Chapter

On Maritime Digitalization in Emerging Environments

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Abstract

The purpose of this chapter is to propose a conceptual framework for implementation of advance info-communication technology and systems (ICT&S) across maritime cluster in emerging environments, with emphasis on some South-East European countries and South Africa. Smart implementation and adoption of the ICT&S in shipping and port management have been considered due to the Holtham's & Courtney's model (2010). Furthermore, particular attention is given to Blockchain-based Maritime Supply Chain System (BMSCS) conceptual model, which includes distributed relational database, smart contracts, and crypto-currency payment mechanism as main constructs. The document workflow management, financial processes, and device connectivity are considered as key scenarios in the blockchain model. The stakeholders, who play the role of traditional intermediaries in the goods and accompanied documents and data flows, including overall supervision of the processes between end nodes, that is, shippers and customers, are encompassed within the BMSCS scheme. Some strengthens and frailty of BMSCS are highlighted, along with the suggestions for further investigation in this field, with the aim of better understanding prospective benefits and challenges of blockchain more extensive deployment across maritime sector in the future, with emphasize on developing environments.

Keywords: maritime, digitalization, emerging economies, conceptual framework

1. Introduction

Maritime is an important industry. Over 80% of the total transport of all goods takes place by sea because it is the most economical and most massive mode of transport. The world's seas provide free waterways. These are the largest absorbers of carbon dioxide and the largest producers of oxygen. The seas are the main source of food for one-third of the world's population. Oil and diamonds, e.g., are extracted from the seabed. However, the seas are exposed to pollution caused by both natural disasters and human factors. Another paradox related to the seas is that the maritime industry lags significantly behind other industries in terms of digitalization. Some facts that support this statement are as follows: a large number of ships do not comply with the requirements of the Safety of Life at Sea (SOLAS) Convention. Some ships do not have modern electronic navigation aids such as Electronic Chart Display and Information System (ECDIS) nor (Satellite) Automatic Identification System ((S)

AIS), for instance. Analyzes of accidents at sea have shown that the crew sometimes is not familiar with these devices. Digitization at land is more developed than at sea, and the main reason for this is the lack of profound investigation of Internet connectivity at sea, which can be hampered by sea surface movements, wave occlusions, rough weather, poor coverage, etc. Consequently, inter-organizational information systems (IOS) are used 75% in hinterland and only 25% in maritime. Internet of Things (IoT) is used considerably less at sea than at land. In road and rail transport, it is possible to track cargo at the level of a single unit or a container, while in maritime transport this is still not possible. As an example, we can use transport of dangerous goods. The casks (drums) with radioactive waste (plutonium, e.g.) can be tracked by Radio Frequency Identification (RFID) chips, Internet connection, and security backend web applications at the level of a single freight unit or a drum in the road and in rail transportation [1, 2], but not in maritime [3]. Furthermore, there are a large number of autonomous vehicles on roads (about 1.5 thousand) and in the air, i.e., drones (about 1.5 million), but only one autonomous ship (Yara), and another one is currently under construction [4]. Blockchain technology is not widely accepted yet, since there are various impediments like the lack of trust between stakeholders; government support; legislation; standards; along with the stakeholders' readiness for risky investments in emerging technology. Some extensive desktop studies of academic writings shown that a very small percentage of articles deal with advanced info-communication concepts such as big data, virtual intelligence, robotics, 3D, virtual reality, digital security, etc., in maritime. There is no clear political strategy for further development of info-communication systems in maritime. This complicates maritime digitization in developed countries, and considerably more in developing ones. Concerning the latest, this chapter is organized in the following manner: Section 2 deals with smart adoption of advanced ICT&S in general, and in maritime business. Additionally, a case study has been conducted in several non-EU and EU countries in this respect, based on the Holtham's & Courtney's model. Section 3 considers rational blockchain adoption in maritime, with a focus on developing environments, concerning BMSCS, TradeLens, smart contracts, and Blockshipping. This section also encompasses a case study on blockchain smart adoption in maritime business in emerging economies, with emphasis on South Africa and Montenegro, while Section 4 gives some concluding remarks.

2. Smart adoption of ICT&S in maritime

We live in a time of massive progress in the field of info-communication technology and systems (ICT&S). The question is do we really need all these innovations and do they always make our lives easier and better. In order to get the best out of ICT&S, we need to know which of these technologies we actually need and how to use them purposely. When it comes to a business environment, it is very important that higher management structures are aware of these needs and discuss them with employees. This is especially important in maritime business, bearing in mind that, stakeholders in maritime are usually conservative and not early new technology adopters. Several studies considered ICT&S rational, intelligent or smart implementation and adoption of advanced ICT&S in maritime [5–10]. On the Holtham's & Courtney's model, in this chapter, it has been examined how stakeholders in maritime assess key constructs in the model, regarding some developed and developing countries in Europe. The considered countries were treated as the European Union (EU) and non-European Union (non-EU) ones. Before presenting the methodology and the obtained results, the overview of the applied Holtham's & Courtney's model is given.

2.1 The Holtham's & Courtney's model

This model is composed of four constructs: knowledge, ICT&S strategy, system effectiveness, and ICT&S management. These constructs are supported by organizational culture and top manager's mindset (**Figure 1**).

Knowledge can be described as the understanding of a subject that one gets by experience or study, known either by one person or by people generally; or, as the state of knowing about or being familiar with something [11]. Furthermore, Cambridge dictionary depictures knowledge as awareness, understanding, or information that has been obtained by experience or study, and that either is in a person's mind or possessed by people generally; or, as skill in, understanding of, or information about something, which a person gets by experience or study. Symbolically, knowledge is one of the steps in the so-called ladder of knowledge. This ladder of knowledge encompasses data, information, knowledge itself, and wisdom stairs. The data and information have easier explanations than the concepts of knowledge and wisdom. In this context, the focus will be on knowledge stair, as a key for understanding contemporary ICT&S and their rational implementation in maritime business. Knowledge here means consciousness about advanced ICT&S availability at the market, including the ICT&C purposiveness regarding particular business strategies, processes, and activities.

