Collaborative Governance of Inter-organizational Relationships

The Effects of Management Controls, Blockchain Technology, and Industry Standards

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Nikola Kostić

April 14th 2022

Abstract

Over the past three decades, accounting scholars have shown significant interest in management accounting and control mechanisms that actors use to sustain inter-organizational relationships (IORs). At the same time, blockchain technology is increasingly emerging as an important organizational phenomenon, especially for collaboration across firm boundaries. Due to its multi-party nature, transparency, and ability to distribute control between legally independent entities, blockchain technology could profoundly impact on governance in IORs, potentially challenging widely held assumptions and findings of the existing literature on IORs in management accounting and related fields. Moreover, business-to-business interactions are increasingly dependent on standards to support innovation through inter-organizational collaboration that drives the emergence of complex industry-wide solutions such as digital infrastructures. However, the existing literature highlights our limited understanding of the management control and governance issues in such settings. To this end, this dissertation seeks to offer new insights related to management control and governance in multi-party settings that can include industry rivals, industry consortia, and standard-setting bodies that are engaged in inter-organizational collaboration with the aim of generating innovative solutions that leverage permissioned blockchain technology and are based on widely-accepted standards. These topics are discussed in detail in the three papers that comprise this dissertation.

The dissertation presents several contributions related to the aims stated above. Firstly, it contributes to the accounting literature on management control in IOR settings. It analyzes governance choices in the presence of blockchain by discussing technical and organizational aspects of permissioned blockchain technology, their effects on transaction hazards, and the corresponding management control remedies in IORs. Based on this analysis, **Paper 1** presents a series of propositions that are further synthesized into an agenda for future research. Secondly, the dissertation presents findings on the reciprocal relationship between particular governance configurations and the organizations' level of interest and willingness to contribute to industry-wide standardization efforts, based on a case study of two such efforts in the container shipping industry. These findings are presented in **Paper 2**, which further offers insights into how an industry need can be met through the collective action of independent organizations. Lastly, based on a longitudinal case study in the container shipping industry and the associated trade ecosystem,

the dissertation presents novel insights into how digital infrastructure development can be governed in an inter-organizational and global setting by explaining interactions between different stakeholders at multiple levels. The findings documented in **Paper 3** outline specific governance units and governance mechanisms and describe a pattern of nesting of governance that allows smaller "subunits" to deal with a global issue of digital infrastructure development collectively. In sum, this dissertation contributes by shedding light on management control issues and governance mechanisms involved in inter-organizational collaboration aimed at generating innovative solutions based on blockchain technology and the accompanying standardization processes that stabilize them.

Abstract in Danish

Regnskabsforskere har i løbet af de sidste tre årtier udvist en signifikant interesse i økonomistyrings og kontrolmekanismer som aktører bruger til at opretholde interorganisatoriske forhold (IOFs). Samtidig har blockchainteknologi i stiigende grad opstået som et vigtig organisatorisk fænomen, især inden for samarbejder på tværs af virksomhedsgrænser. Grundet dens flerpartisnatur, gennemsigitighed, og evne til at distribuere kontrol mellem juridiske selvstændige enheder, har blockchain teknologier evne til at helt igennem at påvirke governance i IOFs, potentielt set udfordre grundlæggende antagelser og resultater fra den eksisterende litterature om IOFS i økonomistyring and relaterede områder. Desuden er business to business interaktioner i stigende grad afhængige af standarder for at understøtte innnovation gennem inter-organisatoriske samarbejder, som driver fremkomsten af komplekse industribrede løsninger, så som digital infrastruktur. Den eksisterende litteratur fremhæver dog vores begrænset forståelse af (or viden om) af økonomistyring og governance problemstillinger i sådan kontekster. I den forbindelse søger denne afhandling at frembringe nye indsigter relateret til økonomistyringen og governance i flerpartisammenhæng som kan inkluderer industririvaler, industri konsortier og standard sættende organer som er engageret i interorganisatorisk samarbejde med det formål at generer innovative løsninger som udnytte permissioned blockchain teknologi og som baserer sig på bredt accepteret standarder. Disse emner bliver diskuteret i flere detaljer i de tre artikler som udgør denne afhandling.

Afhandlingen præsenterer flere bidrag relateret til formålene beskrevet ovenfor. For det første bidrager den til økonomistyringslitteraturen om management control i IOFs sammenhæng. Den analyserer governance valg i blockchain sammenhæng, ved at diskutere de tekniske og organisatoriske aspekster af permissioned blackchain teknologi, dens effekt på transaktions risiko and de korresponderende midler i økonomistyringen af IOFs. Baseret på denne analse, præsenterer den **første artikel** en række propositioner som bliver syntetiseret til en agenda for videre forskning. For det andet præsenterer afhandling resultater omkring det gensidige forhold mellem bestemte governance konfigurationer og det organisatoriske niveau af interesser og villighed til at bidrage til industribrede standardiseringsforsøg, baseret på et case studie af to forsøg på dette i shipping industrien. Disse resultater er præsenteret i **den anden artikel**, som giver flere indsigter ind i, hvordan en industris behov kan blive mødt gennem fælls handling af uafhængige organisationer. Til sidst præsenterer afhandlingen, baseret på et case studie af

containershipping industrien, og det associeret handlesøkosysten, over lang tid, nye indsigter ind i, hvordan udviklingen af digital infrastruktur kan blive ledet/styret i en interorganisatoriske og global sammenhæng ved at forklare interaktionerne mellem forskellige stakeholder på flere niveauer. Resultater i **den tredje artikel** skitserer specifikke governance enheder og governance mekanismer og beskriver et mønster af governanceindlejring som tilader mindre ”underenheder” at håndtere et globalt problem med digitalt infrastruktur udvikling i fællesskab. Alt i alt, bidraget afhandlingen ved at kaste lys over de managmeent control problemstilinger og governance mekanismer involveret i interorganisatoriske samarbejder, der forsøger på generer innnovatirve løsninger baseret på blockchain teknologi and de dertilhørende standardisering processer som stabiliserer dem.

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Introduction

This section introduces the overall aim of the dissertation, which is to advance the understanding of governance issues involved in developing and sustaining IORs. In this context, a particular focus is on the implications of management control practices, blockchain technology, and industry standardization efforts. To this end, an overview of the relevant concepts is provided, and their positioning in the existing literature on IORs is explained. The section further shows how the three research papers are connected. The section concludes with the overall contributions of the three papers and the dissertation as a whole and presents potentially promising avenues for further research.

1. Governance of Inter-organizational relationships

Collaborative arrangements between legally autonomous parties that do not readily fit the "market-hierarchy" dichotomy (e.g., Coase, 1937; Williamson, 1985) have become central to economic activity (Oliveira and Lumineau, 2019). Consequently, they have sparked research interest and are recognized as distinct kinds of organizing, called "hybrids" (Holmström and Roberts, 1998). Coase (1937) posited that outside of the firm, market forces (i.e., prices) direct resource allocation, while in the intra-firm environment the management of the firm fulfills this role. Building on this basic observation, he suggested that there must be a cost to using the price mechanism. Consequently, firm boundaries are explained by managers' actions geared towards minimizing costs. Building on Coase's work, Williamson (1985) discusses the nature of transaction costs concerning firm boundaries by linking the characteristics of transactions (e.g., environmental uncertainty, frequency, interdependence, and asset-specificity) and behavioral constraints of human agents (i.e., bounded rationality and opportunism) with costs of using the market mechanism. More specifically, the argument goes that these transaction characteristics and behavioral constraints act in unison to produce outcomes in which actors cannot write, execute, and enforce complete contracts.

Williamson (1991) characterizes hybrid governance structures as being located between market and hierarchy concerning incentives, adaptability, and bureaucratic costs. While research has identified hybrid governance structures both in intra- and inter-firm settings (Ebers and Oerlemans, 2016), this dissertation focuses on inter-firm settings or “external hybrids” (Ménard, 2004). These comprise a great diversity of agreements among legally independent entities doing business together, mutually adjusting with only limited use of the price system of the market and sharing or exchanging technologies, capital, products, and services without unified ownership (Borys and Jemison, 1989; Ebers and Oerlemans, 2016).

Such hybrid arrangements between organizations can take a variety of forms (e.g., joint ventures, strategic alliances, networks, coalitions, industry consortia, cross-sector partnerships, trade associations, outsourcing agreements, and supply-chain relationships) and have been referred to in the literature as “inter-organizational relationships”, “inter-firm settings”, “hybrid organizational forms”, and “networks” (Anderson and Sedatole 2003; Caglio and Ditillo 2008; Parmigiani and Rivera-Santos, 2011). This dissertation adopts inter-organizational relationships (IORs) as a universal term used throughout the dissertation. In turn, IORs are defined here as voluntarily initiated cooperative agreements between legally independent organizations that involve information exchange, sharing, or co-development of products and services and can include partner contributions of technology, capital, or firm-specific assets (Gulati and Singh, 1998; Dekker, 2004). In this context, in line with Ménard (1995), for the purposes of this dissertation, an “organization” is defined as an arrangement designed to make possible the conscious and deliberate coordination of activities within identifiable boundaries, in which members associate on a regular basis through a set of implicit and explicit agreements, and commit to collective action for the purpose of creating and allocating resources and capabilities by a combination of command and cooperation.

A fundamental characteristic of IORs is that partnering firms essentially play a “mixed-motive game”, in which they have overlapping (to a greater or a lesser extent) but ultimately separate profit motives (Anderson et al., 2014), where the resolution of collective action problems is typically assumed to fulfill the goal of joint value creation (Klein et al., 2019; Chen et al., 2022). In some IORs like joint ventures, the formal, legally enforceable, contractual framework the partners use to formalize such arrangements represents their governance structure. In contrast, others like strategic alliances and industry consortia may operate without recourse to legal enforcement mechanisms but still employ formal control processes to manage the alliance (Parkhe, 1993; Gulati and Singh, 1998; Anderson and Sedatole, 2003). This suggests that IORs do not represent mere deals and strategic agreements but are also entities characterized by boards, boundary-spanning individuals, information-sharing and decision-making processes, databases, and integrated computer systems, as well as other material and immaterial resources, all of which entail practical organizational challenges (Gulati et al., 2012). Such relationships enable organizations to gain access to technologies, competencies, and economies of scale and scope of trading partners in more efficient ways than is in many cases possible through arm's-length transactions (i.e., market) or vertical integration (i.e., hierarchy) (Coad and Cullen, 2006). Parmigiani and Rivera-Santos (2011) observe that what we know about IORs, in general, is likely to be disproportionally influenced by characteristics of the most studied forms such as joint ventures and strategic alliances, thereby limiting our understanding of other increasingly important IOR forms, most notably industry consortia, and cross-sector partnerships (Parmigiani and Rivera-Santos, 2011; Ebers and Oerlemans, 2016). Moreover, the literature has tended to emphasize examining specific IOR forms rather than IORs more generally (Parmigiani and Rivera-Santos, 2011). Relatedly, Caglio and Ditillo (2008) point out that many of the studies in this research stream focus on dyadic or one-to-many relations between organizations, most often from the viewpoint of a dominant IOR partner. To address these concerns, this dissertation takes a broader approach to studying governance issues in IORs.

Paper 1 focuses on the interplay between inter-organizational management control procedures and blockchain technology in formal, purposeful, non-equity-based IORs involving transactional interactions (Williamson, 1985; Castañer and Oliveira, 2020). It outlines fundamental technical features and limitations of permissioned blockchain technology and analytically proposes blockchain as a concept with implications for management accounting practices that underpin inter-organizational collaboration, trust, control, and information exchange. A particular focus of the analysis is on the interplay between the technical capabilities of blockchain technology and inter-organizational management control procedures. Based on this analysis, a series of propositions theorize how these procedures affect how blockchain is enacted in inter-organizational relationships and how it is affected by blockchain, in turn, is developed. The paper concludes with a research agenda for accounting scholars and offers directions for further research.

Paper 2 discusses how and why organizations voluntarily engage in the process of standardization through collective action on an industry level. It relies on a case study of two standardization efforts in the container shipping industry, namely INTTRA and TradeLens, to clarify how consortia of organizations can produce industry standards through contributions to inter-organizational information infrastructure. Although the INTTRA platform was based on EDI technology, and TradeLens as a more recent attempt at creating an industry-wide standard is based on permissioned blockchain technology, the analysis in **Paper 2** does not focus on the particular technical characteristics of blockchain technology and their effects on the standardization effort. The different effects of the use of EDI and blockchain technology on management control and information exchange issues in IORs are discussed in more detail in **Paper 1**. **Paper 2**, on the other hand, considers blockchain as one of the instances of technologies that could enable the creation of a shared inter-organizational information infrastructure and focuses more specifically on the dynamics around the interdependency that arises between organizations as they strive to facilitate mutual value creation through information exchange and process integration, but at the same time constantly need to make decisions to safeguard their commercial interests (Schloetzer, 2012). **Paper 2** argues that the resolution to these issues can only be arrived at through collective action. To this end, an analysis of the findings identifies three critical collective action trade-offs that affect the standardization process: 1) flexibility vs. inclusion; 2) generalizability vs. completeness; 3) investment vs. value capture. The implications of these trade-offs are discussed, and theoretical insights about factors that influence collaborative standardization on an industry level are presented.

Based on a longitudinal case study in the container shipping industry and the broader trade ecosystem, **Paper 3** investigates how developing a global digital infrastructure[1] intended to enable the digitalization of crucial trade documentation can be effectively governed in a complex inter-organizational setting. For the purposes of this dissertation, digital infrastructures are considered technical systems and network resources that enable wide-scale organization by coordinating routines and maintaining standards, processes, and governance structures (Tilson et al., 2010; Constantinides and Barrett, 2015; Constantinides et al., 2018). Digital infrastructures enable the delivery of information-based services by providing a technical and organizational foundation for transacting and system integration. The analysis leverages a polycentric governance perspective (Ostrom et al., 1961; Ostrom, 1990) to make sense of complex dynamics involved in governing the development of digital infrastructure relying on blockchain-based architecture and industry standards. The study identifies distinctive governance units and governance mechanisms linked in a series of layers such that smaller governance units become a part of a larger system without giving up decision-making authority in their particular domain. The analysis further unpacks a successful pattern of "nesting", where governance mechanisms developed at lower levels serve as inputs for forming higher-level governance units and mechanisms.

[1] As noted by several authors (e.g., Henfridsson and Bygstad, 2013; Koutsikouri et al., 2018), the existing literature often uses the terms information infrastructure and digital infrastructure interchangeably. This is the case in this dissertation as well, although Paper 3 uses the term digital infrastructure exclusively. The reasoning is explained in more detail in Paper 3.

2. Information exchange in inter-organizational relationships

Over the past three decades, as the markets have become more competitive, interconnected, and interdependent, and as technology has advanced, collaborative arrangements between market actors have become preferable to outright vertical integration. The emergence of information collection, conversion, dissemination, and monitoring technologies within and across organizational boundaries has played an essential role in these developments. Technology-enabled inter-organizational information systems often represent the primary means of information exchange across firm boundaries (Gulati and Singh, 1998). As such, they play a significant role in the control of IORs as enablers of management control practices, represent an important source of competitive advantage, and are ultimately critical to the success of inter-organizational collaboration (Anderson and Sedatole, 2003; Nicolaou et al., 2011; Beaubien, 2013; Rikhardsson and Yigitbasioglu, 2018).

In IOR settings, new information systems and production technology have increased the interdependence of organizational tasks, prompting otherwise independent firms to engage in simultaneous cooperation and competition, sometimes termed "co-opetition" (Ireland et al., 2002; Grafton and Mundy, 2017). At the most basic level, the purpose of adopting inter-organizational information systems is to implement computerized communications among partnering organizations (Schloetzer, 2012). Moreover, frequent exchange of lateral information between many organizations to ensure effective integration and coordination has become necessary (Hopwood, 1996). Consequently, the accounting, management, and information systems literature has seen "information openness" become an important theme related to the functioning of IORs (Caglio and Ditillo, 2012). Transfers of information of varying types have been shown to work well even without vertical integration.

Moreover, much of this information is accounting-based, albeit sometimes modified to deal with the localized nature of information transfers (Miller et al., 2008). At the same time, the collaborative environment that spans organizational boundaries presents management control challenges for the firms involved. In this IOR setting, the coordination and control of the common activities cannot be handled entirely internally, nor can market forces alone achieve this. The reason is that these activities, even when they are complementary, need to be performed by different organizations, which means that the partners' plans must be in accordance with each other (Håkansson and Lind, 2004). Anderson and Dekker (2014) observe that innovations in management control play an important role in establishing and maintaining IORs, and have made them more durable.

Research on control and performance implications of inter-organizational information systems use broadly identifies information sharing, standardization, and process integration as practices that facilitate mutual value creation (Kulp et al., 2004; Bala and Venkatesh, 2007; Schloetzer, 2012; Christ and Nicolaou, 2016). Furthermore it discusses the role of information exchange systems on IOR governance issues, including the development of standards, as this was found to be a crucial determinant of making inter-firm processes efficient and performance-enhancing (Markus et al., 2006; Bala and Venkatesh, 2007). For example, Zhu et al. (2006) note that the goal of achieving improvement in inter-organizational coordination through inter-organizational information systems is a significant driver for creating industry-level standards. At the same time, studies focusing on the development and diffusion of data and process standards beyond a dyadic buyer-supplier relationship (i.e., "extended supply chain" or industry level) have reported that achieving the goal of establishing a shared information infrastructure is fraught with difficulties, due to factors such as heterogeneity of interests among partners (Markus et al. 2006; Axelrod et al., 1995), high cost of implementation and low reuse value of the investment for smaller partners (Steinfield et al., 2011), and difficulties in reaching an agreement on the design, governance structure, and ownership of the solution.

The formation of industry-wide standard-setting consortia has been proposed to address these issues. Weiss and Cargill (1992) leverage a collective action theory perspective (Olson, 1965) and find that standard development consortia have an incentive to limit membership to a group of participants with a compatible preference structure, especially large firms, because they are more likely than smaller ones to influence others to adopt the standard. Widely established technical standards represent an aspect of broader industry norms that define acceptable behaviors and appropriate practices in IORs, further affecting governance choices by setting expectations and incentives for proper business conduct and performance (Ebers and Oerlemans, 2016). This, in turn, reduces the need for administrative safeguards and controls, allowing the transacting parties to economize on monitoring and enforcement costs by enhancing task programmability and outcome measurability (Ebers and Oerlemans, 2016).

This dissertation focuses on blockchain as an emerging information exchange technology that can create a shared inter-organizational information infrastructure that can be seen as the "blueprint" for the interaction patterns between organizations in IORs (Zhao and Xia, 2014; Nicolaou et al., 2011). While **Paper 1** and **Paper 3** explicitly focus on blockchain technology and the implications of its use on management control and related governance issues in IOR settings, **Paper 2** provides a discussion of technology standardization through collective action on an industry level on a more general level.

