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An Insight into the Impact of Blockchain Characteristics and Applications on the Ship Management Companies

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ABSTRACT

Blockchain techngology has recently started to be adoptedin the shipping industryand is still in the early stage of adoption for most shipping sectors. To boost the technology adoption, shipping companies need to be aware of the impact blockchain characteristics and applications can make on their business process and understand how they can enhance operational efficiency. Eventhough few studies have investigated the blockchain applications in the shipping industry, most of them cover the topic from a general perspective for the industry as a whole. Yet, these applications should be studied from each stakeholder's perspectivein the industry.This paper aims to investigate the impact of blockchain applications on the ship management companies in particular. A systematic literature review has been used as a method to identify and analyze the work related to the blockchain applications in the shipping industry and findings are classified into three categories; blockchain characteristics, blockchainapplications, and impact on ship management companies. The result revealed that most of the studies in this field address the blockchaintechnology in the shipping industry from a general perspective covering all stakeholders involved. In contrast, this study addresses the topic from the perspective of the ship management companies in particular. The finding of this paper indicates that ship management companies are the most beneficiary of the blockchain technology among the supply chain stakeholders. The impact of the technology can enhancetransparency, lower transaction costs, eliminateintermediaries, and reduce fraud. For ship management companies, blockchain applications include documents and updates exchange, eBill of Lading, smart contracts, ship history records, shipment and cargo tracking, and digitalizing and automating shipping documents and transactions.

Keywords: *Blockchain, Applictions, Charactristics, Shipping, Ship Management Companies*

Introduction

Nowadays, the complexity of supply chains is increasing due to the complexity of tasks, diversity of stakeholders, lack of transparency, agility, and traceability, and problems in security and authenticity [1]. Blockchain is a promising and disruptive technology that could potentially remedy the challenges based on its features [2]. Shipping companies responsible for the sea transportation of the goods are one of the main stakeholders of the supply chain, which can facilitate the blockchain technology to increase efficiency in the shipping process. As per the study of [3], which systemically identified and ranked the beneficiaries of Blockchain technology in the Shipping Industry, their study found that ocean carriers (ship management companies) are the highest group that can benefit from the blockchain technology. A study by [4] on the adoption of blockchain technology in the

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shipping industry gave a comprehensive review of blockchain applications from the perspectives of different industry sectors. It suggested that future research examine the economic impact of blockchain in each application area. because the blockchain technology in most shipping sectors is still in its early adoption stage which motivated this study to address the impact of the blockchain application on the ship management companies in order to increase knowledge and awareness which can encourage the ship management companies to take further steps to adopt the new technology.

Introduction to the ship management companies

Sea shipping is classified into several types according to the type of cargo the vessel is shipping which requires the ship to be suitably equipped with needed equipment and tools which can handle the specific type of cargo, such as container ships, tankers, dry bulks carriers, reefer ships and multi-purpose vessels [5]. Ship management is defined as "a complex sequence of decisions required to ensure the effective operations and performance of a ship, as part of the transportation system or, as part of a fleet of ships [12]. As discussed by J. W. Jeon et al, there are three types of ship management companies: in-house management company, third-party management company, and hybrid company. An in-house company is established by a ship owner and handles the owner's vessels, while a third-party management business offers ship owners with outsourced management services. A hybrid organization is a blend of in-house and external management firms. The core function of the ship management companies is to ensure the safe and on-time delivery of cargo from one end to the other [7]. However, as discussed by [8] ship management involves a range of tasks and activities like crewing, technical management, insurance, freight management, accounting, chartering, sale and purchase, provisions, bunkering, and operations. Today, technology revolutionizes traditional operation processes in almost all industries including the shipping industry. The blockchain technology promises to transform the traditional sea shipping model by digitalizing most core shipping processes [9].

