Maritime Blockchains: Decoding Diverse Strategies for Value Extraction

Abstract

In our paper, we present a maritime blockchain research framework, tested via our field study of four maritime blockchain cases. We examined maritime blockchain cases that represent the different archetypal types of organizations that are undertaking enterprise blockchain initiatives, namely; start-up companies, maritime incumbents, blockchain research consortia, and blockchain platform technology providers. For each type of blockchain initiative, we investigate blockchain technology, business strategies and blockchain innovation diffusion factors.

Keywords: *shipping, maritime enterprise blockchains, Hyperledger Fabric, digital innovation*

1. Introduction

Blockchain is considered broadly as a principal, disruptive technology, today. Correspondingly, the need for systematic approaches to understand blockchain technology, its disruptive potential and principles for the development of viable use cases, is also a recognized research issue (Fridgen et al, 2018). Better delineating the "multi-level and multi-actor" phenomenon of digital disruption created by maritime business blockchain technology is a topic of contemporary maritime studies that has only started to engage academics and practitioners, henceforth offers the potential of a plethora of interpretive and normative research angles to employ. Very recent, generic academic research results delineate factors affecting blockchain technology diffusion and management, alongside with important technological perspectives, such as use cases design, blockchain software architectures and blockchain development platforms.

Our paper is structured as follows: in section 2, we overview extant research that frames maritime blockchain phenomena in view of disruptive innovation. In section 3, we exemplify in detail our research model, composed of three main themes; blockchain technology choices, blockchain value, and management practices. Finally in section 4, we explain our field study approach and findings.

2. Maritime Blockchains and Disruptive Innovation

Maritime enterprise blockchain applications are not merely an aggressive communications strategy of industry players pursuing to claim, control and exploit a new market, but a business reality. Incumbent maritime organizations and new entrants actively explore challenges and business opportunities enabled by applying emergent distributed ledger technology, in maritime business-to-business settings. A number of proof of concept systems have already been developed and tested, also a couple of flagship applications, namely TradeLens, Insurwave and CargoX platforms are in operation. Mostly, maritime enterprise blockchains account to smart contracts over permissioned (private) blockchain platforms, which digitise trade documentation processes. Fewer applications account to IoT enabled blockchains for cargo and ship machinery monitoring. A few prototyped applications also include shipping crypto currency services. Maritime applications are expected to further evolve to capture the actual transformational potential of the blockchain fundamental technological features, beyond incrementally improved paperless operations management, or distributed but not decentralized physical asset management.

As Iansiti and Lakhani, 2019 argue, "blockchain is not a disruptive technology, which can attack a traditional business model with a lower-cost solution and overtake incumbent firms quickly". Blockchain is a foundational technology, comparable to other infrastructure technologies, like Internet protocol TCP/IP, or computer operating systems, which took many years of development to mature and enable new transformative applications for the business and social environment. The process of blockchain technology development and market adoption, as early evidence shows, is also expected to comprise a few distinct waves of technological and institutional adjustments, typical of foundational technologies of high complexity and novelty. Building on the above argument, we posit that a persmissioned maritime blockchain for trade documentation, built with Hyperledger Fabric platform v1.3 features and deployed with IBM SaaS cloud technology could be perceived as a viable use case, however of relatively low novelty and low disruptive impact. Self-executing maritime logistics smart contracts could be a rather transformative application of blockchain technology, in the near future. Maritime Distributed Autonomous Organizations (DAO) is another possible outcome that represents a blockchain innovation of higher novelty and disruptive impact, as autonomous agents are involved, being in nearly full control of the blockchain based business operation (Zamani and Giaglis, 2018).

Disruptive innovation involves a considerable change of market actors, in markets' boundaries, the way business needs and perceived and served, and the principal logic of how firms are organized; also it reveals new paradigms for economic development. Hence, disruptive or, in similar terms, radical innovation entails important market, technical, and organizational uncertainty, which is often manifested in terms of a prolonged technology life-

cycle (i.e. blockchain "dominant designs" development, standards development and broad market diffusion). Thus, we posit that a lengthy technology evolution and market adoption process is expected to shape the micro foundations and organizing logic of maritime blockchains. Our study considers the underpinnings of disruption research, in the context of maritime enterprise blockchains, and theorizes and tests maritime blockchain aspects pertaining the current technology trajectory phase; namely in between ferment and maturity.

Hopp et al, 2018 provide a thorough review of disruptive innovation literature, identifying important topics, their interdependencies, and the evolution of disruptive innovation research foci, up to the digital innovation era. Classic, core innovation theory themes, both these currently being heavily invoked, such as Christensen's seminal analysis of disruption (http://www.claytonchristensen.com/key-concepts/), but also individual themes that have lost traction over time, such as the dominant design analysis, technology life cycle analysis, the business behaviour of incumbents, and alliances can all be reemployed and enable new theorizing in the quest to understand and influence digitalization opportunities and outcomes, such as those pertaining blockchain technology.

A main research pathway, presented in Hopp et al, 2018, is to revisit core theory in order to understand and influence new digital economy phenomena, namely the platform business models (Gawer and Cusumano, 2014). Reengaging with the old themes and theory of organizational or innovation capabilities with "a particular focus on issues such as organizational resilience, renewal, and rejuvenation", alongside the need to revisit innovation process issues, also the need for research to link the macro and micro perspectives on disruptive innovation are all emphasized research perspectives. As Stanske and Kautz, 2018 highlight, an incumbent indeed can again advantages by developing a disruptive technology (i.e. from individual service provision to a platform-based business model), however this pro-active paradigm shift can be undergirded by a complex process, entailing vicious and virtuous circles, for legitimacy construction (internal, and at the industry level). In the present paper, we illustrate a blockchain research framework guided, in particular, by the above described main research gaps and prioritized themes and issues, acknowledged in the ongoing information systems and innovation management academic discourse.