3. Blockchain technology

Following its initial rise to prominence as the technology underlying the first successful cryptocurrency Bitcoin (Nakamoto, 2008), blockchain has emerged as an effective information sharing mechanism that enables multiple legally independent actors to jointly generate, maintain, synchronize and update a shared set of authoritative records while ensuring data privacy (Risius and Sproher, 2017; Iyengar et al., 2021). The integrity of a blockchain ledger relies on a combination of cryptography (e.g., hash functions and digital signatures) and mechanisms for achieving distributed consensus, which allows the participants to agree on a unique version of the authoritative records valid for the entire network (Bakos and Halaburda, 2021b). Rauchs et al. (2018, 24) define blockchain as "[…] a system of electronic records that enables a network of independent participants to establish a consensus around the authoritative ordering of cryptographically validated ("signed") transactions. These records are made persistent by replicating the data across multiple nodes and tamper-evident by linking them through cryptographic hashes. The shared result of the reconciliation/consensus process—the 'ledger'—serves as the authoritative version for these records". This general definition is adopted throughout this dissertation.

Although based on the features described above, the term "immutability" is often associated with blockchain-based systems (Narayanan et al., 2016; Catalini and Gans, 2020; Iyengar et al., 2021), thereby implying their irreversibility and reliable security (O'Leary, 2017), it is worth noting that different types of blockchain systems provide different levels of transaction finality. Accordingly, other authors (e.g., Rauchs et al., 2018) have suggested that a more accurate description of blockchain ledgers involves terms such as "tamper-resistant" or "tamper-evident" since blockchain architecture allows network participants to detect non-consensual changes to the records, reliably analyze them and thereby be more confident in uncovering potential opportunistic behavior (Lumineau et al., 2021). Fundamental characteristics of blockchain technology include peer-to-peer transmission, shared recordkeeping, multi-party consensus, independent validation, tamper resistance, tamper evidence, and transparency (Rauchs et al., 2019). Participants in the blockchain network are often referred to as "nodes" and are typically categorized as users and validators. The latter category is responsible for maintaining and ensuring the integrity and consensus in the blockchain network, although the two categories are not mutually exclusive, and nodes often take on both roles (Bakos and Halaburda, 2021b).

One of the most widely discussed innovations related to blockchain systems that distinguish them from existing information-exchange technologies such as EDI (Lumineau et al., 2021) is that they allow for new ways of decentralization and delegation of services that are enacted through smart contracts (Glaser, 2017). The idea behind smart contracts is often attributed to Szabo (1996) but has become more prominent since the emergence of blockchain technology. The reason is that blockchain can broaden the scope and applicability of smart contracts by providing an infrastructure for their recording and execution (Bakos and Halaburda, 2021a). The key characteristic of smart contracts is their automatic algorithmic execution based on mapping certain detectable states of the world to corresponding actions (Bakos and Halaburda, 2021a). A fundamental requirement for smart contracts to be functional and cost-efficient is the ability to produce "hard evidence" of (non)performance on an obligation. When data is endogenous to the blockchain, the necessary evidence may be hard coded; however, when contractual obligations rely on exogenous evidence, a blockchain system (and the corresponding smart contract) needs to rely on incentives and control mechanisms for the disclosure of accurate information about contract performance (Gans 2019). Although several authors (e.g., Xu et al. 2017; Rauchs et al. 2018; Gans 2019) commented that smart contracts are not strictly speaking fully autonomous and adaptive, nor do they at the moment necessarily represent legal agreements in most jurisdictions, recent developments in the legislative sphere suggest a possible shift in the legal treatment of smart contracts. For example, in a recent draft proposal to the Parliament, the Law Commission of England and Wales defined smart contracts as legally binding contracts in which some or all of the contractual obligations are defined in and/or performed automatically by a computer program (Law Commission of England and Wales, 2021). The Commission further concluded that the existing legal principles in England and Wales could be applied to smart contracts, further pointing out that as the technology underpinning smart contracts becomes more sophisticated, a greater range of obligations may be suitable for inclusion in smart contracts, making them able to perform a greater range of tasks than has been the case to date (Law Commission of England and Wales, 2021).

When conceptualizing blockchain technology, several authors start by describing a decentralized, public permissionless blockchain, such as Bitcoin's blockchain. Some papers also categorize blockchains as permissioned and permissionless (e.g., Catalini and Tucker, 2018), public and private (e.g., O'Leary, 2017). Although a consensus on a universally accepted taxonomy of blockchain networks is yet to be reached, they can broadly be categorized based on the rights of participation (public and private) and the rights of validation (permissioned and permissionless). Different types of blockchain networks are illustrated in Table 1.

<table>
<tr><th colspan="4">Who can operate a validator node?</th></tr>
<tr><th colspan="2"></th><th>Permissioned
(Requires permission, selection, or election)</th><th>Permissionless
(Anyone)</th></tr>
<tr><td rowspan="2">Who can submit transactions?</td><td>Public</td><td>Public-permissioned
• Ripple
• Libra
All nodes can read and submit transactions. Only validated nodes can validate transactions.</td><td>Public-permissionless
• Bitcoin
• Ethereum
All nodes can read, submit, and validate transactions.</td></tr>
<tr><td>Private</td><td>Private-permissioned
• TradeLens
• IBM Food Trust
Only authorized nodes can read, submit, and validate transactions.</td><td>(Virtual) Private-permissionless
• EY Ops Chain Public Edition</td></tr>
</table>

Table 1: Types of blockchain networks. Based on Peters and Panayi (2015) and Lacity et al. (2019)

Permissioned blockchains are the predominant type of blockchain architecture currently deployed in enterprise settings since they tend to be more scalable and efficient relative to their permissionless counterparts (Iyengar et al., 2021) and provide assurances of privacy, fast settlement, efficient use of resources, and regulatory compliance (Lacity et al., 2019; Lacity and Van Hoek, 2021a). Accordingly, permissioned blockchains are the type of blockchain discussed in this thesis. At the same time, the properties of permissionless blockchains are still helpful to understand, especially vis-à-vis permissioned enterprise variants that are the focus of this dissertation, as most enterprise networks are based on many of the same types of distributed architectures, design principles, concepts, and tools (Rauchs et al., 2018). These are, in turn, briefly discussed below.

In permissionless blockchains, actors are free to participate in user/validator roles as long as they satisfy the requirements of the applicable protocol, irrespective of their identity. Permissionless blockchains achieve consensus via a decentralized protocol applied across a set of participants or nodes that is theoretically unlimited in number (Bakos and Halaburda, 2021b). For example, the Bitcoin blockchain allows participants to exchange non-duplicable digital tokens that carry monetary value in an environment consisting of pseudonymous[2] actors, which is assumed to be inherently adversarial. Moreover, participants in a permissionless blockchain are free to acquire new pseudonymous identifiers, dispose of old ones and control multiple identifiers at any point in time (Bakos and Halaburda, 2021b). Taken together, these characteristics of permissionless blockchain networks have led authors to describe them as "trust-less" (Xu et al., 2017), able to replace trust in an intermediary with trust in inherent consensus rules and underlying code (Catalini and Gans, 2020). However, what is often neglected in existing studies of permissionless blockchains such as Bitcoin or Etherium networks tailored to handle monetary transactions is that their immutability and security properties crucially depend on a pecuniary incentive scheme that is ensured by the high value of their native cryptocurrencies (Halaburda et al., 2022). Such incentives rely on a computationally-intensive process of appending new blocks of transactions to the ledger by validator nodes known as "miners" and the associated lucrative mining rewards. Authors have noted that, while such a specification can generate robust security guarantees even when nodes are untrustworthy (cf. Nakamoto, 2008), it also generates inefficiencies such as the possibility of a prolonged disagreement over the content of the information stored on the blockchain (Biais et al., 2019; Iyengar et al., 2021; Hinzen et al., 2022). Since the information on the blockchain is ambiguous for as long as such a disagreement persists, Iyengar et al. (2021) argue that permissionless blockchains are especially problematic in business settings because a protracted ambiguity over the system state can be very costly. Moreover, Bakos and Halaburda (2021b) show that the validation costs in permissionless blockchains are incurred during the regular operation of the consensus mechanism and further demonstrate that the level of the mining reward and hence the operating cost of the permissionless consensus mechanism determines the level transaction security. Relatedly, several authors have expressed the view that it is not entirely clear if a permissionless blockchain without a valuable, native cryptocurrency can induce the same high-powered incentives (e.g., Iyengar et al., 2021; Halaburda et al., 2022).

Considering that business settings typically involve repeated interactions between economically motivated entities, a certain level of familiarity and trust is appropriate to assume (Iyengar et al., 2021). Further, for entities with at least partially shared interests that characterize typical IOR

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[2] Every Bitcoin user is tied to a specific alphanumeric address, and can choose to remain anonymous or reveal their identity to others (Iansiti and Lakhani 2017).

settings discussed in this dissertation (e.g., alliances, consortia, networks of firms), the governance structure (e.g., access and decision-making rights, incentives, accountability mechanisms) of permissioned blockchains can be customized by the participants (Iyengar et al., 2021). Moreover, Bakos and Halaburda (2021b) and Iyengar et al. (2021) point out that in the overwhelming majority of cases, the environment that most organizations operate in involves at least a modest level of ex-ante familiarity or trust (e.g., through prior interactions) either referring directly to other participants or accountability and enforcement mechanisms that exist outside of the blockchain domain (e.g., contracts, courts, reputation penalties for opportunistic behavior). Such considerations are most often discussed in the literature on management control issues in IORs (e.g., Dekker, 2008; Gibbons and Henderson, 2012; Reusen and Stouthuysen, 2020).

4. Inter-organizational relationships and blockchain

4.1. Blockchain in accounting research

Contemporary accounting studies predominantly consist of conceptual papers that examine the use of blockchain technology within financial accounting. Coyne and McMickle (2017) considered the possibility of blockchain becoming a more secure, immutable alternative to current ledger database solutions. The most frequently discussed benefits of blockchains are increased speed and reduced costs of maintaining and reconciling ledgers (Dai and Vasarhelyi, 2017), real-time accounting (Yermack, 2017), increased security and control (Peters and Panayi, 2015), and automation of accounting and auditing rules that could be programmed onto the blockchain. Dai and Vasarhelyi (2017) further argue that blockchain could facilitate "triple-entry accounting" by acting as a "neutral intermediary" that would enhance the reliability of firms' financial statements.

In addressing a common critique that blockchain may not be suitable for settings where transacting requires the exchange of proprietary financial or operational information, Cao et al. (2019) provide a blueprint for collaborative auditing using a permissioned blockchain. The authors consider using permissioned blockchains and zero-knowledge proof algorithms in accounting and auditing and show that blockchain adoption can lower regulatory and auditing costs and increase audit quality. The study further sheds light on how accounting data and their management affect the behaviors of firms and their monitors/regulators by providing an infrastructure for independent databases to interact without sacrificing proprietary data privacy. Based on semi-structured interviews with stakeholders, including audit partners in first and second-tier accounting firms in Australia, Dyball and Seethamraju (2021) investigate the perceived (potential) impact of client use of blockchain technology on financial statement audits of accounting firms in Australia. The study uncovers that the potential impact relates to changes to audit methodology, which recognizes different approaches to risk assessment for public and private blockchain applications, and the development of requisite knowledge and expertise of auditors in Australia (Dyball and Seethamraju, 2021).

Centobelli et al. (2021) developed practical guidance to design and adopt blockchain technology in the accounting domain. The authors present a conceptual framework for a private intra-corporate blockchain model with a network of nodes serving as validators of transactions within the company. The framework is organized around three scalable levels: 1) technological infrastructure based on a distributed database and peer-to-peer storage; 2) leveraging permissions and validation to assure increasing control levels; 3) at the higher level, the system provides integration of business and security applications. Gietzmann and Grossetti (2021) conceptually identify four research settings where accounting knowledge is critical to the design choices regarding blockchain systems. These include choices around nodal transparency, achieving cost-effective regulatory compliance, designing effective means of disaggregating asset registries and smart contracts, and ensuring that transactions can be effectively recorded, tracked, and analyzed to enable provenance analysis (Gietzmann and Grossetti, 2021). The authors further argue that blockchains without a native cryptocurrency (i.e., permissioned blockchains) present the most promising solutions for widespread use in private and public sector organizations (Gietzmann and Grossetti, 2021).

4.2. Blockchain in research on inter-organizational relationships and digital infrastructures

In recent years, research has increasingly focused on applying blockchain beyond its origins in computer science. Of relevance to the present study are contributions made in accounting, information systems, supply chain and operations management, and finance. Blockchain technology enables multiple independent parties to jointly generate, maintain, synchronize, and update a shared set of authoritative records. In IOR settings, blockchain allows proprietary databases of IOR partners to interact, thereby enabling the partners to transfer business-relevant information (e.g., about orders, receipts, payments) or digital assets across firm boundaries without sacrificing data privacy (Cao et al., 2019; Kumar et al., 2020).

Early conceptual work discussed how blockchain could improve the transparency of ownership (Yermack, 2017) and simplify transaction verifiability (Catalini and Gans, 2020), further leading to reduced costs of maintaining and reconciling accounting ledgers and improved reliability of financial statements (Dai and Vasarhelyi, 2017). Explicitly contextualizing blockchain in an IOR setting, Babich and Hilary (2020) provide a qualitative discussion of blockchain's promise to improve production and distribution networks in supply chains through improved visibility, information validation, and contract automation. Chiu and Koeppl (2019) examine blockchain-based settlement for asset trading. The authors model blockchain as a record-keeping system that manages ownership of securities, payments related to securities, and settles securities trades by recording information on the transfer of ownership and payment. Chod et al. (2020) study a supply chain finance context and show that it is more efficient to signal a firm's operational capabilities to lenders through inventory transactions on blockchain by opening a window of transparency into a firm's input transactions rather than through loan requests.

A recent stream of qualitative studies offers initial empirical evidence on how blockchain enables efficient information exchange on an ecosystem level (Jensen et al., 2019) and is amenable to new forms of industry-level collaboration through blockchain-driven consortia (Zavolokina et al., 2020). Adding to this literature, a recent study by Lacity and Van Hoek (2021b) documents a blockchain implementation in a supply chain setting where smart contracts running on a permissioned blockchain were leveraged to automate calculations needed to produce invoices by tapping into information on the blockchain (e.g., digital documents from trading partners, information from IoT devices) in near real-time. A practical benefit of this setup was removing several steps in the process of administrative validation of inter-firm transactions and a dramatic reduction in the costs related to handling disputes. Sarker et al. (2021) conducted a case study in the global shipping industry and found that permissioned blockchain mitigates both process and document-related corruption in international trades of agricultural goods. Sarker et al. (2021) further noted that blockchain works by leveraging and extending existing digital technologies instead of displacing them, as was often claimed in earlier conceptual studies (e.g., Iansiti and Lakhani, 2017).

Many blockchain projects we observe today result from collaboration among actors on an industry or even cross-industry level (Jensen et al., 2019; Mattke et al., 2019; Zavolokina et al., 2020). Rival companies interconnect disparate proprietary information systems (Mattke et al., 2019; Lacity and Van Hoek, 2021a), intending to address operational inefficiencies and governance issues in their supply chains (Goldsby and Hanisch, 2022). At the same time, a few recent studies have taken initial conceptual steps toward exploring the role of blockchain in the emergence of digital infrastructures (e.g., Constantinides et al., 2018; Zachariadis et al., 2019). Constantinides et al. (2018) analyze blockchain technology in the context of digital infrastructures and platforms. They highlight the potential of blockchain architecture to improve transactional efficiencies and asset exchange in a digital environment and note that extant research largely (and uncritically) focuses on technical attributes of blockchain technology. This leads the authors to observe that there has been a neglect of research on blockchain's managerial and organizational impact, which would be particularly relevant for research on digital infrastructures (Constantinides et al., 2018). Zachariadis et al. (2019) build on the literature on digital infrastructure governance (e.g., Constantinides and Barrett, 2015; Constantinides et al., 2018) to analyze key governance issues in blockchain-based financial infrastructure. One of the critical issues identified concerns interoperability and standards. A tension exists between open and proprietary standards initiatives, leading to a tendency of blockchain consortia to fragment standardization efforts where multiple standards and protocols continue to co-exist (Zachariadis et al., 2019). Accordingly, Zachariadis et al. (2019) call for further research into the role of standards for blockchain proliferation and tools and mechanisms that would enable interoperability between different blockchain platforms and protocols.

In summary, the existing accounting literature on blockchain technology offers a developing understanding of its effects on financial reporting practices of firms and real-time reconciliation and auditing of accounting records. However, it remains largely unknown how blockchain adoption impacts inter-organizational management control mechanisms used to support IORs. To address this gap, this dissertation responds to Caglio and Ditillo’s (2021) recent call for management accounting and control research to explain the changes brought forth by the use of blockchain technology on how firms interact and organize and control IORs. This topic is the specific focus of **Paper 1**. Similarly, the dissertation responds to the call for research on inter-organizational collaboration intended to produce innovative solutions (Caglio and Ditillo, 2021). To this end, **Paper 2** and **Paper 3** provide empirical findings of the mechanisms used to manage direct horizontal relations between industry competitors, as well as indirect horizontal relations between complementors (Caglio and Ditillo, 2021) in contexts where the parties espousing potentially misaligned interests collaborate to create standardized industry-wide solutions through collective action, and where individual contributions of organizations are difficult to assess. More specifically, **Paper 2** contributes to the emerging literature on technology standardization through collective action by providing insights into the reciprocal relationship between particular governance configurations and participating actors' level of interest and willingness to contribute resources to the standardization effort.

Moreover, the dissertation responds to calls for research on the impact of blockchain on digital infrastructures (Constatinides et al., 2018; Zachariadis et al., 2019). **Paper 3** attempts to fill the gap in our understanding of how the development of digital infrastructure can be governed in an inter-organizational environment and on a global level. Namely, the analysis in **Paper 3** unpacks the role of blockchain-based architecture and industry standardization efforts in establishing a polycentric governance configuration across a broad network of stakeholders in the maritime trade ecosystem.

5. Contributions and implications for future research

While the specific contributions of the three papers presented below are outlined separately in each of the papers, this section synthesizes the overall contributions of the dissertation and outlines promising areas for future research.

Overall, drawing from contributions in accounting and other related fields that study governance issues in IORs, the dissertation positions blockchain technology as a novel inter-organizational information architecture amenable to collaboration between numerous organizations that cuts across the traditional IOR forms studied in the existing literature. Accordingly, the dissertation contributes to the literature on management control issues in IORs by offering novel insights on inter-organizational forms of collaboration that aim to generate innovative solutions. This setting has thus far received only limited attention in this literature (Caglio and Ditillo, 2021). More specifically, **Paper 2** and **Paper 3** provide empirical findings of the mechanisms used to manage direct horizontal relations between industry competitors, as well as indirect horizontal relations between complementors (Caglio and Ditillo, 2021) in contexts where the interests of parties are not necessarily always aligned and where individual contributions towards generating a collective good are difficult to assess. Moreover, **Paper 3** outlines specific governance mechanisms and structures that collectively constitute a polycentric governance configuration underpinning a collaborative effort by numerous types of actors, many of which are direct competitors, to develop a digital infrastructure to support the digitalization of crucial trade documentation.

