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DEMATERIALISATION OF BILLS OF LADING USING BLOCKCHAIN FROM THE LEGAL PERSPECTIVE

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Abstract: Dematerialisation of bills of lading is an important topic from the point of view of maritime transport practice. There are many arguments in favour of dematerialisation, such as simplification and acceleration of trade. Over the years, many attempts have been made to dematerialise bills of lading using EDI systems. All of them were found to be lacking. It was not until the spread of blockchain technology that adequate tools were found. The blockchain makes it possible to meet the requirement of singularity which was haunting the EDI systems. With the introduction of proper provisions of law and if the maritime transport industry could agree on a mutually compatible standard, blockchain-based bills of lading could successfully replace paper bills of lading.

Keywords: bill of lading, blockchain, maritime law, maritime transport.

1. INTRODUCTION

This paper argues that successful dematerialisation of bills of lading is a much-needed step in the further development of maritime transport practice. There are many arguments in favour of dematerialisation, such as simplification and acceleration of trade, and better protection against theft, destruction or counterfeiting of documents. The fact that the bill of lading is very often used in international trade between very different legal systems means that its dematerlisation, despite attempts made, has not spread in the maritime transport industry, nor has it resulted in legislative changes that would enable its popularisation. Alongside the problems that are rooted in the "internationality" of the bill of lading, there is also the problem of inventing the proper technological solutions that would allow the dematerialisation of the bill of lading. The bill of lading, as a security, is very often traded on an international scale, especially in the oil transport industry. It has certain specific requirements that make the simple dematerialisation of this document impossible using only the computers and the Internet itself while maintaining all of its advantages and features, but eliminating its disadvantages rooted in the current physical form. It was not until the blockchain revolution and the popularisation of this technology by the cryptocurrency named Bitcoin that adequate tools were found.

These tools gave hope that the bill of lading after hundreds of years of existence in the form of a record on paper can finally be dematerialised. For these reasons, the problem of dematerialisation of bills of lading deserves an in-depth analysis from the legal perspective.

The article consists of three main parts. First, the regulations and industry practices regarding paper bills of lading were analysed. Then, the previous attempts to dematerialise bills of lading through EDI systems are described. The next section examines the possibility of dematerialising a bill of lading using blockchain technology. The purpose of this article is to identify and analyse the reasons why the dematerialisation of the bill of lading is necessary, and to explain why solutions from before the blockchain era were insufficient and whether blockchain may allow the popularisation of the bill of lading in a new form. The two research methods that were primarily used in the work are the dogmatic-legal method and the sociological method.

2. NECESSITY OF DEPARTURE FROM THE PAPER BILL OF LADING

The genesis of the bill of lading dates to the beginning of the 12th century [Niels-Philip 2020]. In the Mediterranean Sea, the practice of using bills of lading was developed in the 13th century [Łopuski and Dragun-Getner 2016], but they did not gain legal significance until the 16th century, when, for example, clauses on the condition of the goods or clauses limiting the liability of the carrier were introduced into them [Murray 1983]. The bill of lading in a form much like the modern bill of lading was created in the 19th century [Niels-Philip 2020].

The contemporary bill of lading in the Polish doctrine of maritime law is: a unilateral document confirming the carrier's acceptance of the cargo indicated on the bill of lading from the shipper for its transportation by a seagoing vessel; it includes the carrier's obligation to deliver the cargo to an authorised person on the basis of the bill of lading, who has the right to dispose of the cargo during transport and to collect it [Łopuski and Dragun-Getner 2016].

It should be noted that the exact definition of a bill of lading and its legal nature may differ depending on the country. The bill of lading in American maritime law is considered a contract between the owner of the cargo and the carrier [Beecher 2006]. In the Polish doctrine of maritime law, the view that the bill of lading is a contract of carriage is considered completely unjustified based on the Maritime Code [Maritime Code 2001; Łopuski and Dragun-Getner 2016].

The Maritime Code, in article 134 §1, distinguishes three types of bills of lading: straight bill of lading (pol. *konosament imienny*), order bill of lading (pol. *konosament na zlecenie*), and bearer bill of lading (pol. *konosament na okaziciela*). It is also consistent with the types of bills of lading, for example, in the Anglo-Saxon system of maritime law [Ong 2018]. Due to the differences between the various national legal systems, it is generally considered to have the following

characteristics: "1) a contract for the carriage of goods, 2) an acknowledgment of their receipt, and 3) documentary evidence of title" [Zekos 2021].