2.1 Research themes

During this on going, early phase of development and operation of maritime enterprise blockchain applications, effectual organizations primarily perceive *business value* generated by blockchain in terms of the ability to (a) conduct business transactions quickly and cost-efficiently, (b) transparently monitor trade documentation, cargo and further assets, (c) achieve data validity and traceability (d) have a fault tolerant information security infrastructure that enforces business trust or accountability among maritime supply chain partners with diverse interests and organizational traditions (Lacity and Khan, 2019).

Sternberg and Baruffaldi, 2018 have reviewed supply chain blockchain initiatives and theorized the logic and challenges of blockchains in the supply chain industry. The authors conclude that while some incentives of developing and using blockchain technology exist, as of today, it is not apparent how companies can actually benefit with a materialized business advantage. Due to the ever prevailing need for a satisfactory mechanism to establish institutional trust, such as a central trusted authority (despite blockchain platforms' features of private networks and side channels for secure and confidential transactions), and the fact that the integration of logistics activities is of high complexity, leads the authors to question the potential of actual supply chain disruption by blockchain technology.

Kshetri, 2018 also reviews supply chain industry cases, including maritime logistics platforms, and delineates the blockchain's role in supply chain management. The cases illustrate drivers and mechanisms for meeting cost, quality, speed, dependability, risk reduction, sustainability and flexibility objectives. Furthermore, identified determinants of blockchain adoption include the number of entities involved (viable blockchain ecosystem), their capabilities and the extent of industry competitive pressure. Supply chain companies exert (or receive) not only competitive but also normative pressures, effectual to blockchain diffusion, which eventually supports pertinent supply chain objectives such as sustainability, product quality or risk reduction (i.e. opportunistic behaviour).

Lacity and Khan 2019, outline emerging *best practices in the use of enterprise blockchains* applications, in a number of different sectors. The authors optimistically report "dramatic mind-shifts in how organizations approach traditional notions of governance". Furthermore, profound consequences on business emerging business relationship structures, outplacing traditional notions of market power and trust are postulated. The study reveals that leading blockchain actors participate in multiple blockchain working groups/consortia in order to mitigate the risk to invest in one dominant standard, in reality actively shaping blockchain standards, the platform code base and tools to expedite market adoption; an observation also validated in the maritime sector i.e. the Maersk portfolio approach of blockchain projects.

Post et al. 2018 further observe and systematize *factors affecting blockchain technology diffusion*; pertinent factors at the *strategic level* refer to the necessary paradigm shift where organizations realize and experiment with an extravert paradigm with shared information and corporate governance with competing entities. Extensive external and internal collaboration for blockchain exploration and implementation as well as consideration of possible market (re) positioning due to emerging blockchain business models are proposed. Sector pressure to investigate the technology but also investment hesitation is also identified. Regulatory and compliance issue is another prevailing strategic factor identified in the particular study. Similarly, at the *tactical level*, *the knowledge deficit*, regarding blockchain technical

knowledge as well as application domain knowledge for implementing sectoral applications; henceforth a high difficulty in designing viable use cases (that fit with the readiness, maturity and idiosyncrasies of the particular sector) are highlighted. The authors also identify problematic project and change management approaches. Last, at the operational level, *technical shortcomings*, in terms of competing data models, smart contract protocols and inadequate tools (platform supported process modelers, and simplified smart contract modelers) are identified.

3. Maritime Enterprise Blockchain Research Framework

Against this background, examining the incentives (value drivers) of exemplar maritime actors to invest in and adopt blockchain technology, and how these drivers influence the conditions that blockchain initiatives are implemented and managed in the maritime environment (performativity) is our main focus. The interdepended blockchain technology features of various platforms and use cases (affordances) constitute an additional research angle of our paper (Li et al, 2018; Tavakoli and Schlagwein, 2016).

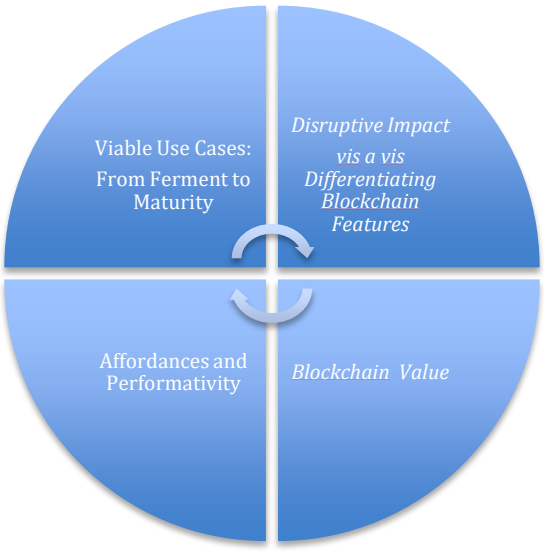

Figure 1: Blockchain Research Model

In the following subsections, we further delineate the above-identified pertinent themes, relating the macro and micro perspectives, and composing our contextualized maritime enterprise blockchain research framework:

3.1 Blockchain Technology Choices

As widely communicated, blockchain can be defined as an immutable ledger for recording transactions, maintained within a distributed network of participants (nodes). The blockchain entities execute a consensus protocol to validate transactions; transaction information is

grouped into blocks, hash (cryptographic) functions are attached to the blocks forming transactions chains. Nakamura and Nakagoshi, 2018, from the viewpoint of system network architecture, divide blockchain into three types: public, consortium and private, and summarize the comparison among them as shown in Table 1. Also, the authors recommend applying consortium/private type for corporate activities.