The dissertation further analyzes how technical characteristics of permissioned blockchain technology interact with formal and informal management control mechanisms in IORs. It clarifies that the extent to which blockchain-related functionalities (e.g., shared recordkeeping, multi-party consensus, independent validation, tamper evidence, transparency, smart contracts) impact governance in IORs may depend not only on the characteristics of a particular blockchain system but also on the particular management control issues that arise in different contexts. Accordingly, although the findings presented below suggest that blockchain technology can play an important role in fostering collaboration and achieving control in IORs (e.g., through standards, narrowing the domain for opportunism, and automatic execution using smart contracts), they do not make management controls obsolete, especially when blockchain is used to manage data exogenous to the system. More specifically, different from some related contributions (e.g., Lumineau et al., 2021), the findings presented below suggest that blockchains do not represent a self-sufficient mode of governance in IORs. Instead, it is suggested that the blockchain architecture needs to be complemented by an appropriate combination of controls and governance structures to address coordination and control challenges that arise in IOR contexts in which blockchain is implemented to connect numerous and/or heterogeneous actors.

5.1. Future research

The insights put forth in this dissertation could offer fruitful directions for future research. The research agenda presented in **Paper 1** could serve as a starting point for accounting scholars to further investigate the effects of blockchain technology use on well-known management control issues in IORs, which could potentially question some of the established assumptions currently found in the literature. At the same time, the propositions developed in **Paper 1** represent potential hypotheses that researchers could empirically test.

Studying different types of blockchain protocols could be another avenue for further research. Although most existing blockchain solutions in enterprise settings employ permissioned blockchains, several authors have argued that the next generation of blockchains could be partly based on public networks (Bear and Rauchs, 2020; Lacity and Van Hoek, 2021a). For example, Ernst & Young (EY) recently launched Nightfall, a set of protocols that allow public transactions on a public permissionless Ethereum network (Lacity et al., 2019). Similarly, the government of Singapore has developed TradeTrust[3], a technological framework for interoperability of

[3] See more at: https://www.tradetrust.io/

business-to-business and business-to-government transactions, including trade and commercial documents that allow different blockchain protocols such as Hyperledger, Quorum, or R3 Corda to interoperate on a shared public blockchain. TradeTrust and similar initiatives rely on international technical and legal standards, an accreditation structure for solution providers and trade parties, and open-source software development to promote interoperability. Relatedly, Bear and Rauchs (2020) predict that the currently prevalent permissioned blockchain networks that often include a dominant entity consisting of a single or a small number of parties could be superseded by semi-public, application-agnostic super networks, which would likely operate beyond industry boundaries. This setting could offer exciting opportunities for research where the arguments advanced in this dissertation could go a long way toward explaining management control and governance dynamics related to the establishment of standards by private actors, industry consortia, and/or government actors and the accreditation structure for involved parties. At the same time, novel insights could be derived by going beyond the focus on permissioned blockchain networks and explicitly examining the dynamics on the higher permissionless public layer.

Going beyond the traditional types of hybrid organizational forms examined in this dissertation, the insights presented below could be relevant for studying management control and governance issues concerning digital platforms, a type of platforms that serves as a standardized digital interface and utilizes digital technologies to facilitate interactions between different parties and coordinate activities across organizational boundaries (Chen et al., 2022). For example, Kretschmer et al. (2022) argue that digital platforms can be viewed as hybrid organizational structures residing between organizational hierarchies and markets, providing a mixture of market-based and hierarchical power and market-based and hierarchical incentives. The topics of incentives and control as two prominent dimensions of organizational governance (Williamson, 1985) that emphasize the role of formal and informal processes in coordinating co-specialized capabilities and resolving collective action problems in pursuit of joint value creation have been investigated in depth in existing management accounting studies. However, investigating these issues in the digital platform context has virtually been neglected in the management accounting and control literature. This is problematic because it leaves a clear gap in our understanding of digital platforms. This organizational form underlies the success of many of today's most prominent and fastest-growing firms accounting for the bulk of economic activity in modern economies (Parker et al., 2016). At the same time, this represents a promising opportunity for management accounting scholars who are uniquely equipped to make sense of these forward-looking technological and organizational trends.

References

Anderson, S. W., and H. C. Dekker. 2014. The Role of Management Controls in Transforming Firm Boundaries and Sustaining Hybrid Organizational Forms. *Foundations and Trends® in Accounting* 8(2):75-141.

Anderson, S. W., and K. Sedatole. 2003. Management Accounting for the Extended Enterprise: Performance Management for Strategic Alliances and Networked Partners. In: Management Accounting in the Digital Economy, Chapter 3, (ed.) A. Bhimani, Oxford University Press.

Axelrod, R., Mitchell, W., Thomas, R.E., Bennett, D.S., Bruderer, E., 1995. Coalition formation in standard-setting alliances. *Management Science* 41:1493-1508.

Babich, V., and G. Hilary. 2020. Distributed Ledgers and Operations: What Operations Management Researchers Should Know About Blockchain Technology. *Manufacturing & Service Operations Management* 22(2):223–240.

Bala, H., Venkatesh, V., 2007. Assimilation of Interorganizational Business Process Standards. *Information Systems Research* 18(3):340-362.

Bakos Y., and H. Halaburda. 2021(a). Smart Contracts, IoT Sensors, and Efficiency: Automated Execution vs. Better Information. http://questromworld.bu.edu/platformstrategy/files/2021/07/PlatStrat2021_paper_19.pdf

Bakos Y., and H. Halaburda. 2021(b). Tradeoffs in Permissioned vs. Permissionless Blockchains: Trust and Performance. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3789425

Bear, K., and M. Rauchs. 2020. Financial Services Leads The Development Of Enterprise Blockchain. *A Research Vignette for Global Digital Finance*. https://www.gdf.io/wp-content/uploads/2020/11/GDF-FS-Leads-The-Development-of-Enterprise-Blockchain-Vignette-October-2020.pdf

Beaubien, L. 2013. Technology, change, and management control: a temporal perspective. *Accounting, Auditing & Accountability Journal* 26(1):48-74.

Bear, K., and M. Rauchs. 2020. Financial Services Leads The Development Of Enterprise Blockchain. *A Research Vignette for Global Digital Finance*. https://www.gdf.io/wp-content/uploads/2020/11/GDF-FS-Leads-The-Development-of-Enterprise-Blockchain-Vignette-October-2020.pdf

Biais, B., C. Bisiere, M. Bouvard, and C. Casamatta. 2019. The Blockchain Folk Theorem. *Review of Financial Studies* 32:1662-1715.

Borys, B., and D. B. Jemison. 1989. Hybrid arrangements as strategic alliances: Theoretical issues in organizational combinations. *Academy of Management Review* 14:234-249.

Caglio, A., and A. Ditillo. 2008. A review and discussion of management control in inter-firm relationships: Achievements and future directions. *Accounting Organizations and Society* 33(7-

8):865– 898.

Caglio, A., and A. Ditillo. 2012. Opening the black box of management accounting information exchanges in buyer-supplier relationships. *Management Accounting Research* 23(2):61–78.

Caglio, A., and A. Ditillo. 2021. Reviewing Interorganizational Management Accounting and Control Literature: A New Look. *Journal of Management Accounting Research* 33(1):149–169.

Castañer, X., and N. Oliveira. 2020. Collaboration, Coordination, and Cooperation between Organizations: Establishing the Distinctive Meanings of These Terms through a Systematic Literature Review. *Journal of Management* 46(6):965-1001.

Cao, S., L. W. Cong, and B. Yang. 2019. Financial Reporting and Blockchains: Audit Pricing, Misstatements, and Regulation. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3248002

Catalini, C., and J. S. Gans. 2020. Some Simple Economics of the Blockchain. *Communications of the ACM* 63(7):80-90.

Catalini, C., and C.E. Tucker. 2018. Antitrust and Costless Verification: An Optimistic and a Pessimistic View of the Implications of Blockchain Technology. *MIT Sloan Research Paper No. 5523-18*. http://dx.doi.org/10.2139/ssrn.3199453

Centobelli, P., R. Cerchione, P. Del Vecchio, E. Oropallo, and G. Secundo. 2021. Blockchain technology design in accounting: Game changer to tackle fraud or technological fairy tale?. *Accounting, Auditing & Accountability Journal* (Forthcoming).

Chen, L., T. W. Tong, S. Tang, and N. Han. 2022. Governance and Design of Digital Platforms: A Review and Future Research Directions on a Meta-Organization. *Journal of Management* 48(1):147-184.

Chod, J., N., Trichakis, G. Tsoukalas, H., Aspergren, and M., Weber. 2020. On the Financing Benefits of Supply Chain Transparency and Blockchain Adoption. *Management Science* 66(10):4359-4919.

Chiu, J, and T. V. Koeppl. 2019. Blockchain-Based Settlement for Asset Trading. *The Review of Financial Studies* 32(5):1716-1753.

Christ M.H., and A.I. Nicolaou. 2016. Integrated information systems, alliance formation, and the risk of information exchange between partners. *Journal of Management Accounting Research* 28 (3): 1-18.

Coad, A.F. and J. Cullen. 2006. Inter-organizational cost management: Towards an evolutionary perspective. *Management Accounting Research* 17(4):342-369.

Constantinides, P., and M. Barrett. 2015. Information Infrastructure Development and Governance as Collective Action. *Information Systems Research* 26(1):40-56.

Constantinides, P., Henfridsson, O., Parker, G.G., 2018. Introduction—Platforms and Infrastructures in the Digital Age. *Information Systems Research* 29(2):381–400.

Coyne, J. G., and P. McMickle. 2017. Can Blockchains Serve an Accounting Purpose? *Journal of Emerging Technologies in Accounting* 14(2):101-111.

Coase, R. H. 1937. The Nature of the Firm. Economica 4(16):386-405.

Dai, J., and M. A. Vasarhelyi. 2017. Toward Blockchain-Based Accounting and Assurance. *Journal of Information Systems* 31(3):5-21.

Dekker, H. C. 2004. Control of inter-organizational relationships: Evidence on appropriation concerns and coordination requirements. *Accounting, Organizations and Society* 29(1):27– 49.

Dekker, H. C. 2008. Partner selection and governance design in interfirm relationships. *Accounting, Organizations and Society* 33(7-8):915-941.

Dyball M. C., and R. Seethamraju. 2021. Client use of blockchain technology: exploring its (potential) impact on financial statement audits of Australian accounting firms. *Accounting, Auditing & Accountability Journal* (Forthcoming).

Ebers, M, and L. Oerlemans. 2016. The Variety of Governance Structures Beyond Market and Hierarchy. *Journal of Management* 46(6):1491-1529.

Gans, J. S., 2019. The Fine Print in Smart Contracts. *NBER Working Paper No. 25443*. https://www.nber.org/papers/w25443.

Gibbons, R., and R. Henderson. 2012. Relational Contracts and Organizational Capabilities. *Organization Science* 23(5):1350-1364.

Gietzmann, M., and F. Grossetti. 2021. Blockchain and other distributed ledger technologies: Where is the accounting?. *Journal of Accounting and Public Policy* 40(5):106881.

Glaser, F. 2017. Pervasive Decentralization of Digital Infrastructures: A Framework for Blockchain-Enabled System and Use Case Analysis. *Proceedings of the 50th Hawaii International Conference on System Sciences (HICSS-50).* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3052165

Goldsby, C., and M. Hanisch. 2022. The Boon and Bane of Blockchain: Getting the Governance Right. *California Management Review* (Forthcoming).

Grafton, J., and J. Mundy. 2017. Relational contracting and the myth of trust: Control in a co-opetitive setting. *Management Accounting Research* 36:24-42.

Gulati, R., and H. Singh. 1998. The Architecture of Cooperation: Managing Coordination Costs and Appropriation Concerns in Strategic Alliances. *Administrative Science Quarterly* 43(4):781-814.

Gulati, R., F. Wohlgezogen, and P. Zhelyazkov. 2012. The Two Facets of Collaboration: Cooperation and Coordination in Strategic Alliances. *The Academy of Management Annals* 6(1):531-583.

Halaburda, H., M., Sarvary, and G. Haeringer. 2022. Enterprise Blockchains. In: Beyond Bitcoin: The Economics of Digital Currencies and Blockchain Technologies (eds. Halaburda, H., M., Sarvary, and G. Haeringer), Palgrave MacMillan.

Henfridsson, O., and B. Bygstad. 2013. The Generative Mechanisms of Digital Infrastructure Evolution. *MIS Quarterly* 37(3):907-93.

Hinzen, F. J., K. John, and F. Saleh. 2022. Bitcoin's Limited Adoption Problem. *Journal of Financial Economics* 144:347-369.

Holmström, B., Roberts, J. 1998. The Boundaries of the Firm Revisited. *Journal of Economic Perspectives* 12(4):73-94

Hopwood, A. G. 1996. Looking across rather than up and down: On the need to explore the lateral processing of information. *Accounting, Organizations and Society* 21(6):589-590.

Håkansson, H., and J. Lind. 2004. Accounting and network coordination. *Accounting, Organizations and Society* 29(1):51-72.

Iansiti, M. and K.R. Lakhani. 2017. The Truth About Blockchain. *Harvard Business Review 95(1)*. Available at: https://hbr.org/2017/01/the-truth-about-blockchain

Ireland, R.D., M.A. Hitt, and D. Vaidyanath. 2002. Alliance Management as a Source of Competitive Advantage. *Journal of Management* 28(3):413–446.

Iyengar, G., F. Saleh, J. Sethuraman, and W. Wang. 2021. Economics of Permissioned Blockchain Adoption. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3602376

Jensen, T., J. Hedman, and S. Henningsson. 2019. How TradeLens Delivers Business Value With Blockchain Technology. *MIS Quarterly Executive* 18(4):221-243.

Klein, P. G., J. T. Mahoney, A. M. McGahan, and C. N. Pitelis. 2019. Organizational governance adaptation: Who is in, who is out, and who gets what. *Academy of Management Review* 44(1):6-27.

Koutsikouri, D., R. Lindgren, O. Henfridsson, and D. Rudmark. 2018. Extending Digital Infrastructures: A Typology of Growth Tactics. *Journal of the Association for Information Systems* 19(10):1001-1019.

Kretschmer, T., A. Leiponen, M. Schilling, and G. Vasudeva. 2022. Platform ecosystems as metaorganizations: Implications for platform strategies. *Strategic Management Journal* 43(3):405-424.

Kulp, S.C., H.L. Lee, and E. Ofek. 2004. Manufacturer Benefits from Information Integration with Retail Customers. *Management Science* 50(4):425-559.

Kumar, A., R. Liu, and Z. Shan. 2020. Is Blockchain a Silver Bullet for Supply Chain Management? Technical Challenges and Research Opportunities. *Decision Sciences* 51(1):8-37.

Lacity, M., and R. Van Hoek. 2021a. What We've Learned So Far About Blockchain for Businesses. *MIT Sloan Management Review*.

Lacity, M., and R. Van Hoek. 2021b. Requiem for Reconciliations: DL Freight, a blockchain-enabled solution by Walmart Canada and DLT Labs. *University of Arkansas Blockchain Center for Excellence Research White Paper*. https://dltlabsweb-media.s3.ca-central-1.amazonaws.com/docs/BCoE202101POSTFINAL-55dcfe44-e73c-4d83-be69-5cb888b7b539.pdf

Lacity, M., Z. Steelman, and P. Cronan. 2019. Blockchain Governance Models: Insights for Enterprises. *University of Arkansas Blockchain Center for Excellence Research White Paper*. https://cpb-us-e1.wpmucdn.com/wordpressua.uark.edu/dist/5/444/files/2019/11/BCCoEWhitePaper022019OPEN.pdf

Law Commission of England and Wales. 2021. Smart legal contracts: Advice to Government. https://www.lawcom.gov.uk/project/smart-contracts/

Lumineau, F., W. Wang, and O. Schilke. 2021. Blockchain Governance—A New Way of Organizing Collaborations? *Organization Science* 32(2):500-521.

Ménard, C. 1995. Markets as institutions versus organizations as markets? Disentangling some fundamental concepts. *Journal of Economic Behavior & Organization* 28(2):161-182.

Ménard, C. 2004. The economics of hybrid organizations. *Journal of Institutional and Theoretical Economics* 160:345-376.

Markus, M. L., C. W. Steinfield, R. T. Wigand, and G. Minton. 2006. Industry-Wide Information Systems Standardization as Collective Action: The Case of the U.S. Residential Mortgage Industry. *MIS Quarterly* 30:439-465.

Mattke, J., C. Maier, A. Hund, and T. Weitzel. 2019. How an Enterprise Blockchain Application in the U.S. Pharmaceuticals Supply Chain is Saving Lives. *MIS Quarterly Executive* 18(4):245-261.

Miller, P., L. Kurunmäki, and T. O'Leary. 2008. Accounting, hybrids and the management of risk. *Accounting, Organizations and Society* 33 (7–8): 942-967.

Nakamoto, S. 2008. Bitcoin: A peer-to-peer electronic cash system. https://bitcoin.org/bitcoin.pdf

Narayanan, A., E. Felten, J. Bonneau, S. Goldfeder, and A. Miller. 2016. Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction. *Princeton University Press*.

Nicolaou, A. I., K. L Sedatole, and N.K. Lankton. 2011. Integrated Information Systems and Alliance Partner Trust. *Contemporary Accounting Research* 28(3):1018-1045.

Oliveira, N., and F. Lumineau. 2019. The Dark Side of Interorganizational Relationships: An Integrative Review and Research Agenda. *Journal of Management* 45(1):231–261.

O'Leary, D.E. 2017. Configuring blockchain architectures for transaction information in blockchain consortiums: The case of accounting and supply chain systems. *Intelligent Systems in Accounting, Finance and Management* 24 (4): 138-147.

Olson, M. 1965. The Logic of Collective Action: Public goods and the Theory of Groups. Harvard University Press.

Ostrom, E. 1990. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, New York.

Ostrom, V., C. M. Tiebout, and R. Warren. 1961. The Organization of Government in Metropolitan Areas: A Theoretical Inquiry. *American Political Science Review* 55(4):831-842.

Parker, G. G., M. W. Van Alstyne, and S. P. Choudary. 2016. Platform Revolution: How Networked Markets are Transforming the Economy, and How to Make Them Work For You. WW Norton.

Parkhe, A. 1993. Strategic alliance structuring: A game-theoretic and transaction cost examination of interfirm cooperation. *Academy of Management Journal* 36(4):794-829.

Parmigiani, A., and M. Rivera-Santos. 2011. Clearing a Path Through the Forest: A Meta-Review of Interorganizational Relationships. Journal of Management 37(4):1108-1136.

Peters, G. W., and E. Panayi. 2015. Understanding Modern Banking Ledgers through Blockchain Technologies: Future of Transaction Processing and Smart Contracts on the Internet of Money. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2692487

Rauchs, M., A. Blandin, K. Klein, G. Peters, M. Recanatini, and B. Zhang. 2018. 2nd Global Cryptoasset Benchmarking Study. *Cambridge Centre for Alternative Finance, Cambridge Judge Business School.* https://www.jbs.cam.ac.uk/faculty-research/centres/alternative-finance/publications/2nd-%20global-cryptoasset-benchmark-study/#.YKkLT6gzaiN

Rauchs, M., A. Blandin, K. Bear, and S. McKeon. 2019. 2nd Global Enterprise Blockchain Benchmarking Study. *Cambridge Centre for Alternative Finance, Cambridge Judge Business School.* https://www.jbs.cam.ac.uk/faculty-research/centres/alternative-finance/publications/2nd-global-enterprise-blockchain-benchmarking-study/

Reusen, E., and K., Stouthuysen. 2020. Trust transfer and partner selection in interfirm relationships. *Accounting, Organizations and Society* 81:101081.