As can be seen, in Polish maritime law, the bill of lading does not have the first feature, but it does have the other two [Łopuski and Dragun-Getner 2016]. The third feature is particularly important from the point of view of economic transactions. It allows the introduction of an order bill of lading and bearer bill of lading (in Poland also a straight bill of lading) into the commercial transactions.

This gives the holder of the bill of lading, if the ownership of the goods has successfully transferred to him or her in accordance with the contract, the right to dispose of the transported goods during transport, the right to collect the goods from the carrier or use the possession of cargo as security for the credit granted, which is a very common practice [Łopuski and Dragun-Getner 2016]. In Poland, a bill of lading is considered a security [Łopuski and Dragun-Getner 2016].

Bills of lading generally take paper form due to an insufficient legal framework which does not provide sufficient legal certainty for trading, and raises concerns that the court might challenge an electronically issued bill of lading, as in the *Glencore International AG* case. In this case, the court questioned the possibility of replacing the paper bill of lading with an electronic system and ruled against Glencore, which was the victim of theft of goods with the PIN code used to authorise the receipt of goods instead of a paper bill of lading [Skopec 2017]. Paper bills of lading have many disadvantages. One of the most obvious is the theft of the bill of lading or its falsification in order to obtain goods from the carrier or obtaining a letter of credit for a falsified bill of lading [Shope 2021]. Delays in the transport of paper bills of lading are also a huge problem. They sometimes reach up to a year [Albrecht 2019]. The developed practices such as the use of letters of indemnity in case of delays do not fully solve the problem and are burdensome [Albrecht 2019]. Paper bills of lading are also an expensive solution to use.

According to the research, the implementation of blockchain technology (details later in the article) by the maritime transport industry would potentially reduce customs costs by up to USD 300 [UNCTAD 2018, p. 15] and significantly reduce the interaction between employees of different entities, and thus reduce the manpower needed to process and send documents. In 2014, an investigation by the transport company Maersk found that one container could necessitate up to 200 interactions between employees of different companies involved in some way in its transport [Ganne 2018]. Another study by Boston Consulting Group found that about 5,000 interactions with a text field containing data are needed for a single trade transaction, and only 1–2% of them are activities involving the creation of some new, needed data, while between 85% and 90% of these interactions are ignoring the message or redirecting it to another entity involved in the transaction [Boston Consulting Group 2017, p. 5].

The problems of paper bills of lading can be solved by electronic bills of lading. For an electronic bill of lading to replace a paper bill of lading, it should possess two

features that a paper bill of lading has: the inability to make duplicates (singularity/uniqueness requirement); creating the possibility for the entitled person to transfer the bill of lading to other persons so that only one person can obtain such rights at a time, while maintaining the ability to prove title to the rights expressed in the electronic record [Łopuski and Dragun-Getner 2016]. Files saved in electronic form can be copied indefinitely until the free memory on a given data carrier is exhausted. This raises concerns that if an unauthorised person accesses such a file-based bill of lading, an almost infinite number of duplicates of the same document could be created. The second issue is the possibility of transferring such a document to other persons and the legal force of such a transfer, which would allow the documentary possession of the goods to be effectively transferred in the eyes of the law. Despite continuous technological progress, this has proven to be a very difficult task, which has not yet been solved in a way that is acceptable to most of the maritime transport industry.

3. SHORTCOMINGS OF BILLS OF LADING IN EDI SYSTEMS

One of the attempts to introduce electronic bills of lading was EDI systems, i.e. Electronic Data Interchange. This system, through a register provided by a third party, enables the transfer of the bill of lading in the form of an Electronic Transferable Record [Ong 2018]. The Electronic Transferable Record contains a reference to the register where the data of the person who can control this electronic bill of lading is recorded [Ong 2018].