Introduction to the blockchaintechnology

Satoshi Nakamoto, the anonymous person or group behind Bitcoin, first presented blockchain technology. Nakamoto stated how blockchain technology, a distributed peer-to-peer linked structure, might be used to solve the problems of maintaining the sequence of transactions and eliminating double-spending [10]. A blockchain network is a decentralized ledger used for trading and exchange of assets. It uses a shared ledger (that is either public or private) for recording the history of electronic business transactions that take place in a peer-to-peer (P2P) business network [1]. As opposed to relying on a third-party mediator, a blockchain network may use proof of work or another consensus process to provide trust, accountability, and transparency [11]. "Blockchain" is a combination of the words "block" and "chain"; the data blocks are connected in time order and combined into a new chain data structure. At the same time, cryptography technology is attached to ensure that it cannot be tampered with and forged and distributed in a distributed way data ledger for storage. Blockchain technology is the use of blockchain data structure to verify and store data, using distributed node consensus algorithm to generate and update data, use cryptography to ensure the security of data transmission and access, Utilize smart contracts composed of automated script code to program and manipulate data A new distributed infrastructure and computing paradigm [12]. While Blockchain and Bitcoin share a historical connection, they are different concepts. Blockchain is the technology that underpins Bitcoin; it is Bitcoin's virtual infrastructure. Blockchain's potential applications go far beyond the cryptocurrency industry [13]. The blockchain technology can be applied in several industries, including international trade, finance, customs and certification processes, transportation and shipping, supply chain, insurance, distribution, intellectual property (IP) and government procurement [13], [14].

Literarture review

To provide a comprehensive bibliography of the academic literature on the blockchain applications in the shipping industry, This research used a methodology of content analysis based on the four-step process model applied by (Seuring & Gold, 2012) to conduct a systematic analysis of blockchain applications in the maritime industry. Material collection, descriptive analysis, category selection, and material evaluation are the four steps used[15].

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Figure 1: Research Approach- Source: Seuring & Gold, 2012. (2012)[15]

Material collection

Since the applications of blockchain technology in the shipping industry is a rather new field of study, the extent of publications was very limited.Available online journal databases were mainly searched and selected from Scopus databases. The keywords used to address the research question were identified in two groups—one includes "Blockchain" AND "shipping", the other includes"blockchain application" AND "shipping". According to these groups, different keywords were used to search, related academic papers in the fields of title, keywords and abstract in the Scopus database. Additional search for related commercial publications, newspapers and magazine papers were done on google.

Table 1: **Inclusion and Exclusion criteria:**

Criteria	Inclusion	Exclusion
Study type	Empirical and theoretical/conceptual studies. Peer-reviewed; working/conference articles included if high quality	Duplicated studies
Language	English	Any other language
Date	Unlimited	
Relevance	. Blockchain applications on shipping . Blockchain characteristics impact on shipping . Blockchain adoption in shipping . Blockchain implementation on shipping	. Not directly relevant to the research topic—e.g.Blockchain applications in the shipping industry . Articles on blockchain applications in other industries other than shipping . General blockchain articles . Technical blockchain development studies

Descriptive analysis

An first screening of article titles and abstracts lead to 92 publications. After screening according to the inclusion and exclusion criteria in Table 1, 27 publications pertinent to the study issue were retained. Additional articles were sourced via the writers' past reading, cross-referencing, and snowballing from database-derived articles.

Table 2**: Most relevant works:**

Author/Year	Title	Relevance
(Pu & Lam, 2021)[4]	Blockchain adoptions in the maritime industry: a conceptual framework	provide a thorough analysis of blockchain applications from the perspectives of different sectors in the maritime industry. The study identified current major blockchain applications and their benefits in the maritime industry, including Electronic Bills of Lading, reducing paperwork, Information sharing, Track and tracing cargoes and ship finance. It recommended a future study to address the impact of each application.
(Yang, 2019)[16]	Maritime shipping digitalization: Blockchainbased technology applications, future improvements, and intention to use	Conduct a comprehensive survey on blockchain applications and upcoming enhancements, and empirically assess the impact on intent to use. The results revealed that customs clearance and management, digitalizing and reducing paperwork, standardization and platform development factors positively affected intention to use.
(Tan & Sundarakani, 2021)[17]	Maritime shipping digitalization: Blockchain-based technology applications, future	The objective of this study is to assess the effectiveness of Blockchain technology in enhancing the freight consolidation process's operational efficiencies. The research emphasizes the use of smart contract applications that can establish crucial