Table 1: Blockchain Types

	Public	**Consortium**	**Private**
Management of participant	-No permission for participant -No management body	-Need permission for participant -Need management body	-Need permission for participant -Need management body
Suitable area	-Open innovation	-Ecosystem (no decentralized)	-Within one company or corporate group
Assumed use case	-Cryptocurrency -Sharing economy	-Community currency -Exchange between banks -Crowdsourcing	-Traceability in factories, production plants -Business Accounting System
Feature	- High availability - No need to operate and manage an environment of established network - Cannot control the confidential data transaction - Slow Processing	- Quick Processing (Compared with public) - Can control confidential data transaction - Low availability (compared with public) - Need to operate and manage an environment of established network (i.e., ecosystem)	- Quick Processing (Compared with public) - Can control confidential data transaction - Low availability (compared with public) - Need to operate and manage an environment of established network (i.e., ecosystem)

Enterprise blockchains have inherited only certain characteristics of the first Bitcoin technology; Enterprise blockchains have mutated to serve the business environment requirements, hence they principally include private (permissioned) blockchains, which in essence operate a blockchain shared among a set of known, identified (yet confidentially transacting) participants. Currently, enterprise blockchains typically execute business transaction logic in the form of smart contracts, effectively comprising a trusted distributed business software application, with strong security performance attributed to the blockchain protocols (Androulaki et al, 2018; Nakamura and Nakagoshi, 2018; Christidis and Devetsiokiotis, 2016).

All main, generic technology platforms, namely Hyperledger Fabric, Enterprise Ethereum and R3-Corda Enterprise are continuously evolving. These platforms constitute the basic

technology (infrastructure layer) used for the development, deployment and operation of maritime enterprise blockchains (application layer). No proprietary blockchain platforms appear to challenge their market dominance (Medium, 2019).

Hyperledger Fabric is a modular and extensible open-source system for deploying and operating permissioned blockchains and consist the dominant, commonly used in maritime enterprise blockchains, development platform (www.hyperledger.org). To a large extent, nowadays, maritime enterprise blockchains bear their capabilities to the embedded features of Hyperledger Fabric platform; the application layer (smart contract) relating predominantly to the maritime business model enabled. A smart contract, also called chaincode, is the code implementing the particular business logic (i.e. tracing shipments and notifying rightful business participants). Except from applications chaincode, system chaincode exists for configuring, managing and running the blockchain system.

We argue that blockchain value is interdependent with the disruptive impact of differentiating blockchain features of these platforms (and the different blockchain types outlined in Table 1), namely the level of permission, data access, transaction consensus protocols, modularity, scalability, interoperability, centralization, and anonymity. The different blockchain platforms features shape the actual maritime enterprise blockchain applications.

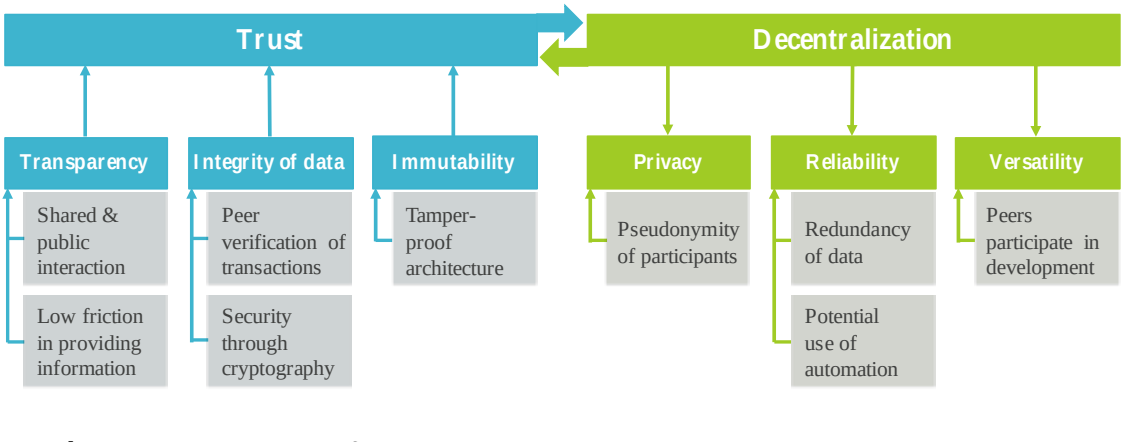

Figure 2: Blockchain Technology Characteristics

Source: Seebacher and Schuritz, 2017

3.2 Blockchain Value

We postulate that blockchain value needs to be elaborated and tested beyond the customary facets of immutability or time and cost efficiency; an extended array of value dimensions, namely the strategic value of pursuing a (near) monopoly blockchain platform position, also new cyber mediation - value creation occasions need to be assessed. Similarly, the operational value and costs, such as the cost of blockchain deployment, migration costs of legacy systems onto blockchain systems (with or without API facilitated solutions) or how to allocate the blockchain costs along the maritime logistics chain need to be addressed;

henceforth, developing a more complete understanding of socio-economic, strategic as well as operational value angles and strategies is essential (Risius and Spohrer, 2017).

Firm level

Bauer et al 2019, investigated the value creation rational of a diverse set of blockchain ecosystem stakeholders. Three pertinent dimensions are articulated, which have also relevance and applicability in the maritime context, as follows:

(a) *distributed service innovation*; blockchain projects' participants explore the possibility to create new services such as the "co-owned trade documentation service", that has multiple owners, namely the particular blockchain ecosystem companies who are all able to co-create and appropriate value through the platform; a strategy predominantly explored in maritime blockchains.

Highly transformative digital business models, such as the self-executing contracts, blockchain marketplaces or any other form of DAO have not been chosen as a viable use case in any of the maritime blockchain platforms. Business model innovation by disrupting traditional maritime intermediaries is not a business (viable) case promoted by any major maritime incumbent-led blockchain initiative.