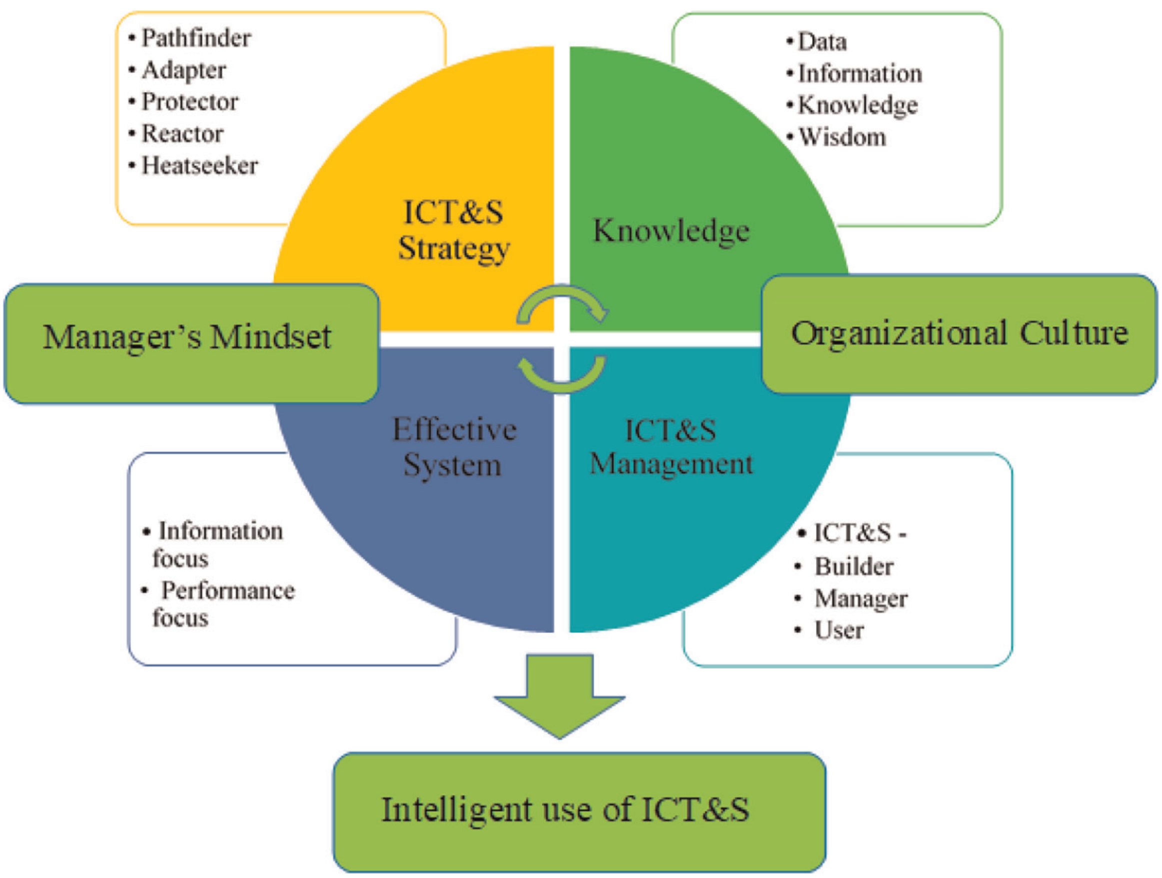

Figure 1.
Adapted Holtham's & Courtney's model (source: Own).

The ICT&S strategy brings together business and technology. Due to the Holtham's & Courtney's model, there are five different strategic orientations.

Pathfinder: Systematically seeks and selectively exploits relevant ICT&S trends to gain competitive advantage and enable entry into new markets. Pathfinder is willing to experiment with new, advanced ICT&S. Pathfinder constantly seeks a competitive advantage by detecting or sensing emerging ICT&S trends and opportunities.

Adapter: Functions at two types of market: one relatively stable and focused on efficiency, and the other where ICT&S plays an increasingly important role. Adapter applies different rates of technological uptake in each. This split feature is typical for businesses where different rates of technological adoption are present, and adaptability rather than uniform solutions are applicable.

Protector: Meticulously assesses ICT&S investment for its efficiency orientation and applies technology primarily to reduce costs of investments and increase communication processes rather than new market opportunities creation. Protector is control orientated and slow to innovate. These organizations work in domains where core ICT&S-based technologies are commonly available and easily replicable.

Reactor: This is a characteristic of an organization where technology is not perceived as a strategic tool. It responds slowly to change and tends to view ICT&S applications as standalone tools. In this strategic orientation, the ICT&S platforms usually appear to be weak or obsolescent. The risk is that the organization could quickly become non-competitive through a lack of capacity to meet customers' needs.

Heatseeker: Seeks upon ICT&S fashioned instead of strategically analyzing the best ICT&S fit for its business processes. Heatseeker is typical for an organization whose structure is in constant change, experimenting with innovations before obtaining steady business performance. This organization is receptive to ICT&S spending and subsequent partial reversals when intended benefits are not realized quickly.

The system effectiveness can be achieved by setting and communicating critical success factors (CSF) [12] and developing them steadily. The first step is to use technology to create an effective operational platform, primarily with internal information. Then, the CSFs can be widened to foster improved skills to use technology. This will start with employees and then extend to suppliers and customers. Once when these two steps work well, the CSFs can be broadened to encompass external information about markets, customers, and competitors. After these, three steps comes business intelligence, which allows organizations to identify and manage risk while developing new products, services, and markets to ensure a successful future.

The ICT&S management is based on ICT&S builders, ICT&S managers, and ICT&S users. A person or management team that communicates the needs of ICT&S users into ICT&S builders or designers has to be engaged in the organization as a knowledge navigator, or information resource manager. There are business organizations, which recognized this triangle and which are working on filling and improving the personnel skills towards achieving this goal [13, 14].

These four constructs, which form the backbone of the Holtham's & Courtney's model are underpinned by organizational culture and top manager's mindset.

Concerning the organizational culture, there is universal agreement that it exists and plays an important role in shaping behavior in organizations. However, there is little consensus on what organizational culture actually is. Here are quoted several expressions that can be used in absence of universally accepted one [15]: organizational culture is how organizations do things; organizational culture is the sum of values and rituals, which serve as glue to integrate the members of the organization; organizational culture is civilization in the workplace, etc.

Top manager or top management team's role is to weave a fabric of horizontal (information, technology, people, and organization) and vertical (direction, knowledge, process, and climate) threads mutually intertwined. In organizations where knowledge is a core dimension, managers have frequently identified people's skills as the major influence, along with organizational climate. Moving from the information-based to the knowledge-based enterprise is a major challenge for today's companies [16]. Therefore, managers have to combine proper notions from several different domains: organizational behavior, human resource management, big data, analytics, artificial intelligence, etc. Technology is a key enabler, but not usually as significant as skills and climate. Top managers' team mindset covers all considered constructs and it affects intelligent or rational use of ICT&S.

These constructs are used in the following analysis as independent variables. As a control variable is used non-compliance between technology-led potential and its everyday usage, while the dependent variable is intelligent use of ICT&S, which reflexes efficient and smooth communication between tasks, technologies, and employees [4].

2.2 Case study on smart ICT&S adoption

Based on the Holtham's & Courtney's model, a survey was conducted among stakeholders in maritime in terms of how rationally they use the ICT&C in their business. Selected stakeholders from four EU (Croatia, Greece, Italy, and Slovenia) and from four non-EU countries (Albania, Bosnia & Herzegovina (B&H), Montenegro, and Serbia) were included in the survey. Forty experts (five per each considered country) from maritime administrative bodies, agencies, private marine companies, ports, and universities (maritime departments) were asked to evaluate the set of fifteen statements by means of Likert (1–5) scale (**Table 1**). The last two statements refer to the control and dependent variables in the model, respectively, while the rest of the statements correspond to the independent variables.

The level of respondents' agreement with the proposed statements is labeled due to the following scheme: (i) if the average score per group of experts from a certain country is between 1 and 2.5 then the level of experts' agreement is "low"; (ii) if it is between 2.6 and 3.5, then the level of agreement is "moderate", and (iii) if it is between 3.6 and 5, then it is "high". The results of the survey are presented in **Table 2**.

According to the results presented in **Table 2**, it is obvious that all respondents evaluate knowledge, ICT&S management, and manager's mindset as highly important for rational application of ICT&S in maritime organizations. When it comes to the system effectiveness and organizational culture, the experts assessed these constructs as high or moderate important for intelligent implementation of ICT&S. Control variable confirms validity of the assessments assigned to the dependent variable "intelligent use of ICT&S in maritime". Namely, all experts highly agreed with the statement "the ICT&S serve as a connective tissue among tasks, technologies, and employees in your organization", which in fact justify smart exploitation of ICT&S in maritime business. When it comes to ICT&S strategy orientation, the respondents are dominantly *adapters*, while only one of the respondents is *reactor*. The *adaptors* are looking for the third path, while reactors leg behind regarding adopting new ICT&S. Adaptation means that emphasis is on modification rather than fundamental reconfiguring of the existing ICT&S. On the other side, reaction means using weak and obsolescent ICT&S platforms. The reasons behind this orientation should be examined through in-depth interviews with respondents and through further analysis

Construct	Statements
C1: Knowledge	S1.1: Knowledge is important for business success. S1.2: Knowledge and skills of employees are important for efficient and effective use of ICT&S?
C2.1: ICT&S Strategy *Pathfinder*	S2.1: New ICT&S solutions adoption is risky for the organization.
C2.2: ICT&S Strategy *Adapter*	S2.2: Analyzing carefully the existing ICT&S solutions prior to their introduction into the organization is important.
C2.3: ICT&S Strategy *Protector*	S2.3: The ICT&S reduces operational costs of the organization.
C2.4: ICT&S Strategy *Reactor*	S2.4: The available ICT&S solutions can be adapted to the current business needs of your organization.
C2.5: ICT&S Strategy *Heatseeker*	S2.5: The latest ICT&S solutions are the best ones.
C3: System effectiveness	S3.1: Your customers intensively use ICT&S resources of your organization (web site and various online users' apps). S3.2: The ICT&S allows you to become familiar with the current market trends in the area of your business.
C4: ICT&S management	S4.1: The ICT&S functions are important for the successful functioning of the organization and its business success. S4.2: The usage of ICT&S for operational takes within your organization (accounting operations, database of employees, database of business partners, market analysis, etc.) is extensive.
C5: Culture	S5: Positive organizational culture and clime are important for effective use of ICT&S.
C6: Manager's mindset	S6: Manager's mindset is important for effective use of ICT&S.
C7: ICT&S capacities versus exploitation	S7: There is a divergence between ICT&S capacities and their real application on a daily basis in your organization.
C8: ICT&S intelligent exploitation	S8: The ICT&S serves as connective tissue among tasks, technologies, and employees in your organization.