Rikhardsson, P., and O., Yigitbasioglu. 2018. Business intelligence & analytics in management accounting research: Status and future focus. *International Journal of Accounting Information Systems* 29:37-58.

Risius, M., and K. Spohrer. 2017. A blockchain research framework. *Business & Information Systems Engineering* 59 (6): 385-409.

Saadatmand, F., Lindgren, R., Schultze. U., 2019. Configurations of platform organizations: Implications for complementor engagement. *Research Policy* 48(8).

Sarker, S., S. Henningsson, T. Jensen, and J. Hedmam. 2021. The Use of Blockchain As A Resource For Combating Corruption In Global Shipping: An Interpretive Case Study. *Journal of Management Information Systems* 38(2):338-373.

Schloetzer, J. D. 2012. Process Integration and Information Sharing in Supply Chains. *The Accounting Review* 87(3):1005-1032.

Scott, S. V., and W. Orlikowski. 2021. The Digital Undertow: How the Corollary Effects of Digital Transformation Affect Industry Standards. *Information Systems Research* (Forthcoming).

Steinfield, C., M. L. Markus, and R. T. Wigand. 2011. Through a glass clearly: Standards, architecture, and process transparency in global supply chains. *Journal of Management Information Systems* 28 (2):75-108.

Szabo, N. 1996. Smart Contracts: Building Blocks for Digital Markets. https://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart_contracts_2.html

Tilson, D., K., Lyytinen, and C., Sorensen. 2010. Digital Infrastructures: The Missing IS Research Agenda. *Information Systems Research* 21(4):685-687.

Weiss, M., and C., Cargill. 1992. Consortia in the standards development process. *Journal of the American Society for Information Science* 43(8):559-565.

Williamson, O. E. 1985. The economic institutions of capitalism. *The Free Press*, New York.

Williamson, O. E. 1991. Comparative economic organization: The analysis of discrete structural alternatives. *Administrative Science Quarterly* 36(2):269–297.

Xu, X., I. Weber, M. Staples, L. Zhu, J. Bosch, L. Bass, C. Pautasso, and P. Rimba. 2017. A taxonomy of blockchain-based systems for architecture design. *In 2017 IEEE International Conference on Software Architecture (ICSA)*:243-252.

Yermack, D., 2017. Corporate governance and blockchains. *Review of Finance* 21(1):7-31.

Zachariadis, M., G., Hileman, and S. V. Scott. 2019. Governance and control in distributed ledgers: Understanding the challenges facing blockchain technology in financial services. *Information and Organization* 29(2):105-117.

Zavolokina, L., R. Ziolkowski, I. Bauer, and G. Schwabe. 2020. Management, Governance and Value Creation in a Blockchain Consortium. *MIS Quarterly Executive* 19(1):1-17.

Zhao, K., and M. Xia. 2014. Forming Interoperability Through Interorganizational Systems Standards. *Journal of Management Information Systems* 30(4):269-298.

Zhu, K., K.L. Kraemer, V. Gurbaxani, and S.X. Xu. 2006. Migration to Open-Standard Interorganizational Systems: Network Effects, Switching Costs, and Path Dependency. *MIS Quarterly* 30:515-539.

Paper 1: Blockchain technology, inter-organizational relationships and management accounting: A synthesis and a research agenda

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Abstract

Blockchain technology is increasingly emerging as an important organizational phenomenon, especially for collaboration across firm boundaries. Over the past three decades, accounting scholars have shown significant interest in management accounting and control mechanisms that actors use to sustain inter-organizational relationships. We outline fundamental technical features and limitations of permissioned blockchain technology and analytically propose blockchain as an empirical concept with implications for management accounting practices that underpin inter-organizational collaboration, trust, control, and information exchange. The particular focus of the analysis is on the interplay between the technical capabilities of blockchain technology and inter-organizational management control procedures. Based on this analysis, we develop a series of propositions that theorize how these procedures affect how blockchain is enacted in inter-organizational relationships and how they are affected by blockchain in turn. The paper concludes with a research agenda for accounting scholars and offers directions for further research.

Keywords: Blockchain; Management Accounting; Inter-organizational Relationships; Management Control; Information Systems; Collaboration.

1. Introduction

This paper is motivated by the rise to prominence of an innovative and arguably organizationally disruptive distributed database technology colloquially referred to as blockchain and its potential in inter-organizational relationship (IOR) settings. In the IOR literature, it is generally understood that legally independent firms essentially play a "mixed-motive game" (Schelling 1960), which entails a mixture of mutual dependence and conflict, partnership and competition. In other words, IOR partners have overlapping but ultimately separate profit motives (Anderson et al., 2014). Blockchain technology's core attributes allow legally independent parties that may or may not fully trust each other to conduct and reliably control mutual interactions without reliance on a single controlling entity (Risius and Sproher, 2017). This makes blockchain highly suitable for IORs, where a mix of private and common goals is inherently present (Castañer and Oliveira, 2020). Against this backdrop, we conceptualize blockchain technology as part of an inter-organizational information infrastructure and analyze its potential and ramifications in IOR settings, focusing on management control and governance implications. We define IORs as voluntarily initiated collaborative arrangements between legally independent firms that involve information exchange, sharing, or co-development of products and services and can include partner contributions of technology, capital, or firm-specific assets (Gulati and Singh, 1998; Dekker, 2004). More specifically, in our analysis, we focus on formal, purposeful, non-equity-based contractual IORs resulting from negotiations between organizations that remain legally independent in the access to, exchange, and/or joint generation of resources (Caglio and Ditillo, 2008; Castañer and Oliveira, 2020). This refers to IOR forms involving transactional types of interactions [4] (e.g., strategic alliances, supply chain relationships, networks, coalitions, industry consortia, outsourcing agreements) and excludes those where at least one of the negotiating organizations ceases to operate as a distinct legal entity as a result of those negotiations (e.g., mergers and acquisitions) (Castañer and Oliveira, 2020).

Organizing transactions between firms involves significant control challenges that have been the topic of extensive research by management accounting scholars (Baiman and Rajan, 2002; Dekker, 2004; Reusen and Stouthuysen, 2020). This topic is particularly salient in inter-firm interactions involving blockchain since the technology allows for multilateral collaborative arrangements that

[4] The concept of a "transaction" is understood as occuring "when a good or service is transferred across a technologically separable interface" (Williamson, 1985: 1).

can encompass several traditional IOR forms. Examples of a blockchain project can include a strategic alliance between an IT vendor and a client, through which a solution is developed that is, in turn, partly governed by a consortium that includes the client's industry rivals (Jensen et al., 2019). The solution is used to foster interactions between traditional supply chain partners and independent bodies such as authorities and regulators from different countries (Jensen et al., 2019; Zavolokina et al., 2020). To focus the analysis, based on a review of IOR literature, we outline collaboration, trust, inter-organizational control, and information exchange as the four most relevant areas to investigate concerning blockchain technology. We analyze literature within each of these areas, focusing on management control issues, identify recurring and pertinent themes, and consider how blockchain could impact each. Based on this discussion, we develop theoretical propositions that collectively inform a research agenda for accounting scholars.

Our paper makes several contributions. Firstly, we contribute to the accounting literature on management control in inter-firm settings. We analytically specify blockchain as an inter-organizational information exchange architecture and propose it as an empirical concept with implications for transaction hazards (Williamson 1985) and the corresponding formal and informal management control remedies in IOR settings, namely trust, partner selection, and contracting (Dekker, 2004, 2008; Ding et al., 2013; Anderson et al., 2017a). In doing so, we discuss the interplay between the technical capabilities, operational realities and limitations of blockchain technology, and inter-firm management control procedures that both impact how blockchain is enacted in IORs and are themselves impacted by blockchain. In discussing the technical capabilities of blockchain technology, we focus on permissioned blockchains and emphasize tamper evidence and reliability of records, multi-party consensus, and automatic execution of agreements codified in smart contracts as technological attributes salient for IORs. Accordingly, we discuss their limitations. Further, we discuss governance choices in IORs in the presence of blockchain, namely partner selection, specification of procedures for information exchange, and the determination of the nature and scope of the collaboration between partners. Additionally, we analyze the interplay between blockchain and inter-firm controls and provide novel insights on the multilateral effects of blockchain on trust between IOR partners and the design and implementation of inter-firm contracts.

Secondly, we analyze different strands of accounting literature that often explore management control issues separately and supplement the analysis with contributions from organizational and information systems studies on the origins, nature, and dynamics of inter-firm collaboration as well as issues regarding inter-firm information exchange. We synthesize the arguments in a theoretically consistent manner in the form of a series of propositions. By integrating and recombining evidence from existing literature on IORs and blockchain, we offer novel insights into two complex technological and organizational phenomena and take a step towards formulating a new theory on management control implications of blockchain technology in IORs.

Thirdly, we contribute to the growing literature that examines blockchain technology as an organizational phenomenon (Beck et al., 2018; Murray et al., 2021; Kumar et al., 2020; Lumineau et al., 2021a). We explicitly focus on permissioned blockchains and discuss their technical capabilities and limitations in the context of inter-firm transacting. In other words, the paper contributes to advancing our understanding of what blockchains can and cannot do in an IOR context and outlines an agenda for future research on blockchain in management accounting.

The remainder of the paper is structured as follows. First, we review the literature that marks a point of departure for our overarching argument that blockchain is an important inter-organizational and management accounting phenomenon, focusing on permissioned blockchains. Generic terms like "blockchain technology" or "blockchain" are used to ease exposition throughout the paper. Second, we outline an organizing framework based on an analysis of literature on IORs in management accounting and related fields. Third, we identify and discuss the most prevalent issues within each of the outlined areas most likely to be impacted by blockchain technology. Based on this discussion, we develop a series of theoretical propositions. We conclude with a synthesis of outlined arguments and present a research agenda for accounting scholars.

1.1. Blockchain as an inter-organizational and accounting phenomenon

Blockchain technology enables multiple independent parties to jointly generate, maintain, synchronize, and update a shared set of authoritative records. Further, it facilitates decentralized information management and supports algorithmic enforcement of shared agreements in smart contracts (Rauchs et al., 2018b). A smart contract is a means by which obligations can be recorded, triggering other obligations that can be set up to operate in an automated way (Gans, 2019). Benefits stemming from blockchain's distributed data management, consensus mechanisms, and automated execution through smart contracts are viable primarily for transactions that can be handled exclusively through blockchain (i.e., endogenously), but also for highly standardized, verifiable, and codifiable transactions, as those can be reliably referenced on the blockchain even though the original data sources are exogenous to it[5]. In IOR settings, blockchain provides the infrastructure for proprietary databases of IOR partners to interact, thereby allowing the partners to transfer business-relevant information (e.g., about orders, receipts, payments) or digital assets across firm boundaries without sacrificing data privacy (Cao et al., 2019; Kumar et al., 2020).

Thanks to its ability to build a tamper-resistant[6] audit trail and simplify settlement and reconciliation between organizations, blockchain has seen fast adoption, particularly within supply chain management, finance, and accounting (Yermack, 2017; Lacity and Van Hoek, 2021a). Blockchain has attracted the interest of many established firms that have engaged in advanced trials or have major commercial projects in production. Examples include but are not limited to logistics and supply chain companies (Jensen et al., 2019; Lacity and Van Hoek, 2021a), pharmaceutical firms (Mattke et al., 2019), car industry actors (Zavolokina et al., 2020), banks (e.g., JPMorgan Chase[7]), accounting firms and consultancies (e.g., Deloitte[8], EY[9]), and retailers (e.g., Walmart) (Lacity and Van Hoek, 2021a, 2021b; Lumineau et al., 2021b). Each of these projects brings together up to hundreds of heterogeneous partners that work collaboratively on the development and deployment of different blockchain-based solutions for their inter-organizational environments. A recent study by Stratopoulos, Wang, and Ye (2021) analyzes corporate disclosures from the SEC Edgar database and finds that blockchain is increasingly adopted as a fundamental technology that improves business processes, further classifying it as a "relatively mature technology". These developments suggest that blockchain has emerged as an economically significant technology with salient real-world business implications. However, it is worth noting that it is still in the experimental phase and surrounded by technological, economic, and operational uncertainties in some cases.

1.2. Blockchain in accounting research

The Institute of Chartered Accountants in England and Wales (ICAEW), one of the world's oldest

[5] See Appendix A for a discussion on some fundamental blockchain and smart contract characteristics, as well as relevant transaction characteristics for blockchain-based transacting in IORs.
[6] The records on a blockchain are made persistent by replicating the data across multiple nodes, and tamper-evident by linking them through cryptographic hashes (Rauchs et al. 2018b).
[7] For more details see: https://www.jpmorgan.com/global/technology/blockchain
[8] For more details see: https://www2.deloitte.com/content/dam/insights/us/articles/2019-global-blockchain-survey/DI_2019-global-blockchain-survey.pdf
[9] For more details see: https://www.ey.com/en_gl/blockchain

and largest accounting organizations, describes blockchain as "[…] an accounting technology, […] concerned with the transfer of ownership of assets, and maintaining a ledger of accurate financial information. For accountants, using blockchain provides clarity over ownership of assets and existence of obligations" (ICAEW, 2018: 3). Financial records have traditionally been maintained by individual entities in a centralized manner, exhibiting an orientation to accounting practices that Hopwood (1996) described as hierarchical. On the other hand, Blockchain offers a radically different (i.e., distributed) alternative for transaction recording in a multi-party setting. According to some authors (e.g., Abadi and Brunnermeier, 2018), this could revolutionize the recordkeeping of financial transactions and data ownership.

Contemporary accounting studies predominantly examine the use of blockchain technology within financial accounting. Perhaps because of the intuitive link between the concept of a blockchain ledger and accounting ledgers, Coyne and McMickle (2017) considered the possibility of blockchain becoming a more secure, immutable alternative to current ledger database solutions. The most frequently discussed benefits of blockchains are increased speed and reduced costs of maintaining and reconciling ledgers (Dai and Vasarhelyi, 2017), real-time accounting (Yermack, 2017), increased security and control (Peters and Panayi, 2015), and automation of accounting and auditing rules that could be programmed onto the blockchain. Dai and Vasarhelyi (2017) further argue that blockchain could facilitate "triple-entry accounting" by acting as a "neutral intermediary" that would enhance the reliability of firms' financial statements. The authors suggest that each account in a contemporary double-entry bookkeeping system could have a corresponding blockchain account. Cao et al. (2019) consider the use of permissioned blockchains and zero-knowledge proof algorithms in accounting and auditing and show that blockchain adoption can lower both regulatory and auditing costs, and increase audit quality. The study further sheds light on how accounting data and their management affect the behaviors of firms and their monitors/regulators by providing an infrastructure for independent databases to interact without sacrificing proprietary data privacy.

In summary, the existing literature offers a developing understanding of the effects of blockchain technology on the financial reporting practices of firms and the real-time reconciliation and auditing of accounting records. However, it remains largely unknown how blockchain adoption impacts inter-organizational management control mechanisms used to support IORs. Therein lies the research gap that we address in this paper. Our study responds to Caglio and Ditillo's (2021) recent call for management accounting and control research to explain the changes brought forth by the use of blockchain technology regarding how firms interact, organize, and control IORs. To the best of our knowledge, ours is the first study to systematically examine the interplay between blockchain technology and formal and informal management accounting and control mechanisms in IORs and formulate actionable theoretical propositions for accounting scholars. We further highlight how collaboration and information exchange issues manifest in and are affected by firms' adoption and use of blockchain technology, thereby contributing to the growing literature on the organizational implications of blockchain-based systems.

2. Organizing theoretical framework

In this section, we analyze the literature on IORs in accounting and related fields and delineate an organizing theoretical framework consisting of four main areas to explore when considering the implications of blockchain technology in IORs. The framework is presented in Figure 1. It is important to note that these topics do not exist in isolation but are strongly interrelated, with considerable overlap between the relevant theoretical concepts.

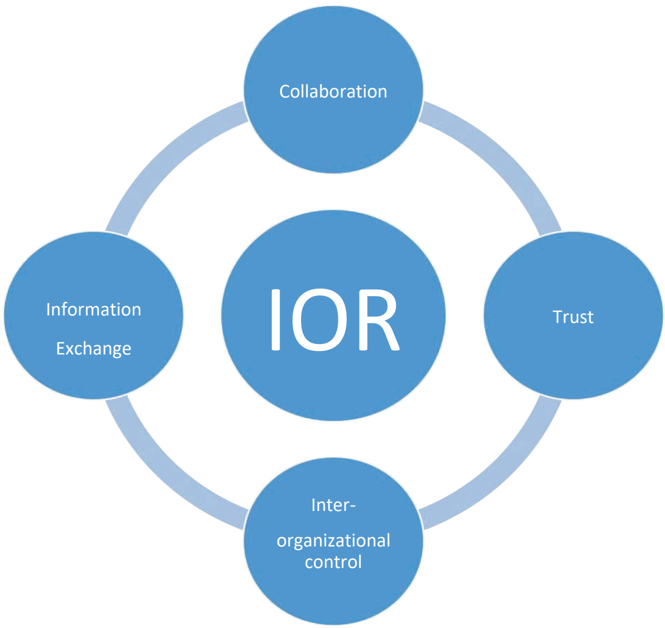

Figure 1: Organizing theoretical framework.

Collaborative arrangements between legally autonomous parties that do not readily fit the "market-hierarchy" dichotomy (Coase, 1937; Williamson, 1985) have become central to economic activity (Salvato et al., 2017; Anderson and Dekker, 2014). Consequently, they have been recognized as a distinct kind of "hybrid" organizing (Williamson, 1985, 1991). These hybrid organizational arrangements can take a variety of forms (e.g., strategic alliances, supply chain relationships, networks, coalitions, industry consortia, outsourcing agreements) and have been referred to by authors as "inter-organizational relationships", "inter-firm settings", "hybrid organizational forms", and "networks" (Caglio and Ditillo, 2008). We adopt inter-organizational relationships as a universal term. Understood in this way, IORs do not represent mere deals and strategic agreements but are also entities characterized by information-sharing and decision-making processes, boundary-spanning individuals, boards and committees, databases, and integrated computer systems, as well as other material and immaterial resources, all of which entail practical organizational challenges (Gulati et al., 2012).

Management accounting and control studies of IORs (e.g., Håkansson and Lind, 2004; Kajüter and Kulmala, 2005; Anderson et al., 2014; Grafton and Mundy, 2017) find that a situation of partial conflict exists between partners even when collaboration comes with clear and observable advantages and strong incentives for partners to establish and maintain the partnership. Moreover, some IOR forms (e.g., supply-chain relationships, networks, strategic alliances, outsourcing agreements) exist in conditions of somewhat unstructured authority. Litwak and Hylton (1962) observe that collaboration between partners is necessary to preserve these IORs, yet it is often the case that no single entity possesses sufficient formal authority to be able to impose collaboration through fiat. Since blockchain is, by design, a multi-party system (Glaser, 2017) with functionalities that inherently imply mutual interdependence and sequential interaction between parties, a certain level of collaboration between partners is necessary both ex-ante and after the blockchain solution becomes operational. Collaborating firms implementing a blockchain system will likely need to identify potential future benefits and clarify expectations for the collaboration ex-ante. Accordingly, inter-firm collaboration is the first area of the framework.