(b) *permissioned, business partner relationship management:* based on the blockchain infrastructure capabilities for controlled data access through meticulous data sharing specifications, a private network of companies performs business transactions with optimal business performance and quality criteria; a primary strategy materialized in maritime blockchains (https://docs.tradelens.com/learn/tradelens_overview/).

For instance, the Shipment Manager application of TradeLens platform, via an easy to use interface allows each maritime ecosystem partner to visualize those business events and documents associated with their consignments. Search and filter options using different, relevant criteria, treat platform users as customers being served with bespoke consignment services. Trusted access to necessary data is further ensured by the blockchain platform capabilities of user/subscription management. Sensitive information including documents is distributed only to those organizations (blockchain nodes) participating in a private and confidential sub network (channel) configured to conduct the particular maritime transaction. Hence, through contextualized design (or simply configuration) of embedded cryptographic algorithms, access permissions and consensus protocols, enterprise blockchains enact better optimized business relationships.

(c) *shared operational efficiency*: a maritime blockchain application typically integrates maritime logistics data from different business partners onto a common, trusted business network, and hence provides *real-time*, *secure* access to *valid* end-to-end supply chain

information to all actors involved in a specific *shipping transaction* (i.e. an X to Y consignment).

For instance, maritime organizations can publish events (i.e. ActualGate In event) and be notified for occurring events related to a specific shipment transaction based on their subscriptions and blockchain channel management. The particular blockchain technical features enable maritime stakeholders to operate in a trust inducing environment, and improve operations through sharing processes and "leveraging cross-organizational efficiencies" (Bauer et al 2019).

Ecosystem factors

Rückeshäuser, 2017 presented a typology of business models that are based on blockchain technology; various market segments served by distinct blockchain technology providers are shown, (in Fig. 2).

Dimensions	***Options***					
Core Value Proposition	Infrastructure Provision	Platform-Based Development	Application-Based Integration	Service/ Application Provision	Supporting/ Supplementary Services	
Market Segment	Software Developers	Big Businesses	Small and Medium-sized Businesses	Business End-Consumer	Private End-Consumer	Gov-ern-ment
Value Network Positioning	Before Transaction		During Transaction		After Transaction	
Revenue Stream	Transaction-Based	Revenue Sharing	Licensing & Consulting		Subscription/ Account-Based	

Figure 3: Blockchain Business Models

Source: Rückeshäuser, 2017

There is a clear decoupling of the blockchain platform provider role, the blockchain application developers, also the various integrators and ancillary service provider roles emerging. Current early stage observations indicate that maritime enterprise blockchain applications are evolving by adhering to these five, generally divergent types of blockchain business models; giant IT companies such as IBM or Microsoft serve the maritime industry business end-customers (i.e. shipping companies) and government customers (i.e. customs), however, bundling most of the above distinct business roles' activities (i.e. blockchain infrastructure, platform and applications provision). More elaborate models, such as the case of the Maersk-IBM co-own TradeLens platform are developing.

According to the above taxonomy, nominally a shipping company operates as a big business and business end customer that passively buys and consumes services of a blockchain platform provider/application provider entity. In this sense, blockchain value is attributed to the various levels of (a) time and cost efficiency, (b) distributed service innovation, (c)

enhanced, permissioned partners relationship management and (d) shared operational efficiency that a particular blockchain platform provider (i.e. IBM) can deliver, interdependently with the blockchain application providers of the ecosystem. (IBM, 2018).

Riasanow et al, 2018 also analyze the current blockchain ecosystem as consisting of eleven generic roles, including the broadly prevailing blockchain application provider, platform provider and infrastructure provider roles, as well as the blockchain alliance and blockchain community roles. Drawing on the developed generic ecosystem, the authors also outline the following *strategic choices*: (i) *governance*, related with granting platform development decision rights, control and ownership among blockchain organizations; the choice of blockchain project participants not only to conduct business transactions but also to co-own the platform technology, offer applications in the blockchain marketplace, or become locked in a particular platform/suite of standards and (ii) degree of *openness*, as many of these projects are open source - blockchain platform providers grant access to their platforms in the form of APIs. An open blockchain ecosystem allows established maritime companies and also new entrants developers to create their own business applications or even participate in the core platform development.

According to the above analysis, a shipping company could more actively influence or extract value from the blockchain ecosystem by assuming certain activities of the platform and application provider, that pertain the conventional boundaries of the blockchain customer/end user roles, and besides the blockchain alliance or community member. In that case blockchain is of strategic value, ascribed to a new business model generation for shipping companies entering the digital market space, extending their maritime affairs' corporate portfolio.

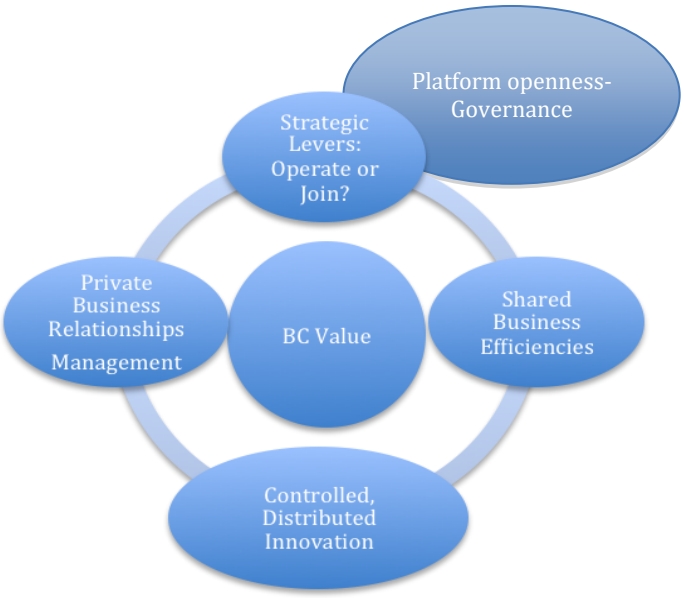

Figure 4: Maritime Enterprise Blockchain Value Dimensions

Market level analysis

Zhang, 2018 analyses the conditions under which market players can decide whether to deploy their own blockchain or just join the blockchain deployed by other players, henceforth affecting the market structure.