Source: Own.

Table 1.
The survey content.

of their business strategies, including the position of the ICT&S in it. This might be the subject of further investigation in the field.

In addition to the analysis of the degree to which ICT&S are used rationally in the maritime business, it was also examined which advanced info-communication platforms are available to the maritime organizations in which the respondents in this study work. The results of this part of the survey are presented in **Table 3**. It is evident that there are efforts to modernize ICT&S in maritime business, but also that some of the analyzed maritime organizations, i.e., countries are lagging behind, especially those that are not members of the EU. Namely, the non-EU countries have to reconsider their business development strategies and ensure funds for implementing new ICT&S and renewal of the existing ones. These countries should follow actual trajectories and scenarios towards efficient and effective digitalization in maritime [17].

Through this case study, it is shown that responders, who are employed in maritime administration and business organizations in four EU and four non-EU countries, have similar attitudes towards concerned constructs inherent to intelligent

Constructs		C1	C2	C3	C4	C5	C6	C7	C8
	Country	**Knowledge**	**ICT&s Strategy**	**System effectiveness**	**ICT&S management**	**Organizational culture**	**Manager's mindset**	**Control variable**	**Dependent variable**
EU	Croatia	▲ High	Adapter	▲ High	▲ High	▲ Moderate	▲ High	▲ Low	▲ High
	Greece	▲ High	Adapter	▲ Moderate	▲ High	▲ Moderate	▲ High	▲ Moderate	▲ High
	Italy	▲ High	Adapter	▲ High	▲ High	▲ High	▲ High	▲ High	▲ Low
	Slovenia	▲ High	Adapter	▲ High	▲ High	▲ High	▲ High	▲ High	▲ Low
Non-EU	Albania	▲ High	Adapter	▲ Moderate	▲ High	▲ High	▲ High	▲ High	▲ Low
	B&H	▲ High	Adapter	▲ High	▲ High	▲ Moderate	▲ High	▲ Moderate	▲ High
	Montenegro	▲ High	Adapter	▲ Moderate	▲ High	▲ Moderate	▲ High	▲ Moderate	▲ High
	Serbia	▲ High	Reactor	▲ High	▲ High	▲ Moderate	▲ High	▲ Moderate	▲ High

Legend: ▲ *High agreement;* ▲ *Moderate agreement;* ▲ *Low agreement*
Source: Own.

Table 2.
The assessments of the constructs.

exploitation of contemporary ICT&S. They all identified knowledge, ICT&S management, system efficiency, organizational culture and manager's mindset as key perpetuators of rational and purposeful use of the ICT&S. This speaks in favor of their sound education and awareness about the importance of ICT&S in today's dynamic maritime business environment. Regarding ICT&S strategical orientation, the respondents are cautious, i.e., not prone to take risks of investing in new ICT&S solutions and experimenting in the market.

When it comes to the availability of common and advanced ICT&S in analyzed maritime organizations, it is shown that there are big differences among EU and non-EU countries. For instance, maritime organizations in Slovenia have almost all listed ICT&S except blockchain technology, AGVs, digital twins, are UxVs. The companies in Italy have, e.g., digital twins and UxVs. Croatia and Greece have also quite an extensive list of available ICT&S. On another side, explored non-EU countries are modestly equipped. The examination of the reasons for such difference and how it can be alleviated in order to avoid disruptions in maritime ecosystem and negative economic implications for the non-EU countries should be the subject of further, more profound studies. None of the considered maritime entities does have on disposal Blockchain-based Maritime Supply Chain System (BMSCS), e.g. Since BMSCS is the advanced emerging ICT&S platform in contemporary maritime business, the following text attempts to explain the basic principles of this platform, including its benefits and challenges.

3. The BMSCS conceptual framework

Bockchain in maritime is a far broader system than cryptocurrency-based electronic financial transactions mechanism. In literature, it is named as Blockchain-based

Available ICT&S	Countries							
	Non-EU countries				EU countries			
	Albania	B&H	Montenegro	Serbia	Croatia	Greece	Italy	Slovenia
Electronic Data Interchange (EDI)		×	×		×	×	×	×
Enterprise Resource Planning (ERP)		×	×		×	×	×	×
Customer Relationship Management (CRM) System	×	×	×		×	×	×	×
Electronic Logistics Marketplace (ELM)		×				×	×	×
THETIS (PSC—Port State Control)			×		×	×	×	×
Blockchain-based Maritime Supply Chain System (BMSCS)	▼	▼	▼	▼	▼	▼	▼	▼
Automatic Identification System (AIS)	×	×	×	×	×		×	×
Long-range and tracking (LIRT)	×		×		×	×		×
Vessel Traffic Monitoring Information System (VTMIS)	×		×		×	×		
Sea Traffic Management (STM)	x				×		×	×
e-Navigation					×			×
e-Maritime					×			×
Common Maritime Communication Platform (CMSP)					×			×
Maritime Surveillance Services (MSS)	×				×			×
SafeSeaNet (SSN)			×		×	×		×
Maritime Single Window (MSW)					×	×	×	×
Automatic Guided Vehicles (AGV)								
Digital twins							×	
Remotely controlled vessels	▼	▼	▼	▼	▼	▼	▼	▼
Unmanned sea or underwater vessels (UxVs)						×	×	
Earth Observation Services —Search and Rescue (SAR) sensors					×	×	×	×

Available ICT&S	Countries							
	Non-EU countries				EU countries			
	Albania	B&H	Montenegro	Serbia	Croatia	Greece	Italy	Slovenia
Earth Observation Services—Optical sensors					×	×	×	×
Satellite-based oil spill detection system at sea			×		×			×
Oil spill prediction modeling system			×		×		×	×

Legend: ▼ *There is no ICT&S of such type*
Source: Own.

Table 3.
Available ICT&S in the examined maritime organizations.

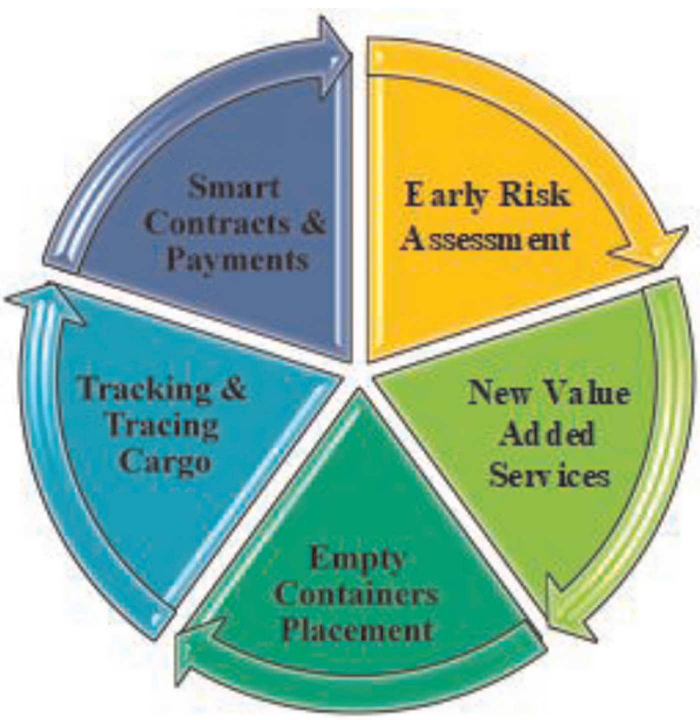

Figure 2.
BMSCS key components (source: Own).