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	improvements, and intention to use	points along the shipping route, such as storage, customs, carrier, transporters, and consignee, to ensure enhanced security and transparency.
(Tsiulin et al., 2020)[18]	Blockchain-based applications in shipping and port management: a literature review towards defining key conceptual frameworks	The objective of this study is to assess the effectiveness of Blockchain technology in enhancing the freight consolidation process's operational efficiencies. The research emphasizes the use of smart contract applications that can establish crucial points along the shipping route, such as storage, customs, carrier, transporters, and consignee, to ensure enhanced security and transparency.
(Ho & Hsu, 2020)[19]	An analysis of key factors influencing integration of blockchain into shipping companies in Taiwan	Investigates the primary influencing elements factors affecting the application of blockchain technology in Taiwan's shipping industry.
(Jugović et al., 2019)[20]	The possibilities of applying blockchain technology in shipping	This paper examines the potential benefits of implementing blockchain technology in logistics and maritime transportation. Implementation of new technology will have a significant impact on shipping. The automation provided by smart contracts, the transparency provided by a decentralized system, and the security provided by immutable data will radically alter the entire sector for the better efficiency
(Jović et al., 2019a)[12]	A review of blockchain technology implementation in shipping industry	Explain the primary obstacles of blockchain technology, and present examples of the blockchain applications in the shipping business. It also illustrates the benefits of the blockchain techngology at the maritime ports
(Wang & Qu, 2019)[2]	Blockchain Applications in Shipping, Transportation, Logistics, and Supply Chain	Intends to clarify I the key features of blockchain that enable its usage in shipping, transportation, logistics, and supply chain, and (ii) how these key features are implemented. Important features include decentralization, open data, and data authenticity. The applications include smart contract, fast payment, information sharing, track and trace, and supply chain finance.
(Filom, 2020)[21]	Blockchain application for shipping industry documents	Present how Blockchain could be a potential solution to existing problems and bottlenecks by providing trust, speed, decentralization, privacy, and lower costs. This paper describes a high-level architecture for a potential solution in which various real-world elements are translated in accordance with blockchain technology principles.

Category selection

Content analysis is based on an analytical framework comprising different dimensions and categories, derived in a combined deductive-inductive way [22]. According to the research objectives, the analytic categories are blockchain application, characteristics, and impact on the shipping companies. Information from the filtered articles was summarized in an Excel spreadsheet organized under descriptive, methodological, and analytic categories.

Material evaluation

This step's purpose was to classify the papers according to the three dimensions and their subcategories. To accomplish this, the obtained data are analyzed using an inductive method that produces results from a thorough detailed examination of the materials [23]. The different kinds of blockchain applications are derived inductively with the authors' industry expertise. The literature is examined and analyzed to identify how the blockchain applications and characteristics impact the ship management companies and enhance efficiency in the business process.

Findings and discussions

Blockchain characteristics and their impacton ship management companies

Blockchain technology integrates the advantages of many cutting-edge technologies, enabling it to have the followingFeatures in several aspects:

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Distributed data storage

The blockchain uses distributed data storage, which means each node/participant in the network keeps a copy of all transaction records and supervises and proves the legitimacy of transactions. Distributed storage enables multiple backups of transaction records so that loss or attacks on individual nodes will not affect the entire data, thereby guaranteeing the data's security [21]. This feature enhances the security of the data as hackers cannot gain control over the blockchain network's data because it is distributed across multiple nodes, unlike traditional systems where data are mainly stored in the main server, which remains vulnerable to hacks every time the cloud is attacked [13]. For the shipping companies, blockchain can provide transparency to all participants as full transactions history is stored and available to be accessed at any time, which in return can enhance the trust in the shipping company operation.

peer-to-peer interaction

The blockchain technology is based on a peer-to-peer network [24], which means that members directly interact with one another on a peer-to-peer network to conduct transactions and share information or documents. Blockchain technology can guarantee the needed interacting trust by providing reliable verification mechanisms and irreversible data editing. Combined with the use of public-key cryptography and the fact that pseudonyms conceal identities, the system enables a high level of anonymity for its users [25]. Peer-to-peer differs from the standard client-server approach, in which resources are stored on a centralized server and shared with the client only upon request. Indeed, a standard client-server architecture acts as a one-to-many distribution model in that information is stored on a central server, whereas a P2P network is composed of many networked peers, or simply computers, who share information point-to-point without the usage of a central server [26]. For the shipping industry, this can eliminate the need for intermediaries such as brokers who connect the charterers with the shipping companies, which means the ship management companies can have access to a wider range of clients from all over the world.