Research in accounting and economics (e.g., Baiman and Rajan, 2002; Williamson, 1993; Clemons and Hitt, 2004; Dekker, 2004) discusses opportunism and coordination as notable management control issues with implications for IOR theory and practice. The concept of "opportunism" refers to the deliberate incomplete or distorted disclosure of information (Williamson, 1985). Examples of opportunism discussed in the literature include ex-ante behavior such as deliberate misrepresentation of a firm's true attributes (Arrow, 1985), and misappropriation of information by the recipient that cannot be legally prevented, and benefits from which cannot be contracted on (Baiman and Rajan, 2002; Clemons and Hitt, 2004). The examples also include ex-post shirking on quality, effort or information provision (Baiman and Rajan, 2002). These can create transaction hazards (Williamson,1985; Dekker, 2004; Reusen and Stouthuysen, 2020) and tension between partners, which necessitate that different formal and/or informal safeguards and control mechanisms be put in place to mitigate the hazards and manage the IOR.

An important informal management control remedy for transaction hazards is inter-firm trust (Dekker, 2004). Blockchain is often described as a "trustless" technology that replaces trust in an intermediary with trust in consensus rules and underlying code (Catalini and Gans, 2020). In the case of permissioned blockchains, this can also involve trust in a "gatekeeper" that grants access to the system (Rauchs et al., 2018b) and other firms that participate in the network. Consequently, some level of familiarity and ex-ante trust must be established between partners. This makes the concept of trust (Rousseau et al., 1998) critical to analyze in our context and was identified as the second area of the framework.

Unlike inter-organizational arrangements backed by extensive contracts such as franchise agreements, IORs that are the focus of this study do not rely solely, or sometimes even primarily, on extensive contracts to achieve control or coordination (Anderson et al., 2017b). Incomplete contracts that typify IORs (Baiman and Rajan, 2002) and the associated residual risks that in some cases preclude inter-firm transacting are made sustainable through the use of management control mechanisms such as improved measurement of actions and outcomes and joint collaborative practices that enhance information sharing across firm boundaries and opportunities for formal and informal monitoring (Dekker, 2004; Ding et al., 2013; Anderson et al., 2017a). Implementation of blockchain technology inevitably involves creating a network of partners, which in turn involves the use of formal controls, making literature on partner selection (Dekker, 2008; Dekker and Van den Abbeele, 2010; Neumann, 2010), and inter-firm contracting (Poppo and Zenger, 2002; Anderson and Dekker, 2005; Reuer and Ariño, 2007; Ding et al., 2013) particularly salient sub-areas to analyze. In this space, termed "inter-organizational control" in our framework, management accounting studies have made notable contributions to understanding the nature of IORs as a modern, interconnected organizational form (Anderson and Dekker, 2014).

Management accounting research has identified "information openness" as an important theme related to the functioning of different forms of IORs, such as supply chain relationships (Baiman and Rajan, 2002; Schloetzer, 2012; Reusen and Stouthuysen, 2020), networks (Håkansson and Lind 2004; Kajüter and Kulmala, 2005), and alliances (Nicolaou et al., 2011; Christ and Nicolaou, 2016). Christ and Nicolaou (2016) find greater collaboration intensity[10] to be associated with greater information system integration and the implementation of a larger portfolio of controls between partners in an alliance[11]. This further makes the establishment of a common information infrastructure a salient issue in the context of IORs. Common information infrastructure is here seen as the "blueprint" for the interaction patterns through which collaborating firms share the risks and govern the partnership (Christ and Nicolau, 2016). Given that blockchain technology enables the transparent, reliable, and efficient exchange of information in networks of legally independent organizations, we conceptualize it as a component of a common information infrastructure in IORs and specifically discuss management control implications of blockchain-enabled information exchange as the fourth major area of the framework.

3. Discussion

This section scrutinizes literature on collaboration, trust, inter-organizational control, and information exchange. The explicit goal of the ensuing discussion is to critically analyze the existing knowledge about these concepts, focusing on the implications of blockchain technology for each of the four main areas of the organizing framework. Major arguments resulting from the discussion are synthesized into theoretical propositions intended to serve as building blocks of a research agenda for future efforts in blockchain-related management accounting research. We contend that this research agenda could help equip accounting scholars with "instruments" to critically study management accounting and control issues in IORs as this important organizational form increasingly becomes interrelated with an emerging technological phenomenon that is blockchain.

[10] Christ and Nicolaou (2016) describe collaboration intensity as referring to the importance of multiple alliance objectives to a firm.

[11] The authors use "alliance" as an aggregate term to connote inter-organizational relationships ranging from joint ventures to strategic partnerships and supply chain relationships.

3.1. Collaboration

Inter-firm collaboration is an important source of competitive advantage for organizations because it enables value creation through accessing and combining complementary resources and capabilities of partnering firms (Coletti et al., 2005). At the same time, Gulati et al. (2012) warn that inter-firm collaboration can be very risky and complex. White (2005) suggests that collaboration necessitates that relationship partners develop and maintain an inter-organizational interface for communication and internally adapt in response to relationship partners' actions or the changing external environment.

Cooperation and coordination have been identified in the IOR literature as two distinct yet complementary facets of inter-firm collaboration (Salvato et al., 2017; Gulati et al., 2012). In line with Castañer and Oliveira (2020) and Gulati et al. (2012), we define cooperation as a complex concept including a willingness to work toward the achievement of agreed-on goal(s) in a manner corresponding to a shared understanding of contributions and payoffs, as well as actions taken by the partners to achieve the stipulated collective goal(s). The reasons for firms to engage in cooperation usually involve sharing of investment risks and pursuing a number of technological, commercial, and operational goals that they might be unable to obtain through arm's-length transactional relationships (Gulati et al., 2012). An explicit definition of terms is essential in IORs, as they provide a clear framework that defines each party's rights and obligations, as well as the principles and procedures of the cooperation (Luo, 2002; Anderson and Dekker, 2005). This is even more critical when introducing blockchain in IORs because of the formalized nature of data exchange, validation, and governance mechanisms. Moreover, blockchain helps create a common information infrastructure between partners in the sense that all the relevant parties share an identical record of data exchanged according to a network-wide protocol.

As partners agree on the inputs and outputs of the relationship, a mutual interdependence is created (Pfeffer and Salancik, 1978). This represents a situation in which partners are dependent on one another in various ways to accomplish organizational goals (Reusen and Stouthuysen, 2020) and become vulnerable to the actions of the other (Parkhe, 1993). This issue is particularly salient in IORs formed between competitors. On the one hand, a firm's rivals can possess the capabilities and/or resources needed for a joint project. On the other hand, past rivalry can cultivate a lack of trust (Trapido, 2007).

Interestingly, Davis et al. (1990) point out that competitors are more likely to become aware of one another through professional associations than are non-competitors. Stuart (1998) further argues that competitors often choose to cooperate because they are "better able to evaluate and internalize the know-how of technologically similar firms" and avoid duplication of effort. This argument is known as competitive embeddedness, a notion that competition increases mutual awareness, which, in turn, breeds familiarity and knowledge-based competence trust (Trapido, 2007). Many blockchain projects we observe today are a result of multilateral cooperation between heterogeneous actors, including industry competitors (Jensen et al., 2019; Mattke et al., 2019), alliance and supply chain partners (Jensen et al., 2019), financial institutions such as banks[12] and insurance firms[13], as well as authorities and research and educational institutions (Zavolokina et al., 2020). Rival companies form initiatives and consortia (Lacity, 2018; Mattke et al., 2019) to address industry inefficiencies using blockchain. Notable examples of blockchain-enabled supply chain applications include TradeLens, a supply chain platform intended for the secure exchange of documentation across global supply chains (Jensen et al., 2019), and IBM Food Trust, a solution for tracking product provenance (Lacity and Van Hoek, 2021a). In these projects[14], rival companies collaborate to create value for a broad ecosystem of organizations.

Taken together, the factors described above should alleviate some adverse selection concerns that would otherwise present obstacles to initiating cooperation. Further, blockchains can employ encryption methods such as zero-knowledge protocols[15] that allow information providers in a blockchain system to safeguard proprietary information while verifying transactions (Cao et al., 2019). Confidentiality and control of the data are significant issues in inter-firm cooperation, especially between competitors (Bechini et al., 2008). At the same time, competitive embeddedness is crucial for establishing cooperation in these cases, as partners get acquainted via professional associations and discuss pressing issues within their industries (Trapido, 2007). Accordingly, we

[12] For recent examples see: https://www.crowdfundinsider.com/2020/03/158652-standard-chartered-joins-tradelens-a-leading-blockchain-based-supply-chain-management-solution-developed-by-ibm-maersk/ and https://www.ledgerinsights.com/hsbc-production-contour-blockchain-trade-finance/

[13] For more details see: https://smartmaritimenetwork.com/2021/03/30/tradelens-electronic-bills-of-lading-approved-by-international-group-of-pi-clubs/

[14] Technologically, both projects are based on Hyperledger fabric, an open source protocol developed through a collaborative effort hosted by the Linux Foundation and supported by firms such as IBM, Intel, and SAP (Stratopoulos and Calderón 2020). For a detailed description of how a complete blockchain transaction is initiated, validated, and recorded on the blockchain [hyper]ledger see Calderón and Stratopoulos (2020).

[15] A zero-knowledge protocol (ZKP) is a set of cryptographic algorithms that can ensure both the validity and confidentialiy of records on a blockchain. Cao et al. (2019) describe a ZKP as a proof of a statement by one party (the prover) to another party (the verifier) without conveying any additional information to the verifier, other than the correctness of the statement.

predict existing cooperation in IORs to be conducive to the introduction of blockchain technology. Furthermore, we contend that blockchain facilitates new cooperative relationships that were previously not feasible due to concerns over data security and the inability to integrate numerous and heterogeneous sets of actors.

Proposition 1**: The introduction of blockchain technology is facilitated by existing cooperative relations in IORs, and facilitates new ones both in number and nature.**

On the one hand, cooperative relationships can provide cost savings, such as a decrease in monitoring costs, leading to increases in efficiency and profitability (Smith et al., 1995). On the other hand, the central problem of cooperation is that firms often have only partly overlapping interests and may pursue incongruent goals if left to their own devices (Schelling, 1960). Axelrod and Keohane (1985) further argue that cooperation is only possible in situations with a combination of complementary and opposing interests. Misaligned interests may cause partners to shirk or claim more benefits than initially agreed through holdup or misappropriation of partners' resources (Gulati et al., 2012). To help explain the success or failure of inter-firm cooperation Axelrod and Keohane (1985) identified three dimensions: (1) the pattern of payoffs; (2) the shadow of the future; and (3) the number of players. Payoffs strongly influence the development and maintenance of cooperation as each relationship partner expects to attain a net positive value (Parkhe, 1993). The shadow of the future argument suggests that considerations about the future promote cooperation, as firms compare immediate benefits from deceiving the partners with the loss of potential future gains resulting from breaking the agreement (Axelrod and Keohane, 1985). The number of actors and the structuring of their relations can also play a role in inducing cooperation, as it might be challenging to detect and punish the potential defectors when many parties are involved (Axelrod, 1979).

The three dimensions proposed by Axelrod and Keohane (1985) are relevant to consider when implementing blockchain in IORs. Participating in a blockchain network requires a priori investments and acceptance of the predefined rules by a given partner firm, which signals a "credible commitment" (Williamson, 1983) to the joint project. This can include significant upfront costs to develop and implement the blockchain system. High switching costs could be incurred by firms with complex legacy systems that would need to be replaced entirely or made compatible with blockchain. This means that, in order to justify those investments, firms will likely need to determine payoffs for each party before they fully commit to the project. Moreover, the development of a blockchain network requires joint efforts across organizational boundaries, making the potential benefits of the solution contingent on the status of network adoption. This means that the payoffs will depend on the success or failure of the entire network rather than on individual partners, which should help align their goals and induce cooperation. The blockchain ledger possesses a critical attribute of tamper-evidence, which improves monitoring through higher data transparency. Consequently, the "shadow of the future" should dissuade actors from engaging in opportunistic behavior. Similarly, blockchain's inherent data sharing and governance protocols, the sequential nature of the data recording process, and the auditability of the shared ledger should enable partners to inexpensively and reliably identify a party trying to submit erroneous transactions, irrespective of the number of actors in the network.

***Proposition 2*: Blockchain use positively affects goal alignment and fosters cooperation in IORs because the economic benefits incurred by partners depend on the success or failure of the entire blockchain network.**

One of the most desirable results of inter-firm cooperation is achieving effective *coordination* (Smith et al., 1995). In line with Castañer and Oliveira (2020) and Gulati et al. (2012), we define inter-firm coordination as a deliberate and orderly alignment or adjustment of a partner's actions in the process of determining common IOR goals. Coordination is typically associated with information sharing, decision-making, and feedback mechanisms, aiming to align partners' efforts and productively combine their resources (Gulati et al., 2012). The regular exchange of information between partners in an IOR has been termed "procedural coordination" by Sobrero and Schrader (1998). It refers to day-to-day communication that allows partners to adapt their activities to one another and handle disputes and exceptions.

Blockchain helps establish a common information infrastructure, meaning that all the relevant partners share identical data references. It further enables new kinds of distributed architectures, as the process through which data is exchanged and recorded relies on responsible and accurate record-keeping by a network of legally independent and mutually constraining "record keepers". This should lead to a significant simplification of procedural coordination, particularly in terms of information sharing and the handling of disputes. A practical illustration of this point is notable efficiency gains in handling shipments between supply chain partners, which have in the past involved (and in many cases still do) numerous ad-hoc manual follow-ups through email, phone calls, and the like. On the other hand, within a blockchain-based network, mutually agreed-upon decision-relevant data references are made available to all the pertinent parties for given events in near-real-time (Jensen et al., 2019)[16]. For accounting scholars and accountants, more generally, such an effect is salient because it can markedly improve the performance of administrative work in participating firms (Anderson and Lanen, 2002; Lacity and van Hoek, 2021b).

Moreover, programmable rules (i.e., smart contracts) could be used to automate several routine day-to-day procedures even when the data being exchanged is not fully endogenous to the blockchain system. The latter is feasible for verifiable and codifiable transactions, which alleviates the "oracle problem"[17]. It is further enabled through standardization of data formats, network-wide protocol rules, and tamper-evidence of the ledger, thereby making the execution of these procedures more efficient, as well as more reliable.

***Proposition 3*: Implementing blockchain in IORs simplifies procedural coordination between partners.**

3.2. Trust

The concept of trust has been widely discussed in the literature in the fields including accounting, economics, psychology, sociology, and philosophy. Rousseau et al. (1998) analyzed the meaning of trust across these disciplines and defined it as a psychological state comprising the intention to accept vulnerability based on positive expectations of the intentions or behavior of another. The development of inter-firm trust is often argued to be the basis for maximizing the value of IORs (Ireland et al. 2002; Dekker 2004). The presence of inter-firm trust can reduce transaction costs (Gulati 1995), spur desirable behavior, lead to decreased levels of conflict, facilitate coordination by enabling greater knowledge and information transfer (Poppo et al., 2016), increase managerial flexibility, and reduce concerns about opportunistic behavior (Gulati et al., 2012). Since it is most

[16] For a detailed technical description of an operational application of a permissioned blockchain and smart contracts in a supply chain context, see Lacity and Van Hoek (2021b).
[17] For a brief discussion on the oracle problem, see Appendix A.

often impossible to manage all risks through formal agreements and controls, firms at least partly rely on trust to sustain IORs (Dekker, 2004; Reusen and Stouthuysen, 2020). Existing research has identified different forms of trust, contingent on the bases from which it is reached. A prominent classification relevant for management accounting studies of IORs differentiates between *competence trust* and *goodwill trust* (Dekker, 2004; Anderson et al., 2017b; Reusen and Stouthuysen, 2020). While competence trust refers to a partner's technical *ability* to perform activities as agreed in the contract (Dekker, 2004), goodwill trust refers to a firm's confidence in predicting partner's *intentions* to act as agreed (Nicolaou et al., 2011).
Williamson (1993) discusses calculative aspects of IORs involving trust where managers believe that the costs of acting opportunistically, which refer to the forgone future value of transactions, will be greater than the benefits associated with opportunistic actions. Susarla et al. (2020) outline two primary trust sources in this context. The first reflects the potential for future economic gains from continued exchange, which has an important disciplining effect on exchange partners to adhere to informal agreements (Baker et al., 2002) and show a willingness to be vulnerable to the actions of the other. Axelrod and Keohane (1985) refer to this disciplining effect as the "shadow of the future". More specifically, this effect refers to the threat of the collaboration being terminated, which further entails that the partners could forego all potential future benefits (Gibbons and Henderson, 2012). The second source is partners' bilateral reputation for satisfactory performance in prior contracting, which assuages partners' fear of performance failure despite full cooperation, thereby reducing performance risk (Anderson and Dekker, 2009; Susarla et al., 2020). This reputation represents an intangible economic asset (Klein and Leffler, 1981; MacLeod, 2007) and arises as partners observe each other's performance over repeated interactions, from which they infer commitment to upholding contractual agreements (Susarla et al., 2020).

Blockchain is often referred to as a "trustless" technology (Xu et al., 2017), which might imply that it has the potential to replace trust within and between organizations. However, while blockchain's cryptography and consensus mechanisms can replace trusted intermediaries when transferring cryptocurrencies, the same does not fully apply to IORs. Namely, entries in permissioned blockchains (e.g., in supply chains) often refer to exogenous data sources. While asset ownership might be verified by blockchain records, their condition, location, and worth must still be assured (ICAEW, 2018). Although the blockchain, in and of itself, cannot prevent a party from breaking an agreement or acting opportunistically, inbuilt mechanisms could decrease the *possibilities* for opportunism. Research has found that third-party information based on a partner's history of cooperation with other firms, even in the absence of own knowledge based on prior interactions, enables the formation of trust through a *transference process* (McEvily et al., 2003), where third parties "rollover expectations" from existing relationships to newly formed ones (Uzzi, 1997).