Maritime Supply Chain System (BMSCS) [18]. It includes smart contracts and payments, tracking and tracing cargo, empty containers placement, early risk assessment, and services that can create new added values in maritime (**Figure 2**).

Maritime is an indispensable link in global supply chains. Hereof, blockchain technology is likely to become unavoidable in shipping and port management, in striving to optimize global supply chains and make these more efficient and effective. The BMSCS should reduce the volume of administrative work, errors that occur due to manual work, delays in the delivery of goods, and consequently overall costs of transportation and delivery of goods. Due to some studies, the costs of global supply chains should be reduced by approximately 15% by implementing blockchain technology [19].

In addition to these advantages, blockchain also has certain disadvantages. Maritime sector is generally risk-averse, tending not to be an early adapter of new potentially risky technology [20]. Some stakeholders in maritime want to keep their data secret, since "competition is fierce" and "a lot of industry actors are basically competing with the same service" [21]. In other words, some partners in the supply chain consider information as a competitive resource and are unwilling to share them. Positional data might be used to track vessels by identifying port locations, fueling locations, and routes [22]. This is particularly the case with tracking dangerous and hazardous goods, pharmaceuticals, or food. The use of blockchain does not guarantee that the information recorded in ledgers is correct and does not prevent tampering data prior to entering it into blockchain ledger, e.g., the contents of a container, fuel production, testing or combustion, and the like [23]. Due to the huge amount of data and traffic generation, including data storage, blockchain requires a wideband like G5 or G6 [24], while the internet speed can be low when the working stage is offshore. Further, blockchain causes high-energy consumption [25]. Blockchain in the maritime sector indicates the potential to reduce transaction costs in a number of areas, including reducing the need for intermediaries such as brokers and courier services and reducing related financial expenses and energy costs. However, one should not forget that this does not include the costs of the overall investment and expenses associated with blockchain implementation and adoption, especially in developing or emerging economies [26, 27].

The present level of awareness, knowledge, and expertise about blockchain is scarce among the stakeholders. Therefore, educational, training, or capacity-building programs are necessary at regulatory, administrative, and operational levels. Higher level of standardization across the global supply chain is necessary as well. The Digital Container Shipping Association (DCSA) conducts efforts in this regard, but further, more extensive, actions are necessary. In general, there is a hesitation by stakeholders in maritime sector to invest in blockchain systems in terms of technological integration, regulatory, organizational, and educational costs, since the maritime sector traditionally relies on its legacy systems. There appears to be a gap between what practitioners in the blockchain area suggest and what has been a range of state-of-the-art approaches in software engineering and information security research and practice [28]. Furthermore, the major liner shipping companies are the most likely parties to benefit from blockchain regarding the complexity of their blockchains and huge requirements on financial resources [29]. This can put other potential actors in the global supply chain at a disadvantage. The last but not the least, the basic attitude should be that technology, in this case, blockchain on the top of the global supply chain should improve the human condition, and not replace humans [30]. Therefore, human and ethical dimensions of blockchain technological development and more extensive deployment, should not be neglected.

In the following text, we shall present blockchain framework in maritime at the example of two applications: TradeLens and Blockshipping. TradeLens is used for tracking and tracing cargo along the global supply chain, early risk assessment, smart contracts, and value-added services created through an open platform. Blockshipping is used for empty containers' optimal placement by autonomous intelligent software agents.

3.1 TradeLens

TradeLens is a new business model in shipping and port management. It enables one-to-many connections for all the actors, all individuals that are involved in a global supply chain instead of bilateral connections. Everybody come together in a maritime industry-neutral, open platform for every participant [31]. Maersk, the world's largest international container shipping and logistics company, and IBM the technology leader in blockchain came together to provide a new, open platform solution underpinned by blockchain to help unlock some of the opportunities for a more efficient global supply chain. Maersk and IBM have a long history of working together, actually decades. In March 2017 these organizations collectively try to improve global trade through digitization. In January 2018, they launched an early adapter program; trials began, and in August 2018, they formally launched the TradeLens limited availability platform, shared among 92 participants. In December 2018, TradeLens is commercially realized, along with 1.5 million events per day published to the platform. Some types of these events are presented in **Table 4**.

The platform can track 120+ unique consignment shipments, while 60+ network members are onboard or in a process of accessing. TradeLens supports 18+ unique, standardized, trade document types. Some of these documents are listed in **Table 5**. In February 2019, enhanced document sharing, permissions, and notifications were released. The platform includes half a billion events on annual basis and this number grows with more and more network members.

More than twenty million containers of cargo information are in the system today, which is roughly 1/5 of global trade and it is growing. The platform involves numerous parties and systems: ocean carriers, ports and terminal operators, inland carriers, shippers, consignees, beneficiary cargo owners, freight forwarders, 3PLs, custom authorities, government agencies, financial and insurance services, transportation management systems, Port Community Systems (PCSs), supply chain validity systems, supply chain, manufacturers, retailers, etc. They all collaborate and share information. TradeLens provides them with comprehensive, real-time visibility and

Actual	Estimated	Planned
Start container tracking	Documentation cutoff: Vessel ETD	Import documents approval
Start shipment tracking	VGM (Verified Gross Mass): Vessel ETD	Discharged from truck
Booking confirmation	Cargo cutoff: Vessel ETD	Loaded on vessel
Stuffing started	Rail ETD	Stuffing started
Vessel ATA	Rail ETA	Stuffing completed
Vessel ATD	Bill of Lading Available	Loading on vessel
Loaded on rail	Vessel ETD	Gate in
Rail ATD	Vessel ETA	Gate out
Rail ATA	Discharged from vessel	Packed container selected for inspection
Loaded on truck	Load on vessel	Packed container passed inspection
+Add more	Custom release	Cargo specific certificate approved
	+Add more	+Add more

Source: [31].

Table 4.
TradeLens standardized events.

Document	Party
Import documentation approved	Customs House Broker
Customs release	Customs Authority
Cargo geography-specific certificate approved	Customs House Broker
Bill of lading available	Beneficiary Cargo Owner (BCO)
Certificate of origin available	Beneficiary Cargo Owner (BCO)
Packaging list available	Beneficiary Cargo Owner (BCO)
Commercial invoice available	Beneficiary Cargo Owner (BCO)
Source: [31].	

Table 5.
TradeLens standardized documents.

immutability across the end-to-end journey of shipment. In other words, data is available immediately, along with the single simplified view across all shipments. For instance, a terminal operator publishes a piece of information about the fact that a container has been loaded onto a ship that becomes immediately available to everybody else in the supply chain. The idea is to build workflow based on smart contracts using chain code to derive cross-organizational workflow by excluding manual work.

Blockchain on which the platform is based, enables the trust in data that are available on the platform. It is an open and censorship-resistant distributed database model, secured by encryption and decentralization. Blockchain records information in blocks on a shared ledger, storing a synchronized copy of it on all the systems participating in the network, hence assuring its immutability. The trust anchors, which are the blockchain nodes, ensure through consensus algorithms that the information should be written on the platform as approved like valid. All information are auditable, verifiable, and temper proof; so, as soon as a piece of data is published to the blockchain it cannot be edited. The only way to edit a document is to create a new version of the document. Consequently, all the documents are fully auditable. Additionally, cryptographic hash of the data is written to the blockchain, and this is a part of the supply chain. It is important to say that private data remain private. TradeLens as an information-sharing model allows ecosystem partners to have access to the information they should access and vice versa. The platform offers a high level of flexibility through application of RESTful APIs (Application Programming Interfaces), back-end ERP (Enterprise Resource Planning), and secured front/back-end web services.

In the middle or at the very core of TradeLens solution, there is the platform and blockchain behind it. Below the platform is the network. The network is not a physical network. It is a set of entities that provide the data, including the data itself. The ocean carriers, ports, terminal operators, customs, shippers, inland transporters, etc., provide the data. On the top, above the platform are applications and services, i.e., RESTful APIs, back-end ERP, and secured web that enable people to exchange information. These are based on open published industrial UN/CEFACT standards that are defined at the platform level, so that third parties are allowed to build new value-added services and applications. This is the basic kind of model, through which TradeLens is moving forward as a paradigm shift in information sharing across the whole ecosystem. A conceptual framework of TradeLens as a blockchain-based solution in the global supply chain is presented in **Figure 3**.