EDI systems operate only based on contractual relations, because there are no mandatory provisions of law that would directly allow the use of such systems as substitutes for paper bills of lading [Łopuski and Dragun-Getner 2016]. An example of an EDI system serving as a register allowing for the dematerialisation of bills of lading is the Bolero system (Bill of Lading Electronic Registry Organization). This system is based on the Bolero Rulebook First Edition, which is a multilateral agreement [Albrecht 2019], for which English law is applicable [Bolero International Limited 1999, p. 12]. The Bolero system consists of two registers: the Core Messaging Platform (BCMP), which is responsible for communication between users and issuing commands [Bolero International Limited 199, p. 5], and the Title Registry (BTR), in which the status of bills of lading, called Bolero Bill of Lading is recorded [Bolero International Limited 1999, rule 1.1.51].

To provide the Bolero Bill of Lading with the possibility of transferring the documentary evidence of title and other features typical of paper bills of lading, the Bolero Rulebook defines the obligations of users of this system. Users declare that their digital messages transmitted via the Bolero system will have the same effects on them as if they had been expressed in writing. This includes the BBL Text (document part of the Bolero Bill of Lading) [Bolero International Limited 1999, rule 1.1.6], for example, the carrier is obliged to consider its declarations expressed

in BBL Text as being as binding as those in the paper bill of lading [Bolero International Limited 1999, Rule 3.1.3]. By assigning an appropriate role in the Bolero system, the Bolero Bill of Lading is transferred with, at least in theory, the same effect as the transfer of the paper bill of lading [Bolero International Limited 1999, rule 3.1.4]. Bolero International, acting as the carrier's agent, then carries out the act of attornment required by English law. The attornment is the formal transfer of the constructive possession to the new holder of the Bolero Bill of Lading [Bolero International Limited 1999, Rules 3.4.1 and 3.4.2]. The transfer of contractual and property rights is performed using novation [Bolero International Limited 1999, rule 3.5]. The carrier shall deliver the goods to the holder of the Bolero Bill of Lading, who shall present the Bolero Bill of Lading to the carrier in accordance with the rules of the Bolero Rulebook [Bolero International Limited 1999, rules 1.1.51 and 3.6].

In 2003, the main reasons for the lack of popularisation of electronic bills of lading systems were the insufficient infrastructure, market, and partners, as well as insufficiently clear or adequate legal frameworks [UNCTAD 2003, p. 27]. It should be noted that in 2003, the Bolero system had already existed for 4 years. Since 1999, it has been operating on the same, unchanged rules from the Bolero Rulebook First Edition. Since 2003, there have been no major changes in this matter, and EDI systems of electronic bills of lading still have many disadvantages that prevent them from spreading in the maritime transport industry. One of the main disadvantages of EDI systems is their hermetic nature.

The EDI system is usually based on one entity that has created the appropriate software and contractual framework and ensures the operation of the system by providing servers through which communication and data recording take place. This effectively necessitates a subscription-based business model being used for EDI systems, which is recognised as one of the main reasons why EDI systems have not been accepted by the maritime transport industry [Ganne 2018]. Any entity involved in the carriage of the given goods would have to be registered in the same closed system to be able to carry out all operations in which the bill of lading is used. The chances are very low that each contractor will use the same, closed EDI system, which involves the obligation of a paid subscription, as shown by the fact that no EDI system has entered more widespread use in the maritime transport industry.

Another disadvantage of EDI systems is the centralisation. Focussing the electronic bill of lading system in the form of a centralised registry exposes the entire system to typical threats that are the same for any centralised registry – failures, unauthorised manipulation, and blocking of the data by hackers [Zetsche, Buckley and Arner 2017]. Entities using these systems expose themselves to the risk, for example, of handing over goods to an unauthorised person, because a centralised EDI system does not guarantee singularity, but is only a kind of circumvention of singularity, and thus introduces uncertainty of trading due to the possibility of a court ruling to the detriment of one of the parties to the transaction, contrary to what the court would rule if paper bills of lading were used in the given case [Herd 2018].

The transferability of documentary evidence of title based on electronic bills of lading recorded in an EDI system is also questioned. It is alleged that, at least on the basis of English common law, the electronic bill of lading in the EDI system is not really transferable, because the system – or rather the register – on which the system is based only changes the data of the person who has control over the electronic record, and does not "deliver" the electronic record from one entity to another, which would allow the transfer of property and contractual rights [Ong 2018]. All of these shortcomings have directed researchers, and even some transport companies, towards the further search for a way to dematerialise bills of lading. Many researchers are proposing to create a system of electronic bills of lading in a blockchain distributed ledger.