Different market structures scenarios are analysed; a first suggestion being that firms do not always benefit from adopting blockchain technology, rather in certain cases they deploy blockchain to avoid being competitively disadvantaged, which may in turn lead to lower profit when the cost of deploying blockchain is high.

In the maritime industry, characterised with high mistrust costs, but also with high blockchain deployment cost (due to process complexity and high product/service differentiation) the incumbent deploys the blockchain service to deter potential entrants. In the case of large maritime players (i.e. the TradeLens platform), Maersk, cooperating with IBM initially attempted to claim and control the blockchain platform opportunities in the maritime supply chain, possibly under a monopoly scenario.

Currently, many large IT companies, such as Microsoft, IBM, Amazon and Oracle, are offering their "Blockchain as a Service" (BaaS) solutions, providing underlying supporting infrastructures and serving as platform providers for companies intending to adopt blockchain technology, i.e. Oracle Cloud Blockchain Service for the CMA CGM and Cosco Shipping led platform or the Microsoft platform for the Maersk and EY led marine insurance blockchain.

According to this analysis, strategic value is ascribed to different options for shipping companies to assume blockchain platform activities, in the emerging blockchain ecosystem, in a monopoly or oligopoly scenario.

Albrecht et al, 2018 study the dynamics of blockchain implementation, and observe that incumbents holding significant market power, while facing pressure from startups and customers will likely engage with the innovation, yet prevent the occurrence of network externalities that may benefit competitors. "Therefore, a company in a dominant market position may not support efforts to foster interoperability. Instead, it may capture this process, tighten path dependencies and aim to raise switching-costs".

Unlike Bitcoin and other crypto currency platforms, enterprise blockchains lack one of the fundamental elements of blockchain technology's disruptive potential: the decentralized structure. Building on Popper and Lohr, 2017, a maritime blockchain platform for tracking shipments, compared to previous blockchain technologies, arguably "concentrates power in a handful of entities", with plausible impact on shipping markets function.

The recent development of launching the Global Shipping Business Network (GSBN) to develop a shipping industry blockchain alliance indicates the maritime sector's commitment to proceed in a harmonized way, having experienced a steady resistance to adopt a monopolistic blockchain platform regime.

3.3 Blockchain Practices

Beck and Muller-Bloch, 2017, examine how incumbents practice the pertinent phases of the blockchain implementation, as a radical innovation process. Applicable to the maritime context, we posit that during the initial phase of a blockchain technology initiative which includes the *technology characteristics awareness and business opportunities realization*, essential organizational capabilities and business activities include; a strategic commitment for digital innovation and strong managerial agency for digitalization to stimulate interest and support within the maritime organization, resources and skills for both conducting internally blockchain research and pursuing partnerships and external resourcing opportunities, also for enacting absorptive capacity, in particular. This blockchain exploratory phase, which to a large extend has been concluded for major, first generation maritime enterprise blockchains, (and those examined in our survey) is followed by the actual *blockchain technology project launching*, which includes extensive resourcing, business model and functional and technical architecture continuous refinement, and extensive pilot testing with market participants. This phase entails important coordination and interaction capabilities, internally in a maritime organization (and it many departments or companies) and with external project partners, including the chosen blockchain technical platform provider (also its numerous departments/units) and an array of pilot business participants/users. A dedicated business structure (subsidiary company, business unit or multi disciplinary-intrer organisational team) is needed. A scarce mix of competent blockchain engineers, technology savvy, application domain experts, and law and innovation experts are involved. Emphasis is typically put on selecting, testing and implementing the viable use case(s) appropriate to attract and lock-in the targeted market. The *commercialization and value appropriation phase* is the final phase, (where two of our survey cases have already entered). It accounts to the capabilities and activities for "selling" the blockchain value proposition to market actors beyond the closed and small circle of pilot – proof of concept participants. Forming necessary business agreements, participating in standardization activities and further market lobbying and communication strategies are materialized. Hence, an important resource pool for non-engineering, non-research capabilities needs to be mobilized, inside maritime organizations also with the technology partners.

Djoumessi et al, 2019 recognize the need for a cautious and profound assessment and refinement of the innovation capability construct, in view of its extensive popularity. Contextualizing this model in the maritime particularities of digital innovation and maritime blockchains' disruptive potential, we posit that pertinent blockchain innovation capabilities entail the distinct elements of *stimulation, institutionalization, and implementation* as follows:

Blockchain institutionalization: creating and communicating a strategic vision for digitalization, enacting senior and middle management agency for high complexity, high risk and high innovation returns, allocating apt resources (experts, funding) constitute blockchain enabling capabilities. Institutionalizing blockchain efforts in different forms and nuances, subject to varying maritime organizational settings, is an integral component of the broader digital innovation process, permeating a lengthy and uncertain technology evolution trajectory, where a number of emergent and interdependent digital technologies (IoT and AI applications), in tandem with blockchain technology are explored and exploited in the maritime business environment.

Blockchain stimulation: a maritime culture that self-reinforces high complexity, high risk technology projects development (i.e. sense giving activities, legitimacy construction) is effectual to "simulating and stimulating" blockchain exploration and development, also adjacent, intertwined digital innovation projects development.