What kind of information is shared across the platform, i.e., over the entire supply chain? This information is mostly shipping milestones. The information on: has a container been staffed; has the container be gated; what is the estimated time of arrival (ETA) of the container at the destination, and so on, are in fact shipping milestones. However, it is more than that. It is also the documents in maritime, both structured and unstructured (like PDFs, scans, images, etc.), by making them available to the participants along the supply chain. The documents need to change 'hands'. They need to be approved, updated, and available to build workflow using smart contracts, like the bill of lading, clearance, insurance, etc. This is powerful in terms of driving cross-organizational data flow in maritime.

Within TradeLens, there is sensor data and IoT for referring to the container number, electronic seal, temperature inside it, for instance, etc. All of that is part of the underlined data that is made available to the participants who need that data. There is a whole concept of seamless and permission data-sharing model that is built on the base: what your role is, i.e., are you terminal, ocean carrier, shipper, inland transporter, etc. The default permission model allows people to share information, so that information is made available to those who need it, but it is not available to those who should not see it.

TradeLens is of utmost importance whenever planned actions turn into unplanned. For instance, the ocean carriers' decision has implications not just for them but for all stakeholders further down the supply chain from customs brokers, port authorities, and terminal operators to inland transporters and consignees. With TradeLens, changes to the shipment are reflected immediately allowing supply chain participants to coordinate actions tightly, delivering the consignee's inventory in time. TradeLens allows near-

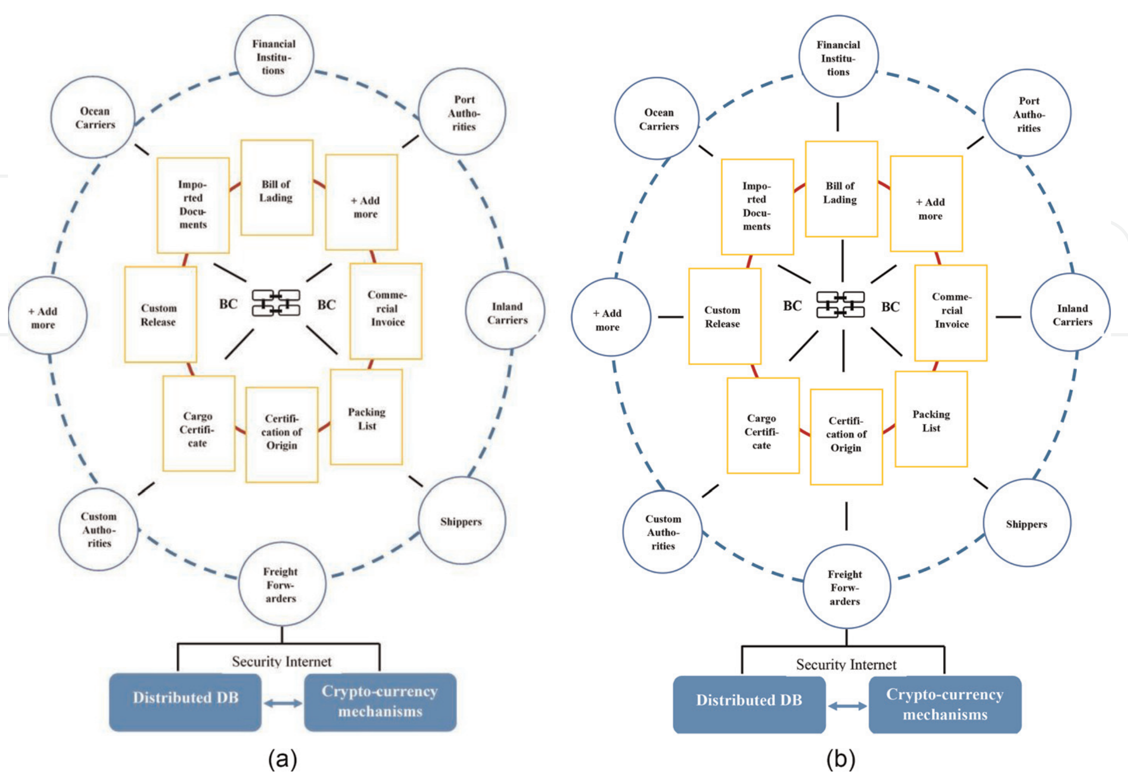

Figure 3.
TradeLens conceptual framework (source: Own).

instant logistics adjustments so the disruptions are kept to a minimum. Global trade is an incredibly complex system, but TradeLens and blockchain create an industry-wide and innovative solution to alleviate this complexity and related impediments.

3.2 Smart contracts

Smart contracts are programs stored on a blockchain that run when predetermined conditions met. They are used to automate the execution of an agreement so that all participants can be immediately certain of the outcome, without an intermediary's involvement or time loss. They can also automate a workflow, triggering the next action when conditions are met [32]. Smart contracts work by following simple "if/when (…) then (…)" statements that are written into code on a blockchain. In the other words, a smart contract presents the lines of code that are stored on a blockchain and automatically executes when predetermined terms and conditions are fulfilled [33]. A network of computers executes the actions when predetermined conditions have been met and verified. These actions could include releasing goods, funds, or confirmations in maritime supply chain. The blockchain is updated when the transaction is completed. That means the transaction cannot be changed, and only parties who have been granted permission can see the results. Blockchain network controls access. Within a smart contract, there can be as many stipulations as needed to satisfy the participants, so that the task will be completed correctly. To establish the terms, participants must determine how transactions and their data are represented on the blockchain, agree on the "if/when (…) then (…)" rules that govern those transactions, explore all possible exceptions, and define a framework for resolving disputes. Then, the smart contract can be programmed by a developer, although organizations that use blockchain for business, provide templates, web interfaces, and other online tools to simplify structuring smart contracts. Key benefits of smart contracts are speed, efficiency, accuracy, trust, transparency, and security (blockchain transaction records are encrypted, which makes them very hard to hack; plus, each record is connected to the previous and subsequent records on a distributed ledger, and hackers would have to alter the entire chain to change a single record). In maritime supply chain, sea waybill or bill of lading can be converted into a smart contract, while it requires an agreement between shipper and carrier, and/or any other relevant and permissioned parties to view the consignment, transport equipment, and documents, as permissions allow [34]. The benefits of such smart contract include simplified transmission of shipping instructions; management of document status and versioning; faster submission of shipping instructions for creation of final bill of lading; quick sharing of documents with all permissioned parties; including immutability, traceability, and auditability of the documents involved.

3.3 Blockshipping

Today the container shipping industry accounts for around 60% of all the world seaborne trade. This valuable industry has been troubled for years by challenges like overcapacity, low freight rates, security threats, and increasing environmental regulations. Currently, there are about 27 million containers in the world, which are moved from one destination to another on trucks, container cars, ships, rail, or waiting in the port, container yard, railway station, and the like. About 5 million containers are uncontrolled and nobody knows their precise locations; if they are currently in transit or waiting for collection. Consequently, no one knows if they are empty or loaded, which means that no one knows if a truck or a train is wasting time and energy carrying an empty "metal box" instead of carrying goods [35]. This is a huge waste of energy; it produces additional costs and negatively affects the environment.

Therefore, the global shared container platform (GSCP) is currently under development. As the world's first blockchain-based container registry, it will allow the industry to help real-time track all containers worldwide. The platform will enable the industry players to manage efficiently all kinds of transactions related to container handling. The GSCP has several user groups like shipping lines, leasing companies, banks, financial institutions, blockchain container investment syndicates, transport service providers, beneficiary cargo owners (BCO), container terminals, container depots, repair shops, etc.