Decentralization

Without a central server, peers or "nodes" (computers) on the blockchain network communicate with one another. Instead of having a single entity control all the data in a system, the blockchain decentralized networks make information directly accessible to all participants, with each node holding equally valid copies of files and documents, hence eliminating the need for trusted third parties [27]. Data exchange between nodes is established according to the system rules and is carried out without the intervention of other redundant institutions, and there is no way to cheat between nodes. Public blockchains offer several advantages compared to centralized systems, including reduced transaction costs, increased transparency and traceability, and security [27].

Immutability

Blockchain records are immutable, i.e., no previous entry or transaction recorded in the ledger can be modified [24]. Each block of data, such as facts or transaction details, is processed using a cryptographic algorithm or a hash value. This hash value is a string of alphanumeric characters created by each block independently. Each block includes a hash or digital signature for itself and the block that preceded it. This guarantees that blocks are retroactively connected and inflexible. This feature of blockchain technology assures that no one can compromise the system or alter the information stored on the block [28]. Simply put, with blockchain, no participant can alter or manipulate a transaction once it has been recorded in the shared ledger. If a transaction record has a mistake, a new transaction must be added to rectify it [11], and both transactions must then be displayed. This feature is available on all blockchain types (permissionless and permissioned). Because of that, for shipping companies, immutability is a key feature because it can greatly enhance trust among all the supply chain participants.

Transparency and Traceability

In the blockchain, a shared and publicly exhibited relationship between the interacting parties is built by a shared view of all prior transactions, and all system participants expose their actions in full [29], recording all phases of a transaction (or all important data points) and allowing the data to be recorded in distributed computers so that all parties can at any moment access, view, and verify transactions [27]. Digital supply chains can force the stakeholders to increase transparency within the chain. This enables better planning for disruptions through modeling the network and performing what-if analysis [30]. In the context of the supply chain, transparency refers to the information available to companies participating in the supply network. For the supply chain to be transparent, product or service origins must be traceable from beginning to end. Consequently,

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transparency and traceability are associated [31]. More global logistics partners, such as shippers, ocean freight forwarders, shipping carriers, marine port companies, terminal operators, and customs agencies, are participating in the blockchain technology platforms. This allows a complete monitoring and tracking of goods and provides open access to information regarding delivery schedules [32]. This will improve the efficiency of ship management companies connecting with stakeholders and can reduce operation cost and reduce shipments transportation time.

Security

Blockchain uses a security technique known as cryptographic hashing. If a transaction is completed within the system and its contents are cryptographically hashed, this means that the original data has been compressed by a mathematical procedure. Consequently, it is impossible to decrypt a hash within a blockchain using this cipher. This is because a blockchain hash is simply a condensed version of the original data. Instead, the hash can be used to verify the complete transaction contents [33]. For example, blockchain can protect the security of documents by preventing identity theft through the use of public-key cryptography; preventing data tampering, compared with document signing and other forms of electronic data interchange; and preventing denial of service attacks by removing the single target that a hacker can attack to compromise an entire system [34]. For the shipping companies, the enhanced security is crucial for high-value documents involved in the ship management companies' operation, such as the Bill of Ladings and letters of credit, and cargo documents.

Blockchain applications and theirimpact on the ship management companies

Smart Contract:

The use of blockchain technology in shipping may include smart contracts, which are contracts in the form of computer programs that run on blockchains and automate the execution of any agreement between parties [9], [35]. This can be accomplished by using an intelligent/smart contract, which is defined by [36] as an automated trading protocol that executes a contract's terms. Trusted transactions are permitted without third parties, which are traceable and irreversible and operate as per the rules specified in the contracts, in a prescribed manner to access and manipulate data in the blockchain. With the automated execution function, when a transaction occurs that satisfies the predetermined contract requirements, new blocks are created and the data is placed in the chain [36]. For the shipping industry, intelligent contracts can realize electronic Bill of Lading without printing and mailing, timely transfer to banks and consignees, and automatically check transaction data bills, which significantly improves the shipping industry's transportation efficiency [36]. In addition, once the use of smart contracts reaches maturity, possible scenarios include the negotiation of freight prices directly between asset owners and their counterparts; the automatic processing of payments upon specified conditions being satisfied; and the issuance of insurance policies and settling of marine insurance claims through blockchain [9]. As per [31] main benefits of smart contracts are: first, self-executing conditions: If-then clauses create a contract that executes itself. It lowers the necessity for interpersonal contact. If a set of requirements are satisfied, the seller receives payment. If the requirements are not satisfied, one of the parties is immediately fined. Second, security: The smart contract is deployed among nodes and encrypted. This ensures that the information will not be lost or altered. Finally, speed and Cost: Due to automation, the procedure is quite speedy. If everything is in order, the vendor does not have to wait for payment. Once the requirements in the smart contract are satisfied, the payment is immediately executed. It also helps eliminate middlemen, resulting in cost savings.