Blockchain implementation entails iteratively and persistently updating and animating the maritime entity's vision in terms of its positioning in the blockchain ecosystem, also in its shipping market, in view of the developing digital transformation; updating and adjusting the resourcing and intra and inter-organizational networking and coordination activities appears a solid, best practice, to mitigate the high risks, that blockchain intitatives involve.

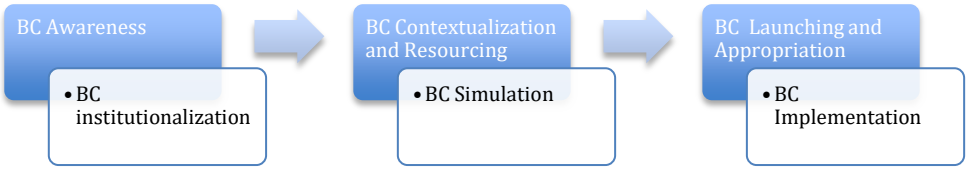

Figure 5: Blockchain Practices

4. Research Approach

The paper draws on a multi-case study of maritime enterprise blockchains, in particular a three-stage, qualitative research based on (a) desktop literature research for identifying and synthesizing pertinent blockchain research issues, as well as contextualizing the theoretical approach, as delineated in sections 2 and 3, (b) empirical research using semi-structured interviews, and (c) a grounded theory refinement, based on findings and further theoretical development. We searched extant literature including an extensive number of maritime business press outlets, technical reports, conference proceedings, and academic journal papers. We reviewed all conference proceedings and journal papers from the AIS Library and

AOM Library with the term “block chain” or “blockchain” within the text. Based on these sources we identified pertinent research themes of business research of blockchain, which we triangulated with prevailing business and research themes identified in maritime blockchain analyses.

For our field test sample, we have selected four different types of blockchain initiatives; (a) a shipping marketplace, exploiting blockchain technology for part of its business processes, also currently testing a shipping crypto currency use, (b) a large, incumbent shipping company and its IT technology partner operating a blockchain platform for trade documentation, (c) one maritime blockchain research consortium and (d) a blockchain technology consulting firm and a large bank jointly offering a marine insurance blockchain application (maritime incumbents). For each case, we have conducted semi-structured interviews, using an appropriately customized questionnaire. We interviewed representatives of the organizations, in senior roles of each blockchain project. Typically, the interviewees comprised a group of 1-3 persons, articulating diverse and complementary perspectives of the maritime and IT industries, coming from different functional and organizational responsibilities, skills and professional culture (i.e. blockchain engineers, marketing, innovation managers, maritime economist and start–up platform CEO). We interviewed maritime blockchain experts in large Japanese national or global firms, including experts from international shipping companies, banking, marine insurance, consulting and blockchain and data technology engineers about their views on digitalization in the maritime sector, their organizations’ strategies, and business practices, as comprehended while participating in their respective blockchain projects. Also, we researched one European start-up company - a blockchain new entrant case, having a strong public presence in maritime digital technology fora. However, the data collected were inconclusive as regards the practices followed and the actual potential of the market and digital innovation strategy pursued (henceforth not represented in the results-Table 3).

Overall, confidential interviews were conducted with 12 experts in 6 organizations, and 4 different blockchain projects/applications, in Japan and Europe. We researched participants’ views regarding the following aspects/questions:

Table 2: Maritime Blockchain Research Issues

How would you delineate the value created with blockchain technology ?
What is the digital strategy or digital business model your company supports with the blockchain project(s)? What is the value proposition? What is the network of actors involved? Which process areas covered? What is the revenue model?
What are the most important use cases for blockchain technology in the shipping/transport

logistics sector?
How would you expect blockchain to affect the shipping/transport logistics sector, in terms of new players, new markets creation, new governance models etc?
Do you consider as a desirable/probable digitalization outcome the development of o Closed, few/dominant maritime digital platforms o Open and common/interoperable digital platform(s)
Is digital innovation part of your company's overall strategy; Are related issues discussed at the highest level in the company?
Do you currently explore or already operate the considered BC platform and transaction?
What would you consider as your next technology/platform phase, in terms of scope and use cases covered?
Could you briefly describe the main technical features of the blockchain project(s) you are currently developing or planning: i.e. technical architecture, platforms and tools used for development
Is your blockchain system implemented as a public, permissionless or private, permissioned or any other hybrid blockchain type?
Have you removed any intermediaries or brokers of the as-is (current) trade procedures in you blockchain application?
What are your digital assets (i.e. BoL, other documents, tracking physical objects), participants, transactions)?
How would you expect blockchain enabled digitalization to affect your company's (i) processes (operations) management, (b) governance?
What is your company's innovation process approach and milestones, as regards the: ✓ Ideation (Blockchain opportunity discovery) ✓ Experimentation (use cases design, simulation), ✓ Acceleration (commercialization strategy)
How do you choose/prioritize your particular digitalization projects? Did you follow a formal process to determine and launch them i.e. brainstorming, Delphi etc
What is your management approach for implementing them, in terms of: ✓ responsible business unit ✓ new structures ✓ roles assigned, and ✓ technology or business alliances, networks you form respectively
What are the most critical digital innovation capabilities for shipping companies; Do you primarily

see the above as necessitating new business capabilities or exploitation of existing, incrementally improved capabilities?
What is your approach to project/portfolio management (i.e. financing, change management)?
How would you assess the maturity/business potential of (i) maritime smart contracts, (ii) block chain based marketplaces (ii) maritime IoT enabled blockchains
Would you expect a number of maritime trade blockchains to (co) operate in the near future?
What are the major obstacles to blockchain technology adoption today?