4. BLOCKCHAIN REVOLUTION

Blockchain distributed ledger technology, which has gained wider recognition thanks to the Bitcoin cryptocurrency, is currently probably the best available technology that allows dematerialising bills of lading. This need is recognised by the maritime transport industry. Electronic bills of lading systems based on blockchain technology are already being created, such as Tradelens [Tradelens "Tradelens eBill…"] and CargoX [CargoX].

The technical side of the operation of blockchain distributed ledger systems (hereinafter referred to as blockchain) requires clarification. Blockchain is a chronological record of transactions stored in a distributed network of computers [Peters and Panayi 2015]. The name blockchain comes from the blocks in which transactions are grouped and saved (for example, issuing or transferring a bill of lading), and on the basis of these blocks, the network checks whether new activities (in the case of cryptocurrencies – transfers, and in the case of bills of lading – for example, their transfer to another entity) are valid [Peters and Panayi 2015]. This system can be compared to a series of indoses, which are required by the Polish Maritime Code to transfer the order bill of lading [*Maritime Code* 2001, art. 144 § 3]. An indos is usually a note on the paper-based security written by the owner named in the order bill of lading, that he or she transfers the bill of lading to another, named person [Łopuski and Dragun-Getner 2016]. The network checks whether the sequence of previous actions in the previous blocks caused the person to have a specific value assigned to his or her private cryptographic key [Peters and Panayi 2015]. Similarly, it is checked whether the holder of the order bill of lading is its legal holder – checking whether an uninterrupted series of indoses leads to this holder [*Maritime Code* 2001, art. 144 § 3].

Already at this stage, one can see the extraordinary similarity of blockchain to legal solutions known for a long time not only in Polish maritime law but also in German or once also in English law [Eckard 2004]. Once a block is filled, it is closed and stored in the network at the end of a chain in the blockchain, but only when the

network reaches a consensus on the validity of the transaction, and the transaction becomes valid only when it is included in the block published on the network [Peters and Panayi 2015]. Computers participating in the network, called nodes, contain identical copies of the entire blockchain [Nærland et al. 2017]. In the event of an attempt to change the information contained in the blocks, for example, to obtain unauthorised cryptocurrency, or more appropriate to the subject of this article, the bill of lading, hackers would have to change this information in copies of blocks on nodes responsible for more than 50% of the computing power in the network [Niels-Philip 2020].

Each node performs advanced, resource- and energy-intensive mathematical calculations to validate blocks [Nærland et al. 2017]. In the case of Bitcoin, nodes are rewarded in Bitcoins for their work [Nærland et al. 2017]. Blockchain systems can be divided into permission blockchains and permissionless blockchains [Peters and Panayi 2015]. In a permissionless blockchain, any person can participate without the consent of a third party, i.e., they can read the content of blocks, process the transactions (validate the blocks) in exchange for remuneration, and perform actions recorded in blocks [Peters and Panayi 2015]. In the case of a permission blockchain, blocks can only be approved by nodes which have been granted permission to do so by a central manager or a differently defined decision-making group [Peters and Panayi 2015]. Permission blockchains can be further divided into public and private systems. In public systems, each node can read the contents of blocks and perform actions on the network, and in private systems, only authorised nodes can do this [Peters and Panayi 2015].

Blockchain-based bills of lading have many advantages that make them a likely successor to paper bills of lading as well as electronic bills of lading in EDI systems. First of all, blockchain by its nature is difficult to counterfeit or take over by a third party, for example, to obtain a letter of credit or receive goods. A potential fraudster or thief would have to make the nodes representing more than 50% of the computing power in the network recognise that he or she is the rightful owner of the bill of lading (the so-called 51% attack). In the case of a geographically distributed network of nodes, which a permissionless blockchain should theoretically be, this would be difficult. Unfortunately, this does not apply entirely to a permission blockchain network, where such a cyberattack on nodes in the network would be easier, due to the usually much smaller number of nodes in the network [Peters and Panayi 2015; Wang 2021].

