.1108/SCM-03-2018-0143>
- Shipowner.io. (2018). Be a SHIP Owner. Anyone. Anywhere. Anytime. Whitepaper, www.shipowner.io/whitepaper [accessed 05.04.2019]
- Tan, H. H, PSA-backed trade platform takes off on desire to cut red tape, *Lloyd's List*, 03.04. 2019
- Todd, S. (2018). APL, Kuehne+ Nagel, in successful blockchain test, *Lloyd's List*, 16.03.2018
- Wang, Y., Singgih, M., Wang, J., Rit, M. (2019). Making sense of blockchain technology: How will it transform supply chains? *International Journal of Production Economics*, Vol. 211, 221-236
- Wiśnicki, B., Milewski, D. (2018). Assessing the Economical Efficiency of Intermodal Chains in Global Trade. GLOBMAR 2018, SHS Web of Conferences 58, 01032 (2018)
- World Economic Forum. (2019). Redesigning Trust: Blockchain for Supply Chains. <https://www.weforum.org/projects/redesigning-trust> [accessed 15.05.2019]