Through a secure login, each user group will have a unique set of functionalities that matches their exact needs. For example, if you are a shipping line export user, you can use GSCP platform to find street turn matching opportunities for ensuring that empty containers meet export demands. You will see an inventory list of all export bookings, which require an empty container to the customer location for stuffing, rather than transporting an empty container from the port or the depo. For convenience, the platform enables users to switch between list and map view. The user can apply one or more filters and inventory will update accordingly, for instance, only showing FEUs (40-feet units). Any set of applied filters can be saved in user's filter presets. This way they are quickly accessible whenever the user needs them. Matching export containers with import containers is easy and swift. This enables both importer and exporter to save an empty container haulage trip, plus gate in and gate out fees at the terminals. The system identifies possible matches based on container size, type, boarding date, previous commodities carried, and availability. The platform also enables sending a request to the involved shipping line with the comment. The GSCP provides various ways to import booking and container data. The user can use EDI and API connection with the in-house booking or order platforms [36].

Blockshipping is, in fact, a shared pool of containers, which enables a "just in time containers" situation. Today more than 40% of all containers in transport are empty. Therefore, resources are wasted and costs are increased. With Blockshipping saving potential for the shipping industry might be at least 5.7 billion USD and reduction of CO_2 emission can be 4.6 million tons yearly [37]. Blockshipping platform is a part of the so-called programmable economy. In such an economy, the interactions among different parties will not occur through mediation of a third trusted party, but automatically through autonomous intelligent software agents (AISA). These are also called dApps (distributed Apps) that run on blockchain and are authorized and instructed by the parties involved in the BMSCS to negotiate autonomously on their behalf.

Four key subsystems of Blockshipping are [38]:

- Global Shipping Container Registry (GSCR), that holds real-time information about every container available through Blockshipping;

- Empty Container Repository Engine (ECRE) that continuously calculates the next best-laden transport for each container. The engine also "understands" the position of every truck available to transport the empty container;

- Autonomous Intelligent Software Agents (AISA) that run on blockchain and negotiate all agreements;

- Smart Contracts (SC) that can be treated as rental contracts established through autonomous negotiations, which persist on the blockchain and govern the rental through binding self-enforcing rental agreements.

Blockshipping has developed a unique revenue-sharing model, while it issues two types of tokens:

- Internal utility token, or Container Platform Token (CPT), and

- External revenue share coin, or Container Crypto Coin (CCC).

The CPT will be used for clearing and settlement of transactions between the users of the platform. These transactions will relate to many different services and fees. A percentage of the revenue goes to a revenue share pool and is passed on to the owners of CCC tokens. Blockshipping exchanges the CPTs in the revenue share pool to Ether via USD. Then, Blockshipping uses smart contracts to convert revenue Dutch auction on the Ethereum blockchain in which Blockshipping offers the owners of the CCC tokens price for their tokens. The offered price will increase until all available Ethers are spent. After the auction, Blockshipping distributes the acquired CCC tokens to all the owners of CCC tokens on a pro-rata basis. In this way, token owners are rewarded regardless of their decision to sell or keep their CCC tokens [39].

The processes flow within Blockshipping is based on several simple and fully automated steps. The easiest way to make an explanation is to follow an example. Let us assume that the shipping line needs to rent a container to transport goods from Nairobi (Kenya) to Rotterdam (Netherlands). Blockshipping empty container repository engine identifies the best-positioned empty container in Nairobi and informs the shipping line about the options. The shipping line informs its autonomous intelligent software agents (AISAs) about the containers. The rental negotiations then happen unsupervised between the shipping line and the container owner through their autonomous agents. The agreements established by AISAs are persisted on blockchain in smart contracts that govern the rental in binding self-enforcing rental agreements. Blockshipping container platform tokens CPT are used to pay rental fees, while the fees are transferred from the shipping line wallet, in accordance with the smart contract and reserved payment. Smart contracts can be changed if conditions change. For example, if the rental period is extended when the container reaches its final destination in Rotterdam. Then, the smart Oracle blockchain enforces the smart contract. The rental ends and releases CPTs to the container owner's wallet [40].

In addition to TradeLens and Blockshipping, there are a number of other blockchain applications in maritime. Some of these are given in **Table 6**. Concerning safety issues, semi-private blockchains are common. The consortium companies' reputation speaks, in fact, about safety. Maritime, as conservative, assesses and recognizes the quality of operation in long run. As we said previously, stakeholders in maritime are not early adopters. However, trust between network participants is a bigger problem than safety. The blockchain is an unorthodox technology and cryptocurrencies are still highly volatile. In such a setting, maritime stakeholders do not like to disclose essential business information about customers, suppliers, and cargo. Many freight forwarders and intermediaries, e.g., earn their profit thanks to information asymmetry. Interoperability will be a smaller problem in terms of technology (since standards have been developing) than in terms of trust and smooth process flows at (inter-)organizational level.

No.	Blockchain		
	Consortium	**Platform**	**Ledger**
1.	Port of Koper, Slovenia	CargoX	Public
2.	Malaysia's West Port & LPR - Brazilian textile importer	300cubits	Public
3.	Maersk & IBM	TradeLens	Consortium (permissioned)
4.	Abu Dhabi Ports and Port of Antwerp	Silsal	Consortium (permissioned)
5.	EY & Guardtime	Marine Insurance Blockchain	Public
6.	PIL, PSA & IBM	Proof of Concept (POC)	Consortium (permissioned)
7.	Port of Antwerp with Belfruco, Enzafruit, PortApp, 1-Stop and T&G Global	Smart Contracts	Consortium (permissioned)
8.	2021.AI Den Danske Maritime Fond, EUDP, INVICTA	Blockshipping	Public
9.	Port of Malmo & Port of Copenhagen	PortChain	Consortium (permissioned)
10.	AAT, FileVersion Health, CROP	CargoChain	Consortium, (permissioned)

Source: Adapted from [41].

Table 6.
Some blockchain applications in maritime.

3.4 Case study on blockchain adoption

Within this case study, we explored how maritime stakeholders in two developing countries, South Africa and Montenegro, perceive blockchain technology and its implementation in maritime. Through the methodological framework given in [26, 27] we conducted the survey, which included thirteen closed-ended questions, or statements on blockchain adaption. Concerned statements included the following blockchain dimensions: knowledge, infrastructure, standards, experts, diverse stakeholders, government and regulatory policy, social influence, loss of jobs, computing and storing capacity, complexity, opportunistic behavior, sharing information, and security. The respondents were from maritime companies, agencies, research organizations, governmental bodies, insurance companies, and universities. They are from the executive management level in industry and governmental bodies, and active researchers, professors, and lecturers from universities (10 from South Africa and 10 from Montenegro, all with more than 5 years of research experience). The respondents have had to express their (dis)agreement with the proposed statements via Likert 1–5 scale, where 1 represents the lowest level of (dis)agreement, and 5 the highest level of (dis)agreement. The rest of the offered numerical values are respectively in-between these two extremes. The statements and average values of assessments are given in **Table 7**. If the average score per group of respondents is between 1 and 2.5, then the level of (dis)agreement is "low"; if it is between 2.6 and 3.5, then the level of (dis)agreement is "moderate", and if it is between 3.6 and 5, then it is "high".

Five statements with the highest "agree" and "disagree" assessment rates are categorized in different PESTEL (political, economic, social, technological, environmental, and legal) dimensions, along with their rank (**Table 8**).