In permissioned blockchains, network participants are often "competitively embedded" (Trapido, 2007) vetted partners. Reusen and Stouthuysen (2020) find that third-party information significantly affects partners' level and dimensions of trust through "trust transfer". The premise behind this "trust transfer" is that, other than being based on own prior experience with a given partner, initial trust impressions are also influenced by the cues provided by third parties, such as other firms in an industry (Reusen and Stouthuysen, 2020). More specifically, knowing other firms that trusted an IOR partner is sufficient for participants' *competence trust* to increase. In a blockchain network, such "third-party" information can be obtained simply by observing successfully executed transactions between other (vetted) participants, even when a given partner is not privy to specific information to which only directly participating or otherwise designated parties may have read, write and/or validation rights. On the other hand, *goodwill trust* is only found to increase when information about positive outcomes is available (Reusen and Stouthuysen, 2020). Achieving this effect in a blockchain network of vetted participants is likely, although it might necessitate more detailed information about interactions beyond mere successful transaction execution in some cases. Combined, these features imply that while the transacting parties in a blockchain network still need to establish expectations regarding partners' behavior and goodwill, as this represents an important aspect of the "network configuration", they no longer need to do so solely based on direct past experience or the ongoing direct interactions with those partners (Lumineau et al., 2021a). Regular monitoring of tamper-evident blockchain records, coupled with the disciplining effect of "trust transfer", would increase the probability that opportunistic behavior will be detected and sanctioned not just by the parties directly involved in a given transaction but by the entire blockchain network. Moreover, the transference effect of trust (McEvily et al., 2003; Reusen and Stouthuysen, 2020) between network participants could help establish a multilateral reputation system (Susarla et al., 2020) in the network, thereby increasing the overall level of both competence and goodwill trust.

***Proposition 4*: Introducing blockchain in IORs increases the level of both competence and goodwill trust among partners.**

3.3. Inter-organizational control

An extensive body of literature in management accounting examines governance choices of firms in IORs, explicitly recognizing the conditions that precede and largely determine these choices (e.g., the threat of partner opportunism and coordination of inter-firm tasks), as well as ways in which firms acquire information about their partners (Dekker, 2004; Anderson and Dekker, 2005; Neumann, 2010). Selecting an appropriate partner in IOR settings is an important way in which firms can mitigate control problems, with some authors suggesting that identifying a suitable partner is critical for the overall success of an IOR (Ireland et al., 2002). Dekker (2004, 2008) further shows that the partner selection process strongly influences the latter stages of the collaboration since it precedes and informs the design of contractual and other management control structures used to sustain IORs. Accordingly, "partner selection" is referred to as searching for, evaluating, and ultimately selecting a transaction partner (Dekker, 2004, 2008; Ding et al., 2013). Management accounting studies (Dekker, 2008; Ding et al., 2013) conceptualize partner selection as an explicit formal ex-ante management control choice in IORs in response to the underlying transaction hazards. In these studies, the partner selection process is analyzed in terms of the time spent by firms to find exchange partners; the effort exerted to evaluate them (including the development of evaluation criteria), as well as the relative importance placed on different selection criteria in the choice of a partner (Dekker, 2008; Dekker and Van den Abbeele, 2010; Ding et al., 2013). The evaluation criteria include those that relate to partners' reliability and technological competencies, as well as the screening of multiple suppliers and information search in networks of related parties to acquire relevant information (Dekker and Van den Abbeele, 2010).

Transacting partners in a blockchain network are obligated to behave according to the collective agreement (i.e., the network configuration), as deviating behaviors would not be verified by the algorithm or other nodes in the system (Catalini and Boslego, 2019). The underlying logic is not to formulate elaborate terms that could be used to seek legal recourse for ex-post breaking of agreements but rather to regulate partners' actions from the outset (Lumineau et al., 2021a). Blockchain architecture provides a resilient, replicated, sequentially-ordered record of interactions between partners maintained by a network of legally independent actors. The latter characteristic is related to tamper-evidence of a blockchain ledger, meaning that relevant parties can readily observe and prevent potential malfeasance through a "majority" vote on the state of the records (i.e., the consensus mechanism). These characteristics significantly increase the reliability of records and make an ex-post observation of prior interactions less costly and less time-consuming. Reliable records validated in a decentralized manner provide a robust “third party” signal of competence and benevolence of transacting partners for the entire network (Reusen and Stouthuysen, 2020), in most cases irrespective of specific levels of data-access authorization. In combination with the reliability of blockchain records, this can mitigate transaction hazards by building a credible reputation system for IOR partners in a blockchain network.

Similarly, joining the blockchain network implies that a partner accepts predefined governance rules (Lumineau et al., 2021a). As such, the willingness of a partner to participate in a network characterized by tamper-evident records and involving automated execution of codified agreements can be seen as a precommitment not to behave opportunistically in the future (Yermack, 2017) and a signal both of the intention and the ability of partners to honor the agreements (Lumineau et al., 2021a) Hence, in an IOR context, blockchain technology could have profound implications for the partner selection process. Namely, the combined effect of reliability of records, ex-ante deterrence of potentially opportunistic actors, and the greater ease of observability of prior interactions should improve the process of informing and designing evaluation criteria for potential partners and reduce partner search and selection costs in IORs.

***Proposition 5*: Blockchain technology mitigates control problems in IORs through improved partner selection.**

Contracts represent an integral part of the management control structure of IORs. Contracts are legally enforceable, voluntarily initiated documented agreements between exchange partners that provide a governance framework for their relationship and incorporate procedures, incentives, mutual obligations, and dispute resolution mechanisms (Schepker et al., 2014). Contracts help partners achieve cooperation and coordination by specifying each party's rights and responsibilities, particularizing the deliverable outcomes, clarifying procedures for monitoring and penalties for non-compliance, and putting forth conflict resolution procedures (Poppo and Zenger, 2002; Ding et al., 2013). As such, they are primarily used to control verifiable actions and outcomes. Contract complexity refers to the number and stringency of provisions in a contract (Reuer and Ariño, 2007). Complex contracts understood this way are detailed and costly to develop and implement, as they include a large number of specific terms, clauses, and covenants and contain detailed agreements that serve to clarify monitoring procedures for non-compliance and describe conflict resolution procedures that are collectively used to mitigate potential transaction hazards (Luo 2002; Ding et al. 2013). A prominent stream of research (Williamson, 1985; Anderson and Dekker, 2005; Reuer and Ariño, 2007) focuses on contractual clauses aimed at aligning and safeguarding partners' interests and facilitating coordination and adaptation. Banker et al. (2006) distinguish between aspects of activities that should be included in the contract and those that should be monitored and suggest that a shared information exchange infrastructure enables greater contract completeness by making monitoring additional dimensions of partner performance more economical.

Blockchains' fundamental technical and governance characteristics improve the reliability and ex-post observability of records. Additionally, smart contracts enable the routinization of inter-firm processes involving blockchain-endogenous data and explicit exogenous (i.e., standardized, codifiable, and verifiable) data references, reducing them to a set of articulated interaction patterns that are automatically executed when predefined conditions are met. The monitoring and the execution phase of this process incur no additional direct costs. Standardization of data formats and execution patterns makes transactional interactions between partners in IORs more predictable, while decentralized governance mechanisms establish clear decision-making rules regarding the data exchanged in the network. Furthermore, sequential ordering of redundantly stored data among participants in the network and the resulting tamper-evidence of the records greatly simplify dispute resolution. Taken together, and to the extent that they refer to blockchain-endogenous or otherwise explicit transactions, blockchain functionalities and smart contracts allow more partner activities to be reliably monitored. Taking the argument one step further, the introduction of blockchain could induce firms to preemptively change their transactional practices to fit the requirements of standardization, codifiability, and verifiability[18], in essence changing the nature of the transactions. Accordingly, this would enable the scope of the activities that can be reliably automatically executed, enforced, and monitored through blockchain to be expanded even further. At the same time, Sheldon (2019) cautions that the proper functioning of blockchain and smart contracts depends on a secure internal controls environment. Concerns over access to transactional data and smart contracts in IORs result in a need for increased scrutiny regarding internal control over financial reporting. This can increase the complexity of the overall IT governance in an IOR, as effective controls in and "around" the blockchain and smart contracts need to be put in place in a setting

[18] For more details on different transaction types in a blockchain environment see Appendix A.

involving multiple legally independent organizations (Sheldon, 2019). On the other hand, Sheldon (2019) points out that this blockchain-related increase in internal control complexity is at least partially offset by the minimization of risks related to modification of historical data, the need for data backups, batch processing between blockchain nodes, and disaster recovery of data and programs enabled by blockchain and smart contracts.

Anderson and Dekker (2005) suggest that more significant exchange hazards induce firms to invest in more complex contracts. Relatedly, we contend that the functionalities of blockchain technology and smart contracts narrow the domain around which parties can be opportunistic (Poppo and Zenger, 2002) and reduce information asymmetry between partners in IORs. In turn, this lowers transaction hazards, increases the level of control over verifiable actions and outcomes, and reduces the scope of activities that IOR partners need to include in formal contracts, ultimately leading to lower demand for highly complex contracts in IORs.

***Proposition 6*: Blockchain technology enables the design of less complex contracts in IORs.**

3.4. Information exchange

Over the past three decades, the boundaries of a single organization have lost some of their explanatory power in defining the relevant entity for management control in many firms. The emergence of information collection, conversion, dissemination, and monitoring technologies within and across organizational boundaries has played an important role in enabling inter-organizational collaboration. A technology-enabled inter-organizational information system (IIS) often represents a primary means of information exchange across firm boundaries in IORs (Gulati and Singh, 1998). As such, IISs play a significant role in controlling IORs (Nicolaou et al., 2011).

At the most basic level, the purpose of adopting IISs is to implement computerized communications among partnering organizations. Studies that investigate control and performance implications of IIS use broadly identify information sharing, standardization, and process integration as practices that facilitate mutual value creation. In this context, information sharing reflects the extent to which partners exchange decision-relevant information via IISs (Schloetzer, 2012). Process integration is here referred to as the extent to which partners standardize and synchronize inter-firm processes, which are, in turn, defined as a set of interrelated and sequential activities shared and executed by two or more trading entities (Schloetzer, 2012). In the IIS context, standards are defined as a set of technical specifications that are agreed upon and used by IIS developers to describe data formats and communication protocols, which enable computer-to-computer communication, and in turn, facilitate inter-organizational information exchange (David and Greenstein, 1990; Zhu et al., 2006). For the purposes of this paper, IISs are defined as technology-enabled information systems used by two or more organizations that can facilitate the creation, storage, and transmission of different types of information (e.g., operational, accounting, performance, contractual, and/or strategic information) across firm boundaries (Nicolaou et al., 2011; Christ and Nicolaou, 2016).

Blockchain records are considered valid only after a uniform view of the ledger's state and the order of events (i.e., a consensus) has been reached on a collective level. This mechanism could entail high overhead costs since the identical data records need to be replicated and maintained by multiple parties (Kumar et al., 2020). Concomitantly, that same mechanism increases data integrity and reliability, as data points from multiple independent sources converge towards shared, mutually agreed upon, authoritative sequential states of records valid for the entire network. As a result, the use of blockchain is likely to significantly reduce the costs and task complexity related to the reconciliation of records, as it essentially collapses the two processes of data exchange and reconciliation of records into one. This is especially relevant in IORs, where partner interactions can be multi-tiered and between heterogeneous parties (e.g., alliance partners from different industries, multiple suppliers, service providers, regulators). Studies have shown that a centralized (e.g., hub-and-spoke) design is pervasive in existing IIS solutions (Hart and Saunders, 1997; Kumar et al., 2020), including data exchange on a point-to-point basis (e.g., through electronic data interchange (EDI) or Extensible Markup Language (XML)-based standards) (Steinfield et al., 2011). This makes the flow of information between partners less than seamless, especially in multi-tier IORs such as extended supply chains (Steinfield et al., 2011), and increases the marginal costs of integrating new partners (Babich and Hilary, 2020). Taken together, this promotes an increase in transaction hazards and results in management control issues.

In the context of IORs, blockchain can be seen as a new form of an IIS. In that sense, it is comparable to other technologies intended for inter-firm communication, the most prominent example being EDI. EDI enables standardized point-to-point communication between independent computerized information systems, making them suitable for dyadic (i.e., one-to-one) or hub-and-spoke information exchange between partners (Anderson and Lanen, 2002). EDI is a widely used and mature technology that can be highly effective in standardized information exchanges such as procurement orders (Clemons et al., 1993). However, EDI mainly serves as a support tool in inter-firm information exchange because it lacks the ability to automatically enforce agreements (Kumar et al., 2020; Lumineau et al., 2021a). The capability of autonomous enforcement without recourse to external governance apparatus (i.e., the legal system) represents a unique characteristic of smart contracts that run on a blockchain, differentiating it from other IIS solutions like EDI (Lumineau et al., 2021a). Although limited by the issues of endogeneity of data references and the overall transaction standardization, codifiability, and verifiability, this is nevertheless an auspicious feature in the context of IORs. In sum, blockchain's core attributes enable end-to-end, multilateral (i.e., network-based) information exchange between partnering firms, as well as implementation and autonomous enforcement of agreements/business logic codified in smart contracts (Beck et al., 2018; Kumar et al., 2020), which makes them suitable for multilateral collaboration among partners in IORs.

Proposition 7: **Blockchain technology enables network-based information exchange between partners and thus facilitates multilateral collaboration in IORs.**

The information exchanged via an IIS has itself been an important topic of inquiry among management accounting scholars. A distinction was made between coordination and control uses of information. Regarding the former, information is used to plan and coordinate the interdependent activities that the collaborating parties collectively engage in (Nicolaou et al., 2011). When the primary goal of information use is control, the information is used to verify and evaluate the partner's actions usually by monitoring performance information to incentivize or compel the partner into achieving desirable or predetermined results (Nicolaou et al., 2011).

Technical attributes of blockchain technology entail that records of exchanged information contain the attributes of transparency, auditability, and consistency across databases of the involved parties. These attributes have a disciplining effect on parties by imposing high costs (e.g., exclusion from the network) on individual participants (or an insufficiently large group of participants) that attempt to change the records or propose fraudulent claims unilaterally. Furthermore, smart contracts enable automated enforcement of interactions between partners. A primary way in which control is implemented via IISs is by using the system as a diagnostic tool, which means that performance information is gathered and monitored after the actions have been taken (Baiman and Demski, 1980;

Nicolaou et al., 2011). Consequently, introducing blockchain as the IIS in IORs should reduce control complexity through improved monitoring, self-disciplining mechanisms, and simplified performance evaluation.

***Proposition 8*: Blockchain technology reduces information exchange-related control complexity in IORs.**

An aspiration to improve inter-organizational coordination through IISs exhibited by an increasing number of firms has led to the development of new network standards (Zhu et al., 2006). Studies focusing on the development and diffusion of data and process standards beyond a dyadic buyer-supplier relationship (i.e., "extended supply chain" or industry level) have reported that achieving the goal of establishing a shared information infrastructure is fraught with difficulties. These include factors such as heterogeneity of interests among partners (Markus et al., 2006), high cost of implementation and low reuse value of the investment for smaller partners (Steinfield et al., 2011), and difficulties in reaching an agreement on the design, governance structure, and ownership of the solution. This can result in a vicious cycle where partners hold off investments, possibly rendering the whole collaboration unsuccessful (Steinfeld et al., 2011). The formation of industry-wide standard-setting consortia has been proposed as a way to address these issues. Leveraging Olson's (1965) seminal work on the theory of collective action, Weiss and Cargill (1992) suggest that standards development consortia[19] have an incentive to limit membership to a group of participants with a compatible preference structure, especially large firms, because they are more likely than smaller ones to influence others to adopt the standard. Furthermore, developing industry-wide IIS standards requires joint efforts across organizational boundaries, making the potential benefits of the solution contingent on the status of network adoption by the rest of the firms in the industry (Zhu et al., 2003).

Basic requirements for the feasibility of blockchain technology include standardization (e.g., of data formats and consensus mechanisms), wide adoption, and interoperability between different platforms (Lacity, 2018; Kumar et al., 2020). Kumar et al. (2020) suggest that after standards have been developed by consortia that individually could include a limited number of large firms (Weiss and Cargill, 1992), the rollout of the technology is regardless likely to happen on a much broader

[19] Weiss and Cargill (1992) refer to consortia that include organizations whose primary role is to facilitate the adoption of standards through promotional activities and compatibility testing, and those that are actively developing the technology that represents the basis of either de facto or voluntary consensus standards.

scale and in collaboration with IT vendors and different actors in a given industry. Since blockchain interoperability is one of the critical requirements for the success and the diffusion of the technology (Kumar et al., 2020), cross-platform and cross-consortia collaboration will be a significant factor in its adoption (Bear and Rauchs, 2020). Taken together, these arguments imply that, in blockchain-based IIS networks, most of the benefits are expected after the compatible blockchain platforms have reached a high level of diffusion. Moreover, due to the novelty of the technology and the associated lack of technical capabilities within some firms, the setup costs of a blockchain network might be higher than for existing technological solutions (Kumar et al., 2020). These can be exacerbated by blockchain's inherent replicated storage requirements. Consequently, it is reasonable to expect that in situations where marginal overhead costs of running transactions are high and when difficulties with integrating different IOR partners exist, a more mature technology such as EDI might still prevail. Therefore, we suggest that wide adoption characterized in some combination by the number and heterogeneity of participants represents a major factor for blockchain adoption.

Proposition 9**: Blockchain technology is best suited for IORs that involve numerous and/or heterogeneous partners.**

4. Conclusion

Blockchain is a multi-faceted innovation, namely: (1) technical - a new distributed version of a transactional database; (2) economic - offering a reliable record of transactions in a decentralized, potentially adversarial environment; and (3) organizational - given that it may fundamentally change how firms organize IORs. Therefore, it is likely to play an important role in major organizational and technological developments in the future. The issues related to the formation and evolution of novel organizational forms have been the topic of extensive research in management accounting and control studies, making scholars in the field uniquely equipped to make sense of these important forward-looking trends. We propose that future research on blockchain in IORs should approach these issues from three perspectives: (1) dynamics of inter-firm collaboration in the presence of blockchain; (2) strategies for the design and use of formal and informal management control mechanisms in IORs; (3) the impact of distributed network-based exchange and governance of decision-relevant information. Propositions developed above act in concert to provide insights across the three perspectives. We argue that combining these insights provides a foundation for understanding the overall impact of blockchain technology in IORs.

The first suggested area for research could look in more detail into the processes leading to the development of collaboration and formation of IORs, as well as the scope of collaboration in existing IORs. Blockchain gives rise to new questions regarding the temporal, relational, and management control dynamics of inter-firm collaboration. An example of temporal dynamics is expectations about the future. Blockchain promotes collective outcomes, where expected future payoffs for collaborating firms depend on the success of the entire network, potentially leading to reversed causality effects such that future expectations shape present behavior. Scholars could explore how relational dynamics such as previous interactions and the associated levels of goodwill and competence trust between IOR partners interrelate with firms' future expectations to inform the design of formal ex-ante (criteria for partner selection) and ex-post (contracts) management control mechanisms in the presence of blockchain.

Relatedly, blockchain promotes the expansion of the pool of potential collaborators with no prior ties through the standardization of information exchange and management protocols, reliability of records, and ledger auditability and tamper resistance. Mitigating transaction hazards and aligning and safeguarding partners' interests in such settings usually involves the specification of mutual obligations and deliverable outcomes through contracts. In this context, a topic that could be investigated is the control implications of expanding the pool of collaborators that can include heterogeneous actors by leveraging a blockchain-based common information infrastructure and multilateral information exchange. The use of blockchain technology and smart contracts in IORs could have a notable effect on the level of frictions and transaction hazards. In turn, research should examine the implications of these changes in transaction hazards on firm boundaries and the nature of formal and informal management control mechanisms used to sustain traditional IOR forms in those new circumstances. Looking ahead, a promising avenue for research could involve exploring these issues beyond traditional IOR settings discussed in this paper, focusing on new and emerging IOR forms such as digital platforms and ecosystems.