Blockchain bills of lading are also much cheaper than paper ones, both in terms of their issuance and handling. Issuing a paper bill of lading can cost between $350 and $500, while issuing an electronic bill of lading on the CargoX platform costs $15 [Peronja, Lenac and Glavinović 2020]. Paper bills of lading are most often transported by delivery companies, and the cost of sending a bill of lading by courier is determined at 35–100 USD [Peronja, Lenac and Glavinović 2020]. In the case of an electronic bill of lading on the CargoX platform, there are no shipping costs,

because the transfer is carried out electronically and at least in the case of this platform, it is free of charge [Peronja, Lenac and Glavinović 2020]. Blockchain electronic bills of lading are also very fast. For example, CargoX claims that transferring a bill of lading on their platform takes place in a matter of seconds [CargoX], while transferring a paper bill of lading takes up to 10 days under standard conditions [CargoX], and delays of up to a year are not unheard of [Albrecht 2019].

With the help of blockchain, some of the disadvantages of EDI systems can also be bypassed. First of all, thanks to the decentralisation of the network, the entire system is more resistant to various types of failures, such as power cuts, especially in the case of the permissionless blockchain network, where a large number of nodes are decentralised [Peters and Panayi 2015] and a power failure in one region will only limit the computing power of the entire network, instead of turning it off. The essence of introducing amendments to permissionless blockchain systems, through so-called hard forks, i.e. putting them to the vote, in which the vote is cast through, for example, updates to the software used to operate the network, such as in the Ethereum network, means that the chances of abuse on the part of the entity that manages a given network are also much lower because they can meet with opposition from nodes which will lead to a split in the network, resulting in the creation of two separate blockchain systems [Kiffer, Levin and Mislove 2017]. Unfortunately, this cannot be guaranteed in the case of the permission network, where the entity managing the network by giving and taking permits to work on the network has much more control over individual nodes and users. Blockchain also makes it much more likely that the courts will recognise that electronic bills of lading stored in the blockchain meet the requirement of document singularity because due to its structure, resembling a sequence of indos, it has eliminated the possibility of duplicating an electronic document indefinitely and guarantees that only one person can own and dispose of a given bill of lading at a time.

Despite the many advantages, blockchain also has disadvantages. First of all, blockchains are very energy-intensive. One transaction in the Ethereum network consumes as much electricity as 3700 Visa payment card transactions [Brosens/ING 2017]. There are already proposals for alternative, much less energy-consuming ways of making calculations in the blockchain network [Brosens/ING 2017]. An unlikely but inconceivable problem, the so-called 51% attack, where 51% of the network's computing power tries making changes to it in order to gain unfair benefits, needs to be solved [Niels-Philip 2020]. There are already proposals for solutions that allow making changes in the blocks only when over 99% of computing power is attacks the network [Ganne 2018]. Another key issue remaining to be solved is the compliance of blockchain systems with personal data protection regulations and anti-money laundering regulations. It is virtually impossible to delete data once saved in the blockchain, so a possible solution to the problem of personal data protection is data encryption [Hwaidi 2018].

The already existing electronic bills of lading platforms based on blockchain have not been successful so far. Only 10 national customs institutions are enrolled in Tradelens, based on a permission blockchain [Tradelens „Ecosystem…"]. Tradelens also replicates other shortcomings that electronic bills of lading had in EDI systems, such as a closed, membership-based ecosystem that prevents the use of electronic bills of lading in relationships with partners who are not Tradelens members [Wang 2021]. CargoX and Wave are other (after Tradelens) [O'Dwyer 2021] electronic bills of lading systems accepted by the International Group of P&I Clubs [CargoX 2020; Wave 2020]. As they are based on permissionless blockchains, they do not require membership [Wang 2020].