Statement	Agree	Disagree
S1: The level of awareness and knowledge of BC affects its adoption.	▲ (High)	▲ (Low)
S2: The BC adoption is affected by the availability of the infrastructure and functionality to integrate and interoperate within and across the business ecosystem.	▲ (High)	▲ (Low)
S3: Standardization and ensuring smooth interoperability is necessary, otherwise, BC can make things difficult instead of making them easier.	▲ (Moderate)	▲ (High)
S4: The BC adoption is affected by the availability of skilled and expert resources.	▲ (High)	▲ (Low)
S5: The BC adoption is affected by a large number of stakeholders, with different mindsets, organizational culture, and working habits.	▲ (Moderate)	▲ (Moderate)
S6: The BC adoption is increased by favorable government and regulatory policies.	▲ (High)	▲ (Low)
S7: Social influence positively affects the behavioral intention of using BC.	▲ (Low)	▲ (High)
S8: A perception that BC implementation might lead to loss of jobs can be an obstacle in its adoption.	▲ (High)	▲ (Moderate)
S9: Development in storage, computing, and cloud infrastructure will affect BC adoption.	▲ (High)	▲ (Moderate)
S10: The BC adoption reduces opportunistic behavior (opportunistic behavior means maximization of economic self-interest and occasioned loss of the other partners).	▲ (Low)	▲ (High)
S11: The BC adoption is reduced if the information is not shared by the partners, while some stakeholders are hesitant to share information considering it is a competitive advantage.	▲ (High)	▲ (Moderate)
S12: Privacy and security of models and data need to be ensured, as BC technology is still immature and vulnerable.	▲ (Moderate)	▲ (Moderate)
S13: Blockchain offers a high level of complexity and observability at the same time.	▲ (Low)	▲ (High)

Legend: ▲ *High (dis)agreement;* ▲ *Moderate (dis)agreement;* ▲ *Low (dis)agreement; BC – blockchain*
Source: Own.

Table 7.
The assessments of blockchain adoption.

The respondents consider awareness and knowledge about blockchain as a social dimension of the highest importance for its adoption in maritime. This is understandable, since knowledge is the biggest asset; the only one which grows with exploitation during the time. On the second place is infrastructure, which falls under technological dimension. This is reasonable since, without it, blockchain adoption is practically impossible. In the third places are favorable government and regulatory policies that fall under political and legal dimensions. This is of crucial importance since economic development in South Africa and in Montenegro is controlled by the government. On the fourth place is experts' knowledge, which belongs to the social dimension of PESTEL model, and which is to a certain extent connected with awareness and knowledge, but it can be outsourced in the case of its lack, and under the assumption that awareness and general knowledge about blockchain are in place. The fifth place is the hesitancy of sharing information among the parties, and it falls under both economic and environmental dimensions of PESEL. This is understandable, since once blockchain becomes well established; the impact of this issue will be reduced.

The highest disagreement is observed regarding 'simultaneous' presence of blockchain complexity and observability. Majority of the respondents show suspicion

P Political	E Economic	S Social	T Technological	E Environmental	L Legal
Respondents "Agree"					
*Favorable government policies (rank 3)	*Hesitancy of sharing information (rank 5)	Awareness and knowledge about BC (rank 1) Skilled and expert resources (rank 4)	Infrastructure (rank 2)	*Hesitancy of sharing information (rank 5)	*Favorable regulatory policies (rank 3)
Respondents "Disagree"					
	Reduction of opportunistic behavior (rank 2)	Social Influence (rank 3)	Complexity and observability (rank 1) *Standardization (rank 4) **Ensuring privacy and security (rank 5)	**Ensuring privacy and security (rank 5)	*Standardization (rank 4) **Ensuring privacy and security (rank 5)

- Constructs marked with "" correspond with two different PESTEL dimensions.*
*- Constructs marked with "**"correspond to three different PESTEL dimensions.*
Source: Own.

Table 8.
PESTEL analysis.

regarding this paradox. Furthermore, the respondents do not agree with the statement that blockchain will reduce opportunistic behavior. South Africa and Montenegro are countries that are for decades in transition and suffer from the permanent reproduction of crisis. Consequently, the responders' rather skeptic attitude towards this statement is completely understandable. The social influence is in the third place. The respondents do not believe that society can affect considerably the implementation of this advanced technology, and this belief is based on their experiences from transitional settings. The statement, which deals with the standardization issue, is "negatively" assessed, but it might be the case due to the experts' belief that standardization must be achieved and that it cannot as such threaten blockchain key advantages. The need for ensuring privacy and security is assessed negatively. This means that some respondents strongly disagree with the statement that blockchain technology is still immature and vulnerable. Due to their response, one can conclude they believe that blockchain technology is at a high level of development and that is less vulnerable than it can appear due to its complexity and deployment at a global scale. This construct can correspond with technological, environmental, and legal PESTEL dimensions at the same time.

Since we collected only twenty survey responses, further research should include in-depth interviews or a survey upon a larger poll of experts and profound discussion on the respondents' assessments, including comments and suggestions. In addition, the following investigation in the field should include experts from other developing and transitional countries (besides South Africa and Montenegro), including a longitudinal approach. Building new knowledge and transfer of existing one on blockchain technological and other crucial dimensions are necessary, particularly in developing countries, which suffer the lack of skilled personnel and expert knowledge, dominantly in the technological domain.

4. Conclusion

Maritime is lagging behind other areas of business and industry in terms of digitization. This is especially true in developing countries. Therefore, in this chapter, the results of two case studies on digitalization in maritime, conducted in developing countries, are presented, along with some comparative analyzes with developed countries in certain areas. These studies were conducted on a relatively small sample and in the future, longitudinal studies should be conducted on a larger sample and in a larger number of countries in transition. The results should be presented to ICT&S designers in developed countries in order to find solutions for intelligent design of ICT&S in maritime in perspective. These systems should provide benefits for all. If we strive for sustainable development, then it must ensure development for all. Entire continents cannot be excluded from the plans for further development of ICT&S, artificial intelligence, and virtual reality. This, of course, requires a broader platform, which includes standardization of ports and ships as basic maritime structures onto which ICT&S are built.

General knowledge about new technologies in developing countries exists, but there is a lack of expertise when it comes to hardware, software, network architecture, cyber safety, security, etc. Furthermore, developing countries suffer lack of funds for investments in advanced ICT&S. These countries are excluded from the strategic plans on the development and implementation of new ICT&S solutions. The governments should consequently invest more into attaining sound knowledge in contemporary ICT&S, including disruptive technologies like blockchain and its implementation in global supply chains. Standardization in maritime is the key enabler of faster modernization. In addition, profound research of internet connectivity at sea is of crucial importance for further development of IoT applications in maritime as the key condition for achieving equal presence of ICT&S applications on land and at sea. Maritime industry and high(er) maritime education institutions should cooperate much more closely to alleviate the gap between developing and developed countries in terms of achieving a higher level of graduates' employability, while the sphere of digitalization can provide many opportunities in this respect. Rising awareness about digital transition in maritime and opening discussions among professionals and academics should become common practice. The involvement of legislatures and tight collaboration of key stakeholders in maritime emerging economies are necessary regarding harmonization of ICT&S deployment across global maritime ecosystem and overcoming the existing gap in digitalization.

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References

[1] Tsai HC, Chen K, Liu YY, Shuler JM. Demonstration (DEMO) of radiofrequency identification (RFID) system for tracking and monitoring of nuclear materials. Packaging, Transport, Storage & Security of Radioactive Material. 2010;**21**(2):91-102. DOI: 10.1179/174650910X12628787557739

[2] Tsai HC, Chen K, Liu YY, Norair JP, Bellamy S, Shuler J. Applying RFID technology in nuclear materials management. Packaging, Transport, Storage & Security of Radioactive Material. 2008;**19**(1):41-46. DOI: 10.1179/174651008X279000

[3] Bauk S, Dzankic R. Tracking radioactive materials in sea transportation via RFID technology. In: Proceedings of the 8th Maritime Transport Conference (MT2020); 17–18 September 2020. Barcelona, Spain: UNCTAD; 2020. pp. 91-102

[4] Kapidani N, Bauk S, Davidson IE. Digitalization in developing maritime business environments towards ensuring sustainability. Sustainability. 2020; **12**(21):9235. DOI: 10.3390/su12219235

[5] Bauk S, Kapidani N, Schmeink A, Holtham C. Concerning intelligent ICT exploitation in some maritime business organizations: A pilot study. International Journal of Maritime Science & Technology Our Sea. 2017;**64**(2):63-68. DOI: 10.17818/NM/2017/2.5

[6] Bauk S, Kapidani N, Schmeink A. On intelligent use of ICT in some maritime business organizations. Montenegrin Journal of Economics. 2017;**13**(2): 163-173. DOI: 10.14254/1800-5845% 2F2017.13-2.11