4.1. Results

Interview data were analysed in an inductive and iterative fashion to help themes emerge and coalesce into: (1) adopted ***Blockchain Technology Choices***: blockchain type, development platform used, type of uses cases (of high or low disruptive impact), (2) major business ***Value*** drivers for blockchain technology adoption (2) the ***Best Practices*** followed by the researched entities for implementing blockchain inititatives: the formation of dedicated technology partnerships, as well as developing a strong internal blockchain research capability, applying state of art methodologies for software development and project management, activating extensive internal and external collaboration.

All interviews were recorded into detailed memos, finally validated by interviewees. Technical and business reports and presentation material of the specific blockchain projects were handed and used for triangulating the interviews' findings.

Table 3 – Maritime Blockchain Research Themes and Findings

Maritime Enterprise Blockchain Case **Stakeholder /Solution**	**Technology Choices**	**Value**	**Best Practices**
Shipping Incumbent A	Private Enterprise Blockchain Use Case - Incrementally Innovative Top Development Platform	Platform Monopoly Advantage Shared Operational Efficiency Business Partners Relationship Management Forthcoming Innovation Outcomes	Strategic Thinking-Paradigm Shift - Digital Mindset Partnerships Structures (subsidiary company) Internal and External Collaboration Internal Research Resources State of the Art Methodologies
Maritime Incumbent B	Private Enterprise Blockchain	Shared Operational Efficiency	Strategic Thinking-Paradigm Shift - Digital Mindset

			Partnerships
	Use Case - Highly Innovative	Business Partners Relationship Management	Structures (research project, subsidiary company)
	Complementary Development Platform	Forthcoming Innovation Outcomes	Internal and External Collaboration
			State of the Art Methodologies
Blockchain Platform Provider	N/A	Positioning in the Maritime Blockchain Ecosystem	Strategic Thinking
			Partnerships
	Continuous Development of Platform Features and Tools for Enterprise Blockchain Use Cases Support	Entering New Markets	Internal and External Collaboration
			State of the Art Methodologies
Maritime Blockchain Consortium	Private Enterprise Blockchain	Research and Development Strategy	Strategic Thinking
			Partnerships
	A Portfolio of Use Cases	Positioning in the Maritime Blockchain Ecosystem	State of the Art Methodologies
	Top Development Platform	Entering New Markets	

5. Discussion

Our field study findings are illustrative but also bear certain limitations, as we have examined maritime blockchain ecosystem leading players; their strategies, practices and technology base clearly represents the state of the art approach to blockchain initiatives; outstandingly informed by global standards, and across industries, highly professional in terms of their approach to digital strategy formulation and management practices.

Private, enterprise blockchains is uniformly the main technology choice observed. Uniformly, as well, the key technology choice is that of a leading *platform development and deployment environment, provided by a trusted big IT partner.* The applications developed constitute exemplar cases of *viable use cases*; designed, implemented and launched by employing all software, management and innovation economics textbook theory and best practices. These three main choices constitute the foundation that allows the examined organizations to shape the maritime blockchain evolution in a cautious, informed and strategically leading manner.

A clear understanding of the *importance of standards* complemented with an outstanding competence in gaming, with a level playing field attitude, the ecosystem and market level determinants is found.

Both maritime organizations, and the technology companies (the blockchain technology platform entity and the blockchaing research consortium leading entity) of our study have a clear resourcing advantage and *management competences* that correspond to excellent practices, as identified in academic literature (reporting on blockchain across industries).

In particular, the *resourcing and knowledge advantage* of the surveyed organizations are determinant factors of blockchain innovation, incurred by incumbents. Furthermore, the surveyed blockchain platforms have all been developed on the basis of extensive *technology partnership schemes*, combining the capabilities and market leverage of individual blockchain ecosystem actors.

The reported project and change management methodologies used, however, are established ones, presenting no clear adaptation or enhancements to the blockchain technology specificities, (i.e. design thinking and iterative software development (garage method), spin off organizational structures). Similarly, it was not evident from the results to what extent the specific blockchain projects where critically influenced by C-level leadership and/or middle management agency.

In addition, *governance aspects* are handled in a cautious, stepwise refining approach; in the examined enterprise blockchain initiatives, traditional maritime intermediaries were not excluded (disrupted). Furthermore, trusted business relationships are management both based on the inherent blockchain features for closed and confidential transactions, also with the presence of a reputable trusted third party (the platform entity) augmenting institutional trust.

Blockchain platform technology governance is also managed based on state of the art approaches, namely an advisory board progressively deciding on platform openness, (co-) ownership and intellectual property aspects.

In summary, the examined organizations (Table 3) have institutionalized and successfully stimulated blockchain innovation. The surveyed incumbent maritime organizations publicly, officially communicate their blockchain strategies primarily in terms of the broadly acknowledged business value of shared efficiencies, immutability and data validity (tactical and operational level). In essence, the examined organizations *explore and introduce every foreseeable blockchain possibility, having secured a principal position in the emergent blockchain ecosystem*. In that sense, in our sample, maritime incumbents are aiming at *strategic value* levers (i.e. platform ecosystem control), while also *optimizing tactical and operational value elements* (i.e. business partner relationship management, maritime logistics process cost and quality).

References

ALBRECHT S., et al. 2018, Dynamics of Blockchain Implementation – A Case Study from the Energy Sector. Proceedings of the 51st Hawaii International Conference on System Sciences (HICSS), Hawaii, January 2018.

ANDROULAKI V., et al, 2018, Hyperledger fabric: a distributed operating system for permissioned blockchains. Proceedings of the 30th EuroSys Conference (EuroSys '18). ACM, New York, DOI: https://doi.org/10.1145/3190508.3190538

BAUER, I., ZAVOLOKINA, L., LEISIBACH, F., and SCHWABE, G., 2019, Exploring Blockchain Value Creation: The Case of the Car Ecosystem. Proceedings of the 52nd Hawaii International Conference on System Sciences (HICSS), Hawaii, January 2019.