The second area for research could investigate how blockchain technology influences the way in which firms navigate around processes of developing and maintaining trust. Further, researchers could explore how those processes affect firms' strategies for designing formal management control mechanisms. Blockchain establishes a reliable "third party" source of information (Reusen and

Stouthuysen, 2020) and a "multilateral reputation system" (Susarla et al., 2020), which can have profound effects on inter-firm trust (Dekker, 2004). Scholars could examine how multilateral information flows enabled by blockchain dynamically influence both competence and goodwill trust during the different stages of IORs. Similarly, a salient topic in this context is determining the levels of trust necessary to initiate new cooperative relations with heterogeneous partners. Further, studies could elucidate whether, or to what extent, trust in the overall IOR context shifts from trust between organizations to "trust in the blockchain system" (Catalini and Gans, 2020) that is established through collective consensus and governance decisions pertaining to technical design characteristics of blockchain in a given case.

Blockchain simultaneously narrows the domain for opportunism and expands the scope of activities that can be reliably monitored. Smart contracts further allow for the automatic execution of agreements. Combined, these functionalities suggest that inter-firm contract complexity in terms of the number and stringency of contract provisions can be reduced. On the other hand, these mechanisms will potentially increase the complexity of the internal control environment. Future research could therefore explore the effects of formalization and automation of processes and day-to-day communication through blockchain on the administrative work of accountants and the design of internal control procedures.

A third promising avenue for research could focus on the impact of new ways of exchanging and governing decision-relevant information enabled by blockchain. The exchange of information between IOR partners has been extensively studied by management accounting scholars (Baiman and Rajan, 2002; Christ and Nicolaou, 2011; Schloetzer, 2012). While notable contributions have been made in this research stream, Caglio and Ditillo (2008) point out that, with a few exceptions, most of these studies focus on dyadic or one-to-many inter-firm relations typically from the viewpoint of a dominant IOR partner. As a result, the conceptualization of management control mechanisms has been wedded to the notions of hierarchy and efficiency in strictly defined IOR forms (e.g., strategic alliances, buyer-supplier relationships) (Hopwood, 1996). Blockchain technology as the basis for a common information infrastructure enables multilateral collaboration between partners from different IORs, as traditionally defined. Researchers should focus their attention on examining the circumstances in which blockchain could be superior to or preferred over existing solutions such as EDI. Such research could hone in on elucidating how pre-existing contractual arrangements and trust influence the design of the blockchain system. Additionally, Caglio and Ditillo (2021) point out that blockchain could question some of the existing management accounting literature's conclusions regarding how to control IORs. Considering the heterogeneity of actors in new collaborative arrangements enabled by blockchain, research is needed to understand how primary control mechanisms discussed in this paper may change in this context.

Looking beyond the context of the present study and our specific focus on permissioned blockchains, technological advances in the blockchain space warrant consideration as they might have implications for the arguments we presented. The vast majority of enterprise blockchain networks in the current landscape are "private" and permissioned and are typically organized around a narrow use case with one or a few entities exerting a disproportionate influence over the network (Bear and Rauchs, 2020). However, this may change in the future, and the next generation of enterprise blockchains could at least partially rely on public networks (Lacity and Van Hoek, 2021a). Ernst & Young (EY), for instance, recently launched Nightfall, a set of protocols supporting private transactions on a public Ethereum blockchain (Lacity et al., 2019) in anticipation of a market pivot from private to public networks (Lacity and Van Hoek, 2021a). The idea behind Nightfall is essentially to create a "virtual private blockchain", akin to a virtual private network (VPN) connected to the public internet (Lacity et al., 2019; Lacity and Van Hoek, 2021a). Bear and Rauchs (2020) similarly predict the rise of semi-public (permissioned), application-agnostic "super networks", which will support the development of numerous novel use cases, possibly operating beyond industry boundaries. These developments might have interesting implications for the issues discussed in this paper and offer exciting opportunities for researchers to extend our arguments.

For almost three decades, management control issues in IORs have been an important topic of inquiry among accounting scholars. We hope that the propositions developed in this paper, together with the suggested areas for further research, will support laying the groundwork for management accounting researchers interested in blockchain in the context of IORs. The research agenda outlined in this section aims to inspire novel and impactful research that could significantly increase our understanding of blockchain technology as an inter-organizational phenomenon and develop a more comprehensive notion of IORs and management controls used to sustain them in the ever-changing technological and organizational landscape.

References

Abadi, J., and M. Brunnermeier. 2018. Blockchain economics. *National Bureau of Economic Research*. https://scholar.princeton.edu/sites/default/files/markus/files/blockchain_paper_v7a.pdf

Albizri, A., and D. Appelbaum. 2021. Trust but Verify: The Oracle Paradox of Blockchain Smart Contracts. *Journal of Information Systems* (Forthcoming).

Anderson, S. W., and W. N. Lanen. 2002. Using Electronic Data Interchange (EDI) to Improve the Efficiency of Accounting Transactions. *The Accounting Review* 77(4):703-729.

Anderson, S. W., H. F. Chang, M. M. Cheng, and Y. S. Phua. 2017a. Getting to Know You: Trust Formation in New Interfirm Relationships and the Consequences for Investments in Management Control and the Collaboration. *Contemporary Accounting Research* 34(2):940-965.

Anderson, S. W., M. H. Christ, H. C. Dekker, and K. Sedatole. 2014. The Use of Management Controls to Mitigate Risk in Strategic Alliances: Field and Survey Evidence. *Journal of Management Accounting Research* 26(1):1-32.

Anderson, S. W., and H. C. Dekker. 2005. Management Control for Market Transactions: The Relation Between Transaction Characteristics, Incomplete Contract Design, and Subsequent Performance. *Management Science* 51(12): 1733-1902.

Anderson, S. W., and H. C. Dekker. 2009. Strategic Cost Management in Supply Chains, Part 1: Structural Cost Management. *Accounting Horizons* 23(2):201-220.

Anderson, S. W., and H. C. Dekker. 2014. The Role of Management Controls in Transforming Firm Boundaries and Sustaining Hybrid Organizational Forms. *Foundations and Trends® in Accounting* 8(2):75-141.

Anderson, S. W., H. C. Dekker., and A. Van Den Abbeele. 2017b. Costly Control: An Examination of the Trade-off Between Control Investments and Residual Risk in Interfirm Transactions. *Management Science* 63(7):2163-2180.

Arrow, K. 1985. The Economics of Agency. In *Principals and Agents: The Structure of Business,* edited by J. Pratt, and R. Zeckhauser. Cambridge, Mass: Harvard University Press.

Axelrod, R. 1979. The Rational Timing of Surprise. *World Politics* 31(2):228-246.

Axelrod, R., and R.O. Keohane. 1985. Achieving Cooperation Under Anarchy: Strategies and Institutions. *World politics* 38(1):226-254.

Babich V., and G. Hilary. 2020. Distributed Ledgers and Operations: What Operations Management Researchers Should Know About Blockchain Technology. *Manufacturing & Service Operations Management* 22(2):223–240.

Baiman, S., and J. S. Demski. 1980. Economically Optimal Performance Evaluation and Control Systems. *Journal of Accounting Research* 18:184-220.

Baiman, S., and M. V. Rajan. 2002. The Role of Information and Opportunism in the Choice of Buyer-Supplier Relationships. *Journal of Accounting Research* 40(2):247-278.

Baker, G., R. Gibbons, and K. J. Murphy. 2002. Relational Contracts and the Theory of the Firm.

The Quarterly Journal of Economics 117(1):39-84.

Banker, R. D., J. Kalvenes, and R. A. Patterson. 2006. Information Technology, Contract Completeness and Buyer-Supplier Relationships. *Information Systems Research* 17(2):180– 193.

Bear, K., and M. Rauchs. 2020. Financial Services Leads The Development Of Enterprise Blockchain. *A Research Vignette for Global Digital Finance*. https://www.gdf.io/wp-content/uploads/2020/11/GDF-FS-Leads-The-Development-of-Enterprise-Blockchain-Vignette-October-2020.pdf

Bechini, A., M. G. Cimino, F. Marcelloni, and A. Tomasi. 2008. Patterns and technologies for enabling supply chain traceability through collaborative e-business. *Information and Software Technology* 50(4):342-359.

Beck, R., C. Müller-Bloch, and J. L. King. 2018. Governance in the Blockchain Economy: A Framework and Research Agenda. *Journal of the Association for Information Systems* 19(10):1020-1034.

Caglio, A., and A. Ditillo. 2008. A review and discussion of management control in inter-firm relationships: Achievements and future directions. *Accounting Organizations and Society* 33(7-8):865– 898.

Caglio, A., and A. Ditillo. 2020. Reviewing Interorganizational Management Accounting and Control Literature: A New Look. *Journal of Management Accounting Research* (forthcoming).

Calderón, J., and T. C. Stratopoulos. 2020. What Accountants Need to Know about Blockchain. *Accounting Perspectives* 19(4):303-323.

Castañer, X., and N. Oliveira. 2020. Collaboration, Coordination and Cooperation between Organizations: Establishing the Distinctive Meanings of These Terms through a Systematic Literature Review. *Journal of Management* 46(6):965-1001.

Cao, S., L. W. Cong, and B. Yang. 2019. Financial Reporting and Blockchains: Audit Pricing, Misstatements, and Regulation. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3248002

Catalini, C., and J. Boslego. 2019. Blockchain Technology and Organization Science: Decentralization Theatre or Novel Organizational Form? *Working Paper, Massachusetts Institute of Technology, Cambridge*.

Catalini, C., and J. S. Gans. 2020. Some Simple Economics of the Blockchain. *Communications of the ACM* 63(7):80-90.

Christ, M. H., and A. I. Nicolaou. 2016. Integrated information systems, alliance formation, and the risk of information exchange between partners. *Journal of Management Accounting Research* 28(3):1-18.

Clemons, E. K., S. P. Reddi, and M. C. Row. 1993. The Impact of Information Technology on the Organization of Economic Activity: The "Move to the Middle" Hypothesis. *Journal of Management Information Systems* 10(2):9-35.

Clemons, E. K., and L. M. Hitt. 2004. Poaching and the Misappropriation of Information: Transaction Risks of Information Exchange. *Journal of Management Information Systems* 21(8):87-107.

Coletti, A. L., K. L. Sedatole, and K. L. Towry. 2005. The effect of control systems on trust and cooperation in collaborative environments. *The Accounting Review* 80(2): 477-500.

Coyne, J. G., and P. McMickle. 2017. Can Blockchains Serve an Accounting Purpose? *Journal of Emerging Technologies in Accounting* 14(2):101-111.

Coase, R. H. 1937. The Nature of the Firm. *Economica* 4 (16):386-405.

Dai, J., and M. A. Vasarhelyi. 2017. Toward Blockchain-Based Accounting and Assurance. *Journal of Information Systems* 31(3) 5-21.

David, P. A., and S. Greenstein. 1990. The Economics Of Compatibility Standards: An Introduction To Recent Research. *Economics of Innovation and New Technology* 1(1-2): 3-41

Davis, G. F., R. L. Kahn, and M. N. Zald. 1990. Contracts, treaties, and joint ventures. In *Organizations and Nation States: New Perspectives on Conflict and Cooperation,* edited by R.L. Kahn and M.N. Zald, 19-54. San Francisco: Jossey-Bass.

Dekker, H. C. 2004. Control of inter-organizational relationships: Evidence on appropriation concerns and coordination requirements. *Accounting, Organizations and Society* 29(1):27– 49.

Dekker, H. C. 2008. Partner selection and governance design in interfirm relationships. *Accounting, Organizations and Society* 33(7-8):915-941.

Dekker, H. C., J. Sakaguchi, and T. Kawai. 2013. Beyond the contract: Managing risk in supply chain relations. *Management Accounting Research* 24(2):122-139.

Dekker, H. C., and A. Van den Abbeele. 2010. Organizational Learning and Interfirm Control: The Effects of Partner Search and Prior Exchange Experiences. *Organization Science* 21(6):1233-1250.

Ding, R., H. C. Dekker, and T. Groot. 2013. Risk, partner selection and contractual control in interfirm relationships. *Management Accounting Research* 24(2): 140-155.

Doney, P. M., and J. P. Cannon. 1997. An examination of the nature of trust in buyer-seller relationships. *Journal of Marketing* 61(2):35-51.

Dulleck U., R. Kerschbamer, and M. Sutter. 2011. The economics of credence goods: An experiment on the role of liability, verifiability, reputation, and competition. *American Economic Review* 101(2): 526-555.

Gans, J. S., 2019. The Fine Print in Smart Contracts. *NBER Working Paper No. 25443*. https://www.nber.org/papers/w25443

Gibbons, R., and R. Henderson. 2012. Relational Contracts and Organizational Capabilities. *Organization Science* 23(5):1350-1364.

Glaser, F. 2017. Pervasive Decentralisation of Digital Infrastructures: A Framework for Blockchain Enabled System and Use Case Analysis. *Proceedings of the 50th Hawaii International Conference on System Sciences (HICSS-50)*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3052165

Grafton, J., and J. Mundy. 2017. Relational contracting and the myth of trust: Control in a co-opetitive setting. *Management Accounting Research* 36:24-42.

Gulati, R. 1995. Does familiarity breed trust? The implications of repeated ties for contractual choice in alliances. *Academy of Management Journal* 38(1):85-112.

Gulati, R., and H. Singh. 1998. The Architecture of Cooperation: Managing Coordination Costs and Appropriation Concerns in Strategic Alliances. *Administrative Science Quarterly* 43(4):781-814.

Gulati, R., F. Wohlgezogen, and P. Zhelyazkov. 2012. The Two Facets of Collaboration: Cooperation and Coordination in Strategic Alliance. *The Academy of Management Annals* 6(1):531-583.

Halaburda, H. 2018. Blockchain revolution without the blockchain. *Communications of the ACM* 61(7):27-29.

Hart, P., and C. Saunders. 1997. Power and Trust: Critical Factors in the Adoption and Use of Electronic Data Interchange. *Organization Science* 8(1):23-42.

Hopwood, A. G. 1996. Looking across rather than up and down: On the need to explore the lateral processing of information. *Accounting, Organizations and Society* 21(6):589-590.

Håkansson, H., and J. Lind. 2004. Accounting and network coordination. *Accounting, Organizations and Society* 29(1):51-72.

ICAEW. 2018. Blockchain and the future of accountancy. *ICAEW Thought Leadership - IT Faculty* (Institute of Chartered Accountants in England and Wales).

Ireland, R. D., M. A. Hitt, and D. Vaidyanath. 2002. Alliance Management as a Source of Competitive Advantage. *Journal of Management* 28(3):413–446.

Jensen, T., J. Hedman, and S. Henningsson. 2019. How TradeLens Delivers Business Value With Blockchain Technology. *MIS Quarterly Executive* 18(4):221-243.

Kajüter, P., and H. I. Kulmala. 2005. Open-book accounting in networks: Potential achievements and reasons for failures. *Management Accounting Research* 16(2):179-204.

Klein, B., and K. B. Leffler. 1981. The Role of Market Forces in Assuring Contractual Performance. *Journal of Political Economy* 89(4):615-641.

Kogut, B., and U. Zander. 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science* 3(3):383-397.

Kokina, J., R. Mancha, and D. Pachamanova. 2017. Blockchain: Emergent Industry Adoption and Implications for Accounting. *Journal of Emerging Technologies in Accounting* 14(2):91- 100.

Kumar, A., R. Liu, and Z. Shan. 2020. Is Blockchain a Silver Bullet for Supply Chain Management? Technical Challenges and Research Opportunities. *Decision Sciences* 51(1):8-37.

Lacity, M. 2018. Addressing Key Challenges to Making Enterprise Blockchain Applications a Reality. *MIS Quarterly* Executive 17(3):201-222.

Lacity, M., and R. Van Hoek. 2021a. What We've Learned So Far About Blockchain for Businesses. *MIT Sloan Management Review*.

Lacity, M., and R. Van Hoek. 2021b. Requiem for Reconciliations: DL Freight, a blockchain-enabled solution by Walmart Canada and DLT Labs. *University of Arkansas Blockchain Center for*

Excellence Research White Paper. https://dltlabsweb-media.s3.ca-central-1.amazonaws.com/docs/BCoE202101POSTFINAL-55dcfe44-e73c-4d83-be69-5cb888b7b539.pdf

Lacity, M., Z. Steelman, and P. Cronan. 2019. Blockchain Governance Models: Insights for Enterprises. *University of Arkansas Blockchain Center for Excellence Research White Paper*. https://cpb-us-e1.wpmucdn.com/wordpressua.uark.edu/dist/5/444/files/2019/11/BCCoEWhitePaper022019OPEN.pdf

Litwak, E., and L. F. Hylton. 1962. Interorganizational Analysis: A Hypothesis on Co- ordinating Agencies. *Administrative Science Quarterly* 6(4):395-420.

Lumineau, F., W. Wang, and O. Schilke. 2021(a). Blockchain Governance—A New Way of Organizing Collaborations? *Organization Science* 32(2):500-521.

Lumineau, F., W. Wang, O. Schilke, and L. Huang. 2021(b). How Blockchain Can Simplify Partnerships. *Harvard Business Review*.

Luo, Y. 2002. Contract, cooperation, and performance in international joint ventures. *Strategic Management Journal* 23(10):903-919.

MacLeod, W. B. 2007. Reputations, Relationships, and Contract Enforcement. *Journal of Economic Literature* 45(3):595-628.

Markus, M. L., C. W. Steinfield, R. T. Wigand, and G. Minton. 2006. Industry-Wide Information Systems Standardization as Collective Action: The Case of the U.S. Residential Mortgage Industry. *MIS Quarterly* 30:439-465.

Mattke, J., C. Maier, A. Hund, and T. Weitzel. 2019. How an Enterprise Blockchain Application in the U.S. Pharmaceuticals Supply Chain is Saving Lives. *MIS Quarterly Executive* 18(4):245-261.

McEvily, B., V. Perrone, and A. Zaheer. 2003. Trust as an organizing principle. *Organization Science* 14(1):91-103.

Murray, A., S. Kuban, M. Josefy, and J. Anderson. 2021. Contracting in the Smart Era: The Implications of Blockchain and Decentralized Autonomous Organizations for Contracting and Corporate Governance. *Academy of Management Perspectives* 35(4):622-641.

Neumann, K. 2010. Ex-ante governance decisions in inter-organizational relationships: A case study in the airline industry. *Management Accounting Research* 21(4):220-237.

Nicolaou, A. I., K. L Sedatole, and N.K. Lankton. 2011. Integrated Information Systems and Alliance Partner Trust. *Contemporary Accounting Research* 28(3):1018-1045.

Olson, M. 1965. The Logic of Collective Action: Public goods and the Theory of Groups. Harvard University Press.

Parkhe, A. 1993. Strategic alliance structuring: A game theoretic and transaction cost examination of interfirm cooperation. *Academy of Management Journal* 36(4):794-829.

Peters, G. W., and E., Panayi. 2015. Understanding Modern Banking Ledgers through Blockchain Technologies: Future of Transaction Processing and Smart Contracts on the Internet of Money. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2692487

Pfeffer, J., and G. R. Salancik. 1978. The external control of organizations: A resource dependency perspective. New York: Harper & Row.