[7] Bauk S, Calvo LJA, Schmeink A, Azam S, Mathar R. On deploying vehicular communication at the developing seaport and related innovation success impediments. Transport. 2019;**34**(1):126-134. DOI: 10.3846/transport.2019.7987

[8] Holtham C, Stace D, Courtney N. Balancing technology, business processes and skills: key determinants of firm-level information systems success? In: ITU and LBS Digital Transformations in the Information Society Conference; 1-2 June 2006. Geneva, Switzerland: WHO; 2006

[9] Holtham C, Stace D, Courtney N. Mapping opportunity space: Options for a sustainable E-strategy. Strategic Change. 2004;**13**(5):237-251. DOI: 10.1002/jsc.691

[10] Holtham C, Courtney N. Developing managerial learning styles in the context of the strategic application of information and communication technologies. International Journal of Training and Development. 2001; **5**(1):23-33. DOI: 10.1111/1468-2419. 00119

[11] Cambridge Dictionary. Make Your Words Meaningful. n.d. Available from: https://dictionary.cambridge.org/ dictionary/english/knowledge [Accessed: 09 Febuary, 2022]

[12] Rockart J F. The Changing Role of the Information Systems Executive: A Critical Success Factors Perspective. 1982. Available from: https://dspace.mit. edu/bitstream/handle/1721.1/2010/ SWP-1297-08770929-CISR-085.pdf?se quence=1 [Accessed: 13 Febuary, 2022]

[13] Earl MJ. Information Management: The Organizational Dimension. New York, NY, USA: Oxford University Press; 1998. p. 514

[14] Earl MJ. Management Strategies for Information Technology. London, UK: Prentice Hall; 1989. p. 232

[15] Weil P, Ross JW. IT Savvy—What Top Executives Must Know to Go from Pain to Gain. Boston, MA, USA: Harvard Business Press; 2009. p. 182

[16] Kadiri SE, Grabot B, Thoben KD, Hribernik K, Emmanouilidis C, Cieminski G. Current trends on ICT technologies for enterprise information systems. Computers in Industry. 2016; **79**:14-33. DOI: 10.1016/J. COMPIND.2015.06.008

[17] Sanchez-Gonzalez PL, Diaz-Gutierrez D, Leo TJ, Nunez-Rivas L. Towards digitalization of maritime transport. Sensors. 2019;**19**(4):926. DOI: 10.3390/s19040926

[18] Liu J, Zhang H, Zhen L. Blockchain technology in maritime supply chains: Applications, architecture and challenges. International Journal of Production Research. 2021:1-15. DOI: 10.1080/00207543.2021.1930239

[19] World Economic Forum. Enabling Trade, Valuing Growth, Opportunities. 2013. Available from: https://www3.weforum.org/docs/WEF_SCT_EnablingTrade_Report_2013.pdf [Accessed: 09 Febuary, 2022]

[20] Gausdal AH, Czachorowski KV, Solesvik MV. Applying blockchain technology: Evidence from Norwegian companies. Sustainability. 2018;**10**:1985. DOI: 10.3390/su10061985

[21] Ytterstrom J, Lengerg L. What Role Will Blockchain Play Within the Maritime Shipping Industry in Five Years? Gothenberg, Sweden: University of Gothenburg School of Business, Economics and Law; 2019 Available from: https://pdfs.semanticscholar.org/b6d7/cf06c4853ef1745ab4dd12f65f3cc7f5bcb2.pdf [Accessed: 09 Febuary, 2022]

[22] Knirsch F, Unterweger A, Engel D. Privacy-preserving blockchain-based electric vehicle charging with dynamic tariff decisions. Computer Science – Research and Development. 2018;**33**: 71-79. DOI: 10.1007/s00450-017-0348-5

[23] Green E H, Carr E W, Winebrake J J, Corbett J J. Blockchain Technology and Maritime Shipping: An Exploration of Use Cases in the U.S. Maritime Transportation Sector. 2020. Available from: https://www.maritime.dot.gov/sites/marad.dot.gov/files/2020-07/Blockchain%20Use%20Cases%20Final%20Report%20%2820200622%29.pdf [Accessed: 09 Febuary, 2022]

[24] Bhattacharya P, Saraswat D, Dave A, Acharya M, Tanwar S, Sharma G. Davidson I E, coalition of 6G and blockchain in AR/VR space: Challenges and future directions. IEEE Access. 2021; **9**:168455-168484. DOI: 10.1109/ ACCESS.2021.3136860

[25] Vardai Z. Top 5 Blockchain Trends for 2022 and Beyond. 2021. Available from: https://forkast.news/top-5-blockchain-trends-with-lasting-impact/ [Accessed: 11 Febuary, 2022]

[26] Kapidani N, Bauk S, Davidson IEA. Developing countries concerns regarding blockchain adoption in maritime. Journal of Marine Science and Engineering. 2021;**9**(12):1326. DOI: 10.3390/ jmse9121326

[27] Kapidani N, Bauk S, Davidson IEA. Deploying blockchain in maritime: Developing environments concerns. High Technology Letters. 2021;**27**(9): 942-951

[28] Drljevic N, Aranda D, Stantchev A. Perspectives on risks and standards that

affect the requirements engineering of blockchain technology. Computer Standards & Interfaces. 2020;**69**: 103409. DOI: 10.1016/j.csi.2019.103409

[29] Zhou Y, Soh YS, Loh HS, Yuen KF. The key challenges and critical success factors of blockchain implementation: Policy implications for Singapores maritime industry. Marine Policy. 2020; **122**:104265. DOI: 10.1016/j. marpol.2020.104265

[30] Burgess M. Artificial Intelligence – How Machine Learning Will Shape the Next Decade. London, UK: Penguin Random House; 2021. p. 165

[31] TradeLens. Shipping in the Age of Blockchain. 2019. Available from: https://www.youtube.com/watch?v= Xwqo_fwPEJo&t=1925s [Accessed: 11 Febuary, 2022]

[32] IBM. What are Smart Contracts on Blockchain? n.d. Available from: https:// www.ibm.com/za-en/topics/smart-c ontracts [Accessed: 01 January, 2022]

[33] Jensen T, Henningsson S, Hedman J. Delivering business value with blockchain technology: The long journey of TradeLens. MIS Quarterly Executive. 2019;**18**(4):221-243. DOI: 10.17705/ 2msqe.00018

[34] IBM and Maersk. TradeLens Documentation: Actionable Doc Flows. 2020. Available from: https://docs.trade lens.com/how_to/actionable_doc_flows/ [Accessed: 10 Febuary, 2022]

[35] NewsBTC – Bitcoin & Cryptocurrency News. First view of Blockshipping's Global Shared Container Platform. 2018. Available from: https:// www.newsbtc.com/sponsored/first-view-of-blockshippings-global-shared-container-platform/ [Accessed: 11 Febuary, 2022]

[36] Blockshipping GSCP. Just in Time Containers. 2018. Available from: https://www.youtube.com/watch?v= BUas6vfWLeo&t=85s [Accessed: 11 Febuary, 2022]

[37] Blockshipping GSCP. The GSCP Explained. n.d.. Available from: https:// medium.com/@Blockshipping/the-gscp-explained-17804b0b09fc [Accessed: 01 Febuary, 2022]

[38] Blockshipping GSCP. The Four Critical Components of the GSCP 2018. Available from: https://www.youtube. com/watch?v=YIz9-e70hmw&t=55s [Accessed: 11 Febuary, 2022]

[39] Lennart M. Introducing Blockshipping: The Global Shared Container Platform. 2018. Available from https://medium.com/@lennart_ 7988/introducing-blockshipping-the-global-shared-container-platform-4da 87abf0dba [Accessed: 11 Febuary, 2022]

[40] Blockshipping GSCP. The GSCP Flow. 2018. Available from: https:// www.youtube.com/watch?v=kMV0A-L-dMw&t=89s [Accessed: 11 Febuary, 2022]

[41] Marine Insight. 7 Major Blockchain Technology Developments in Maritime Industry. 2021. Available from: https:// www.marineinsight.com/know-more/ 7-major-blockchain-technology-deve lopments-in-maritime-industry-in-2018/ [Accessed: 09 Febuary, 2022]