eBill Lading

The bill of Lading is the most important document issued by the shipping company after loading the cargo, which is evidence of the contract of carriage that proves the cargo has been shipped onboard and it also plays the role of a certificate of ownership of the cargo, which means that whoever owns the bill of Lading has the right to control and claim the cargo, and it has been argued, the value of the B/L is approximately equal to the goods it describes [37], [38]. Bills of Lading are traditionally paper-based documents, and the transfer of goods from one party to another requires the physical possession of the B/L [38], [39]. Physical Bill of Lading is issued by the shipowner (usually shipmaster or ship agent), and physically distributed through several parties, including shippers, banks, and receivers. Blockchain platforms can be used to issue and process the Bill of Lading [3]. Some of the benefits include saving time, lowering administrative costs, and providing security for shippers, shipping companies, freight forwarders, and financial institutions [3]. For instance, the

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technology may enable the use of a digital bill of Lading that cannot be secretly altered because the original is always visible on the blockchain platform. In addition, a totally digital bill of Lading would allow for the acceleration of laborious operations and the reduction of expenses, since it would eliminate the vast quantity of paper paperwork connected with existing business practices [40]. In this regard, ship management companies should consider using the available platforms designed for facilitating the digitalization of the Bill of Lading. One of the first projects in this aspect is the CargoX project which developed a BDTS platform (Blockchain Documentation Transaction System). CargoX project began in January 2018, and has created a blockchain-based platform for sharing smart Bills-of-Lading [38]. CargoX aims to unite issuers, carriers, importers, exporters, and other stakeholders in a balanced system built on trust and engagement by offering an incredibly quick, secure, dependable, and cost-effective solution to process shipping papers anywhere in the world. CargoX's purpose in this regard is to eliminate the need for a middleman by providing solutions for safe document exchange, therefore dramatically decreasing delivery costs and time by providing a high level of security and transparency [41].

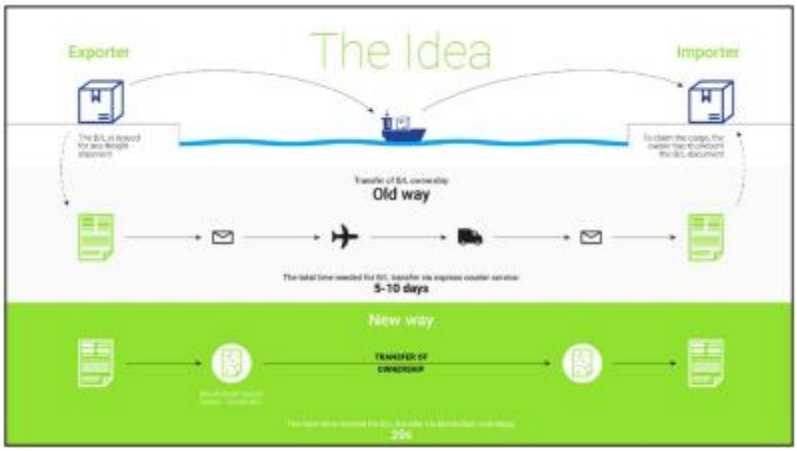

Figure 2: A Review of Blockchain Technology Implementation in Shipping Industry Adopted