BECK, R., and MULLER-BLOCH C., 2017, Blockchain as Radical Innovation: A Framework for Engaging with Distributed Ledgers as Incumbent Organization. Proceedings of the 50th Hawaii International Conference on System Sciences (HICSS), Hawaii, January 2017.

CHRISTIDIS K., and DEVETSIOKIOTIS, M., 2016, Blockchains and Smart Contracts for the IoT. IEEE Access, 4, 2292-2303.

DJOUMESSI, A., CHEN, S.L. and CAHOON, S., 2018, Deconstructing Lawson and Samson's Concept of Innovation Capability: a critical assessment and a refinement. International Journal of Innovation Management, https://doi.org/10.1142/S1363919619500531

FRIDGEN, G., LOCKL, J., RADSZUWILL, S., RIEGER, A., SCHWEIZER, A. and URBACH, N., 2018, A Solution in Search of a Problem: A Method for the Development of Blockchain Use Cases. Proceedings of the 24th Americas Conference on Information Systems (AMCIS), New Orleans, August, 2018.

GAWER, A., and CUSUMANO, M. A., 2014, Industry Platforms and Ecosystem Innovation, Journal of Product Innovation Management, 31, 417–433.

HOPP, C., ANTONS, D., KAMINSKI, J. and SALGE, T. O., 2018, The Topic Landscape of Disruption Research—A Call for Consolidation, Reconciliation, and Generalization. Journal of Product Innovation Management, 35(3), 458–487.

IANSITI, M., and LAKHANI, K. R., 2017, The Truth About Blockchain: It will take years to transform business, but the journey begins now. Harvard Business Review, 95 (1), 118–127.

IBM, 2018, IBM and Maersk to form joint venture to bring efficient, secure trade to global shipping industry. Date of access: 09/02/2019. https://www-03.ibm.com/press/us/en/photo/53603.wss

KSHETRI, N., 2018, Blockchain's roles in meeting key supply chain management objectives. International Journal of Information Management, 39, 80–89.

LACITY M., KHAN, S., 2019, Exploring Preliminary Challenges and Emerging Best Practices in the Use of Enterprise Blockchains Applications. Proceedings of the 52nd Hawaii International Conference on System Sciences (HICSS), Hawaii, January 2019.

LI, Y., MARIER-BIENVENUE, T., PERRON-BRAULT, A., WANG, X., and PARE, G., 2018, Blockchain Technology in Business Organizations: A Scoping Review. Proceedings of the 51st Hawaii International Conference on System Sciences (HICSS), Hawaii, January 2018.

MEDIUM, 2019, Technical difference between Ethereum, Hyperledger fabric and R3 Corda, 2019, Date of access: 09/02/2019, https://medium.com/@micobo/technical-difference-between-ethereum-hyperledger-fabric-and-r3-corda-5a58d0a6e347

NAKAMURA, S., and NAKAGOSHI K., 2018, System Design of Blockchain. Ric Telecom Ltd. (in Japanese)

POPPER, N., and LOHR, S., 2017, Blockchain: A better way to track pork chops, bonds, bad peanut butter? Date of access: 09/02/2019. https://www.nytimes.com/2017/03/04/business/dealbook/blockchain-ibm-bitcoin.html.

POST, R., SMIT, K., and ZOET, M., 2018, Identifying Factors Affecting Blockchain Technology Diffusion. Proceedings of the 24th Americas Conference on Information Systems (AMCIS), New Orleans, August, 2018.

RUCKESHAUSER, N., 2017, Typology of Distributed Ledger Based Business Models. Proceedings of the 25th European Conference on Information Systems (ECIS), Guimarães, Portugal, June 2017.

SEEBACHER S., and SCHURITZ R., 2017, Blockchain technology as an enabler of service systems: A structured literature review. Exploring Services Science (S. Za, M. Dragoicea, and M. Cavallari, eds.), 12–23, Springer International Publishing.

STERNBERG, H., and BARUFFALDI, G., 2018, Chains in Chains – Logic and Challenges of Blockchains in Supply Chains. Proceedings of the 51st Hawaii International Conference on System Sciences (HICSS), Hawaii, January 2018.

TAVAKOLI, A., and SCHLAGWEIN, D., 2016, A Review of the Use of Practice Theory in Information Systems. Proceedings of the 20th Pacific Asia Conference on Information Systems (PACIS), Tchiayi, Taiwan, June, 2016.

RIASANOW, T., CATTAI, M., SETZKE, D.S., BOHM, M., and KRCMAR, H., 2018. The Generic Blockchain Ecosystem and its Strategic Implications.2018. The Generic Blockchain Ecosystem and its Strategic Implications. Proceedings of the 24th Americas Conference on Information Systems (AMCIS), New Orleans, August, 2018.

RISIUS, M., and SPOHRER, K., 2017, A Blockchain Research Framework. Business and Information Systems Engineering 59(6), 385–409.

STANSKE S., and KAUTZ, K., 2018, Legitimizing Digital Transformation: From System Integration to Platformization. Proceedings of the 39th International Conference on Information Systems (ICIS), San Francisco, December 2018.

ZAMANI, E. D., and GIAGLIS, G. M., 2018, With a little help from the miners: distributed ledger technology and market disintermediation. Industrial Management & Data Systems, 118 (3), 637-652.

ZHANG, X., 2018, How Will Blockchain Change the Market Structure. Proceedings of the 39th International Conference on Information Systems (ICIS), San Francisco, December 2018.