The lack of mass popularisation of any of the blockchain bills of lading platforms is seen as caused by the fragmentation of the electronic bills of lading platforms market and their incompatibility with each other, and in the lack of clear legal provisions recognising electronic bills of lading in this form [Wang 2020]. It seems like a good idea to call for the creation of several mutually compatible platforms with very low membership thresholds (for example, a printout from the register of entrepreneurs) by entities independent of the largest players on the maritime transport market [Albrecht 2019]. Such a project is already being created – the International Port Community Systems Association is creating a blockchain-based system, one of the functions of which will be blockchain bills of lading. China-based Alibaba has already declared joining this system [IPCSA 2020]. In addition, it may be worth considering creating such a system on the basis of an already existing (or one that is yet to be created) blockchain system with the function of a smart contract, such as Ethereum, which would allow for significant decentralisation of nodes and solve the problem of rewarding nodes for their work in the network. The creation of a blockchain bill of lading system based on Ethereum is already voiced in the doctrine [Niels-Philip 2020].

Even the best blockchain bill of lading system that is most accessible to all may not enter general use in the absence of appropriate legal regulations [Takahashi 2016] recognised by most countries in the world, which is currently the case. The United Nations Convention on Contracts for the International Carriage of Goods Wholly or Partly by Sea of 2008, referred to in Poland as the Rotterdam Rules, would regulate and probably allow the use of transferable bills of lading in blockchain systems because, with their proper configuration, they meet the requirement of functional equivalence expressed in Article 9 of the Rotterdam Rules [Takahashi 2016].

Unfortunately, this convention has not entered into force in any of the countries that have signed it [UNCITRAL 2017], and even if it did, national regulations would still have to specify the procedural aspects of electronic bills of lading or leave it to the parties to determine in a contractual form [Albrecht 2019]. In addition, the Model Act on Electronic Negotiable Records of 13 July 2017 [UNCITRAL 2017] [hereinafter: Model Law] developed by the UN Commission on International Trade

Law can also contribute to further development in the field of electronic blockchain bills of lading by influencing the national legislatures of individual states [Takahashi 2016].

The Model Law is based on three principles: the principle of non-discrimination of electronic communications in Article 7(1), the principle of technological neutrality in Article 12, and the principle of functional equivalence in Articles 8, 9, 10, and 11. In the doctrine of law, it is recognised that blockchain probably meets all of the conditions set by the ‚Model Law [Albrecht 2019], although some argue that when adapting the Model Law to the national legal systems, it must be done in such a way as to take into account blockchain because otherwise it could not be covered by this law and would remain without regulation [Takahashi 2016].

5. CONCLUSIONS

The need to dematerialise bills of lading has been evident for a long time. The physical nature of the paper bill of lading and its flaws do not fit into the modern, digital world. Theft, damage, and delays made it seem that the Internet would be a suitable tool for dematerialising bills of lading, unfortunately it was found to be a much more difficult task than initially assumed. The requirement of singularity was the main issue encountered. It turned out that it is virtually impossible to fully meet this requirement only with the help of EDI systems. This requirement has been circumvented, which has allowed the introduction, based on contractual ties, of electronic bills of lading.

These electronic bills of lading were burdened with the possability of being challenged by the courts and doctrine. This significantly limited the possibilities of using the systems that are offering electronic bills of lading. The EDI systems did not gain widespread acceptance in the maritime transport industry due to numerous restrictions in comparison to paper bills of lading and the lack of necessary legal regulations that would ensure legal certainty for trading using electronic bills of lading.

The seed of the blockchain revolution, which has probably finally provided the necessary tools to create electronic bills of lading systems that can equal paper bills of lading, came with the Bitcoin cryptocurrency. Although blockchain was known before this, the idea of using this technology to create electronic bills of lading systems only began to spread alongside the spread of blockchain thanks to Bitcoin and other cryptocurrencies. Blockchain made it possible to solve the problem of singularity, which was inherently related to the nature of digital recordings on computers. By creating a series of blocks in which all of the activities performed on the network are recorded, a system was created that documents each passage of the bill of lading from hand to hand, as documented by the indos placed on the paper order bill of lading. This allows, with the introduction of appropriate legislation, the creation of legally certain systems of electronic bills of lading, which, if the other

conditions mentioned above are met, have a chance to enter general use in the maritime industry and at least partially replace paper bills of lading.

There are already existing systems and systems under development that offer hope for the further development of bills of lading based on blockchain, and in the face of the ever-increasing costs of maritime transport [Justeen 2021], the spread of blockchain bills of lading could reduce costs, reduce delays, and simplify actions taken within supply chains, which may help in the fight against the rise in global inflation [OECD].

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