Documents and updates exchange

Transactions requiring paper documentation frequently involve physical scrutiny of documents, resulting in high transaction costs for shipping. Poor information management is estimated to account for 20% of operating expenditures [42]. The shipping process relies heavily on documents exchange between many stakeholders [1]. This documents exchange is associated in all stages of the shipping business from pre-fixing the cargo till after cargo delivery and is done traditionally, including reliance on hardcopy paperwork, documentation exchanged physically and by emails, which make the process slow, time-consuming, which in many cases cause a delay in shipments delivery. The many parties and intermediaries involved in the shipping business process, including ship owners, charterers, brokers, ship agents, shippers, receivers, terminals, ports customs authorities, surveyors, banks, etc., make it very inefficient and time-consuming to share and process the documents required in the shipping process [43]. The report submitted to the U.S Maritime Administration by [37] explained that blockchain presents one way in which paperwork could be digitized in the maritime sector as it allows for the documentation and storage of recorded data on a ledger managed collaboratively allowing all parties to access identical, immutable, and consistently available information. All relevant parties having access to this information in a single location would save transaction costs and auditing and accounting expenses [44]. Blockchain has also been envisioned as enabling the automated tracking of the transfer of ownership of a package within seconds of its sale [19]. According to IBM estimates that complete digitalization of the shipping process could save shipping carriers up to $38 billion per year [13]. The most known initiative in the shipping industry for the document sharing, tracking and updates exchange is the TradeLens (partnership between IBM and Maersk) project which is a platform for digitizing and transforming trade for the benefit of industry and authorities all along the global supply chain [45]. This partnership seeks to connect the container shipping stakeholders (ecosystem) by bringing together all parties in the supply chain – including traders, freight forwarders, inland transportation, ports and terminals, ocean carriers, customs, and other government authorities – onto a single, secure data-sharing and collaboration platform by providing for the seamless, secure sharing of real-time, actionable supply chain information across all

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parties – encompassing shipping milestones, cargo details, trade documents, customs filings, sensor readings and more [45]. The ship management companies can utilize such platforms to digitalize the shipping documents and facilitate transaction tracking and records including starting consignment tracking, planned loading on the vessel; ship movement tracking, and loading and discharging operations.

Ship history record

The creation of a full, secure record of a ship's existence using blockchain technology might give a highly practical answer for future vessel transactions including paperwork. The ship can be recorded as a digital asset in the form of non-fungible tokens (NFTs), a digital asset that links ownership to unique physical or digital items, such as works of art, real estate, music, or videos [46]. The NFT represents digital proof of ownership of any given item. NFTs are securely recorded on a blockchain which ensures the asset is one-of-a-kind. The technology can also make it difficult to alter or counterfeit NFTs [21]. In this regard for the shipping industry, some initiatives facilitate the blockchain as a record for the ship registration, which can significantly speed, standardize, and enhance the present cumbersome ship registration and renewal procedure. Immediate benefits include considerable reductions in operational expenses, turnaround time, human error, and fraud. The Singapore Shipping Association (SSA), the International Chamber of Commerce (ICC) and Singapore tech startup Perlin have teamed up to build an advanced digital blockchain ship registration system for international adoption [47]. Another use of blockchain NFT is creating a digitalized record of the ships as a token, which includes animated profile pictures, digitized records of the ship, its ownership certificate and surveys records, and sales transitions. Unlike other types of records, NFTs are decentralized and distributed, making them next to impossible to lose, which means they can serve as a permanent record — easily restored and reviewed [48]. A Bruneian company, Amann Shipping, has created a virtual version of its first boxship in its fleet. The ship NFT cryptoship is a digital version made by the company so that it could live on forever in their care. The NFT was created to represent the ship as it existed under their care and was permanently registered on the blockchain [46]. The Amman case may just be the tip of the iceberg of creating cryptoships because it was just made for memorizing and recording the ship under their management; however, this technology can be expanded to be considered as a single-ship blockchain where the ongoing full record of the ship activities are recorded and shared with stakeholders (including investors of the ship) and can serve as a trusted record of the ship which can be used as a reference for the ship future sales and investments. Because in many cases, the ship owners are not operating their ships by themselves and usually ship owners hand the ship to ship management companies so when the ship owners can access a trusted un-alerted record of all the ship activities at any time this can build a strong trust relationship between the ship owners and ship operators.

Conclusion

The business process and tasks of the ship management companies involve different players from different industries and countries. for this business nature, blockchain technology is considered a promising technology with characteristics that can fundamentally enhance the industry by enhancing transparency, lowering transaction costs, eliminatingintermediaries, and reducing fraud. For ship management companies,most potential blockchain applications include documents and updates exchange, eBill of Lading, smart contracts, ship history records, shipment and cargo tracking, and digitalizing and automating shipping documents and transactions. These applications require collaborative adoption from all stakeholders involved in order to be utilized and implemented. Future studies need to explore the impact and adoption likelihood of these applications on each supply chain stakeholder and sector, which can increase knowledge and awareness of the technology benefits and boost the adoption lifecycle.

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