Poppo, L., and T. Zenger. 2002. Do formal contracts and relational governance function as substitutes or complements? *Strategic Management Journal* 23(8):707-725.

Poppo, L., K. Z. Zhou, and J. J. Li. 2016. When can you trust "trust"? Calculative trust, relational trust, and supplier performance. *Strategic Management Journal* 37(4):724-741.

Rauchs, M., A. Blandin, K. Klein, G. Peters, M. Recanatini, and B. Zhang. 2018 (a). 2nd Global Cryptoasset Benchmarking Study. *Cambridge Centre for Alternative Finance, Cambridge Judge Business School.* https://www.jbs.cam.ac.uk/faculty-research/centres/alternative-finance/publications/2nd-%20global-cryptoasset-benchmark-study/#.YKkLT6gzaiN

Rauchs, M., A. Glidden, B. Gordon, G. Pieters, M. Recanatini, F. Rostand, K. Vagneur, and B. Zhang. 2018 (b). Distributed Ledger Technology Systems: A Conceptual Framework. *Cambridge Centre for Alternative Finance, Cambridge Judge Business School.* https://www.jbs.cam.ac.uk/faculty-research/centres/alternative-finance/publications/distributed-ledger-technology-systems/#.YKkLi6gzaiO

Rauchs, M., A. Blandin, K. Bear, and S. McKeon. 2019. 2nd Global Enterprise Blockchain Benchmarking Study. *Cambridge Centre for Alternative Finance, Cambridge Judge Business School.* https://www.jbs.cam.ac.uk/faculty-research/centres/alternative-finance/publications/2nd-global-enterprise-blockchain-benchmarking-study/

Reuer, J. J., and A. Ariño. 2007. Strategic alliance contracts: dimensions and determinants of contractual complexity. *Strategic Management Journal* 28(3):313-330.

Reusen, E., and K. Stouthuysen. 2020. Trust transfer and partner selection in interfirm relationships. *Accounting, Organizations and Society* 81:101081.

Risius, M., and K. Spohrer. 2017. A blockchain research framework. *Business & Information Systems Engineering* 59 (6): 385-409.

Rousseau, D. M., S. B. Sitkin, R. D. Burt, and C. Camerer. 1998. Not so different after all: A cross-discipline view of trust. *Academy of Management Review* 23(3):393-404.

Salvato, C., J. J. Reuer, and P. Battigalli. 2017. Cooperation across Disciplines: A Multilevel Perspective on Cooperative Behavior in Governing Interfirm Relations. *Academy of Management Annals* 11(2):1-45.

Schepker, D. J., W. J. Oh, A. Martynov, and L. Poppo. 2014. The Many Futures of Contracts: Moving Beyond Structure and Safeguarding to Coordination and Adaptation. *Journal of Management* 40(1):193-225.

Schelling, T. C. 1960. The Strategy of Conflict. Harvard University Press.

Schloetzer, J. D. 2012. Process Integration and Information Sharing in Supply Chains. *The Accounting Review* 87(3):1005-1032.

Sheldon, M. D. 2019. A Primer for Information Technology General Control Considerations on a Private and Permissioned Blockchain Audit. *Current Issues in Auditing* 13(1):A15-A29.

Smith, K. G., S. J. Carroll, and S. J. Ashford. 1995. Intra-and interorganizational cooperation: Toward a research agenda. *Academy of Management Journal* 38(1):7-23.

Sobrero, M., and S. Schrader. 1998. Structuring inter-firm relationships: A metaanalytic approach. *Organization Studies* 19(4):585-615.

Steinfield, C., M. L. Markus, and R. T. Wigand. 2011. Through a glass clearly: Standards, architecture, and process transparency in global supply chains. *Journal of Management Information Systems* 28(2):75-108.

Stratopoulos, T. C., and J. Calderón. 2020. Introduction to Blockchain for Accounting Students. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3395619

Stratopoulos, T. C., V. X. Wang, and H. J. Ye. 2021. Use of Corporate Disclosures to Identify the Stage of Blockchain Adoption. *Accounting Horizons* (Forthcoming).

Stuart, T. E. 1998. Network positions and propensities to collaborate: An investigation of strategic alliance formation in a high-technology industry. *Administrative Science Quarterly* 43(3):668-698.

Susarla, A., M. Holzhacker, and R. Krishnan. 2020. Calculative Trust and Interfirm Contracts. *Management Science* 66(11):5465-5484.

Swanson, T. 2015. Consensus-as-a-service: A brief report on the emergence of permissioned, distributed ledger systems. https://allquantor.at/blockchainbib/pdf/swanson2015consensus.pdf

Tasca, P., and C. J. Tessone. 2017. Taxonomy of Blockchain Technologies. Principles of Identification and Classification. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2977811

Trapido, D. 2007. Competitive embeddedness and the emergence of interfirm cooperation. *Social Forces* 86(1):165-191.

Uzzi, B. 1997. Social structure and competition in interfirm networks: The paradox of embeddedness. *Administrative Science Quarterly* 42(1):35-67.

Weiss, M., and C. Cargill. 1992. Consortia in the standards development process. *Journal of the American Society for Information Science* 43(8):559-565.

White, S. 2005. Cooperation costs, governance choice and alliance evolution. *Journal of Management Studies* 42(7):1383-1412.

Williamson, O. E. 1983. Credible Commitments: Using Hostages to Support Exchange. *The American Economic Review* 73(4):519-540

Williamson, O. E. 1985. The economic institutions of capitalism. *The Free Press*, New York.

Williamson, O. E. 1991. Comparative economic organization: The analysis of discrete structural alternatives. *Administrative Science Quarterly* 36(2):269–297.

Williamson, O. E. 1993. Calculativeness, Trust, and Economic Organization. *The Journal of Law and Economics* 36(1):453-486.

Xu, X., I. Weber, M. Staples, L. Zhu, J. Bosch, L. Bass, C. Pautasso, and P. Rimba. 2017. A taxonomy of blockchain-based systems for architecture design. *Proceedings of the 2017 IEEE International Conference on Software Architecture (ICSA)*:243-252.

Yermack, D. 2017. Corporate governance and blockchains. *Review of Finance* 21(1):7-31.

Zavolokina, L., R. Ziolkowski, I. Bauer, and G. Schwabe. 2020. Management, Governance and Value Creation in a Blockchain Consortium. *MIS Quarterly Executive* 19(1):1-17.

Zhu, K., K. L. Kraemer, V. Gurbaxani, and S. X. Xu. 2006. Migration to Open-Standard Interorganizational Systems: Network Effects, Switching Costs, and Path Dependency. *MIS Quarterly* 30:515-539.

Zhu, K., K. L. Kraemer, and S. X. Xu. 2003. Electronic business adoption by European firms: a cross-country assessment of the facilitators and inhibitors. *European Journal of Information Systems* 12(4):251–268.

Appendix A

Blockchain and smart contract characteristics

Fundamental characteristics of blockchain technology include peer-to-peer transmission, shared recordkeeping, multi-party consensus[20], independent validation, tamper resistance, tamper evidence, and transparency (Rauchs et al., 2019).

Blockchain systems allow for new ways of decentralization and delegation of services that are enacted through smart contracts (Glaser, 2017). Conversely, other authors (e.g., Gans, 2019; Rauchs et al., 2018b; Xu et al., 2017) comment that such contracts are not strictly speaking fully autonomous and adaptive, nor do they at the moment necessarily represent legal agreements in most jurisdictions, and especially across jurisdictions. A fundamental requirement for smart contracts to be functional and cost-efficient is the ability to produce "hard evidence" of (non) performance on an obligation. When data is endogenous, the necessary evidence may be hardcoded. However, when contractual

[20] Swanson (2015) describes network consensus as the process in which a majority (or in some cases all) of network validators come to an agreement on the state of a ledger. It is a set of rules and procedures that allows maintaining a coherent set of facts between multiple participating nodes.

obligations rely on exogenous evidence, a blockchain system (and the corresponding smart contract) needs to create incentives and control mechanisms for the disclosure of accurate information about contract performance (Gans, 2019). Successful execution of transactions in IORs is based on critical information about responsibilities, procedures, and objectives of the parties involved, attributes that can be pretty explicit for some and tacit for other transactions (Lumineau et al., 2021a). Lumineau et al. (2021) build on the notion of "tacitness"[21] in transactions as a function of the transaction's level of *codifiability*[22] and *verifiability*[23]. To this, we add the concept of *standardization*[24] as a multi-level construct salient in various contexts, including transacting *within* an IOR (Steinfield et al., 2011) or *across* different industry sectors (Markus et al., 2006). Studies have referred to the issue with automatic execution based on data exogenous to the blockchain as the oracle problem (Murray et al., 2021; Albizri and Appelbaum, 2021). While this is undoubtedly a drawback of using blockchain technology in IOR settings where many data references are exogenous, the oracle problem is not impossible to address, nor are all types of transactions equally susceptible to it. In a permissioned blockchain environment consisting of vetted participants, several management control mechanisms, including trust (Halaburda, 2018), can be used to reduce transaction hazards and thus address the oracle problem. Furthermore, it is important to note that in explicit transactions for which specific plans can be devised ex-ante (e.g., procurement of standardized materials from an alliance partner), the oracle problem represents less of an organizational challenge, and the benefits of using a blockchain could outweigh the associated risks (Lumineau et al., 2021a). At the same time, the benefits of relying solely on blockchain in tacit transactions that include complex interdependent activities requiring the ability of the partners to adapt to unforeseen events are less than clear primarily because of the standardization, codification, and verification challenges involved in these transactions.

[21] Tacitness refers to the difficulty of codifying key transaction attributes (Kogut and Zander, 1992) or complications in encoding attributes such as responsibilities, procedures, and objectives.
[22] Codifiability represents the ability to characterize precisely product/service, delivery, and settlement requirements in an electronic format, and in a manner understandable to relevant parties (Lumineau et al., 2021a).
[23] Verifiability signifies the extent to which transacting parties are able to observe and evaluate the quality of an item of exchange or adherence to specified requirements ex-post (Dulleck et al., 2011).
[24] The issue of standardization in a broader blockchain context also refers to interoperability or "linking the chains" (Kumar et al., 2020).

Paper 2: Standardization as collective action: Evidence from the Shipping Industry

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Abstract

Business-to-business interactions are increasingly dependent on standards to support technology innovations that drive the emergence of complex industry-wide solutions. Prior studies predominantly focus on technology standardization as a definite activity, in most cases explaining either the phase of standard development or standard diffusion, but not both. This limits the understanding of how technology standardization, seen as a continuous process including both phases of development and diffusion, evolves over time. We analyze two industry-wide standardization efforts in the container shipping industry, applying a collective action theory lens to understand the factors that influence standardization dynamics as they unfold over time. Our analysis identifies three critical collective action trade-offs that affect the standardization process: 1) flexibility vs. inclusion; 2) generalizability vs. completeness; 3) investment vs. value capture. We discuss the implications of these trade-offs and offer theoretical insights about factors that influence collaborative standardization on an industry level. We further provide evidence and recommendations relevant to the managerial decision-making of industry actors involved in complex technology standardization efforts.

Keywords: Standardization; Technology Standards; Collective action; Information systems; Platforms

1. Introduction

The complexity of modern technology and its pervasiveness across all major industries, which gives it a systemic character, has led to tremendous growth in the economic importance of technology standards over the last decades. More recently, technology standardization has assumed a vital role in supporting innovation in emerging economic trends (Wiegmann et al., 2017) such as complex systems and industry platforms (Saadatmand et al., 2019), novel technological solutions, and related organizational forms such as blockchain technology (Kostić and Sedej, 2022) and ecosystems (Thomas and Ritala, 2022). Additionally, because such standards represent a crucial element of the technical infrastructure, which exhibits characteristics of a collective good, they emerge from "reasoned, collective choice and enable agreement on solutions to recurring problems" (Tassey, 2000, p. 588). We study how and why organizations voluntarily engage in the process of technology standardization through collective action on an industry level. The study is situated in the context of the container shipping industry (henceforth, the shipping industry). Explaining how and why technology standardization efforts in the shipping industry emerge and evolve holds great theoretical and practical relevance considering the industry's centrality in global supply chains that are at the heart of much economic activity today (World Trade Organization, 2018).

Logistics in global supply chains represent a complex web of interrelations that entail simultaneous competitive and cooperative actions (Klein et al., 2007). Organizations constantly need to make decisions to safeguard their commercial interests while at the same time striving to facilitate mutual value creation through information exchange and process integration with industry partners (Schloetzer, 2012). These dynamics create systemic challenges on an industry level that no single organization can resolve on its own (Foray, 1994; Steinfield at el., 2011; Zhao et al., 2011). Consequently, a unique type of dependency develops between firms, where a resolution to these challenges can only arise through some form of collective action. Yet, how and under which circumstances such a broad group of legally independent organizations can successfully resolve industry-level challenges is far from being self-evident. Significant inefficiencies in global supply chains are related to the flow of information across organizational boundaries. This is caused by the lack of shared information infrastructure and generally accepted standards for exchanging information and trade documents (Jensen et al., 2019). Annual administrative costs in global supply chains, caused mainly by document processing, have been estimated to be about 22% of the retail cost of associated goods (Anderson and van Wincoop, 2004).

Consequently, despite traditionally fierce competitive relations and often conflicting commercial interests among prominent actors in the shipping industry, such as large ocean carriers, these actors agree, albeit often tacitly, on at least one crucial common issue: they recognize the pressing need for more standardization-driven efficiency (Klein et al., 2007; Steinfield et al., 2011; Jensen et al., 2014; Jensen et al., 2019; Voorspuij and Becha, 2021). These actors have nevertheless repeatedly failed to address this universally agreed-on common interest. Governmental (EU) and standard-setting bodies (ISO and ANSI) developed and sponsored several standards that have since been made publicly available (Jensen et al., 2019, p. 224). However, these have been only partly adopted by some global supply chain actors despite significant institutional support on an international level. The absence of collective action in standard-making might arise because organizations face a multiplicity of interests, some of which are conflicting and, as such, lower the likelihood of collaboration on achieving a broader common goal (Markus et al., 2006; Thambar et al., 2019). To shed new light on this complex issue, our study addresses the following research question: How does a process of technology standardization through collective action on an industry level arise and evolve?

We define technology standards as technical specifications that describe data formats and protocols for computer communication, which are therefore seen as the "blueprint" for the interaction patterns between organizations (Zhu et al., 2006; Zhao and Xia, 2014;). Additionally, in line with Olson (1965), we frame a technology standard as an *inclusive collective good*. Collective because it is not economically feasible to prevent any of the members of the group[25] from consuming the good, irrespective of the size of their contributions to its attainment, and inclusive because consumption of the good by new members of the group results in little or no reduction in consumption of the existing members (Olson, 1965). When discussing technology standardization, it is important to note that a particular solution (e.g., an information exchange system) itself is not the good; rather, the good is the functionality that the information system affords the participating organizations (Monge et al., 1998). This means that general insights can be derived from more than one case where different solutions offer participating actors functionalities comparable in nature.

[25] In this context, a "group" broadly refers to an assemblage of organizations that serves to further the common interests of its members. For the purposes of this paper, we consider *inclusive groups* of organizations as defined by Olson (1965). When there is organized or coordinated effort in inclusive groups, as many organizations as can be persuaded to participate will be included in the effort. A specific characteristic of inclusive groups is that it is not essential that every member participates in governance or decision-making. Consequently, an inclusive collective good produced by these efforts is by definition such that the benefit of a noncooperator is not matched by corresponding losses to those that do cooperate (Olson, 1965).

On the other hand, Wiegmann et al. (2017) remind us that functional attributes of standards have an important effect on both the stakes and the characteristics of actors involved in standardization, meaning that standardization efforts exhibit case-specific dynamics and interactions. Therefore, to generate theoretical insights and understand how these dynamics and interactions play out, it is necessary to consider and analyze the participating actors, their interests (Markus et al., 2006), and the strategies they apply to attain those interests (Wiegmann et al., 2017) over time. This calls for an approach where technology standardization is seen as a process in which standards development and subsequent diffusion are not mere sequential steps but are mutually related (Botzem and Dobusch, 2012). Further, according to the process perspective (Wiegmann et al. 2017), an established standard represents an equilibrium reached between the involved parties, which may be short-lived, and is therefore not seen in the analysis as a definitive endpoint to a standardization process. We take a process perspective to examine how technology standardization efforts develop and evolve over time and what the crucial factors are that influence their trajectories. To explain these issues, we analyze two collaborative technology standardization endeavors in the shipping industry. We apply a collective action theory lens to invoke explanations for factors that influence how the process of technology standardization occurs and unfolds in an inter-organizational setting and in the absence of an external standard-setting body with authority to mandate the use of the standard and steer consensus-seeking among members. Further, we particularly emphasize the multiple and interdependent dimensions of collective action among actors and delineate our findings through three novel collective action trade-offs.

Research has long recognized that technology standards play a prominent role in facilitating firms' operations, especially inter-organizational communications (Markus et al., 2006; Bala and Venkatesh, 2007; Zhao et al., 2011). Traditionally, technology standardization literature has focused on examining standardization efforts resulting in winner-take-all scenarios in the market (David and Greenstein, 1990; Chiao et al., 2007) or efforts sponsored by regulatory (Ferrell and Shapiro, 1992) or international standard-setting bodies (Chiao et al., 2007; Leiponen 2008; Simcoe, 2012). However, over the past decades, driven by industry needs and technological advances, organizations have increasingly leveraged industry partners' resource contributions and engaged in collaborative standardization efforts driven by private actors (Foray, 1994; Narayanan and Chen, 2012; Zhao et al., 2011). Collaborative efforts in technology standardization include committees, consortia, and alliance-like structures (Wiegmann et al., 2017). They are understood here in line with Weiss and

Cargill (1992) as a collection of like-minded interests that participate in what may be a market-accepted solution to what is perceived to be a common problem.

Research in technology standardization predominantly focuses either on standard development (Weiss and Cargill, 1992; Leiponen, 2008; Uotila et al., 2017), or standard diffusion (Weitzel et al., 2006; Zhu et al., 2006), with only a few empirical studies considering both phases simultaneously (Markus et al., 2006; Botzem and Dobusch, 2012 being notable examples). In other words, the existing literature has adopted a somewhat fragmentary approach to analyzing technology standardization. It, therefore, lacks insights into how the factors involved in the development and broad adoption of the standards interrelate within and between the two phases, which further limits our understanding of standardization as an ongoing process. This is important because, as Wiegmann et al. (2017) observe, the ongoing nature of technology standards lies not only in the need for updates to their technical attributes but also in the temporal variability of the level of interest in the standard provision and the ability and willingness of actors to contribute resources to the standardization efforts. This is particularly salient for collaborative standardization efforts predominantly driven by legally independent organizations, which due to strategic considerations, may seek to challenge an already established standard (Wiegmann et al., 2017).

Collective action theory (Olson, 1965; Marwell and Oliver, 1993) maintains that a group that has members with highly unequal degrees of interest in the collective good, where one or a few members deem the collective good extremely valuable relative to the costs of its provision, will be more apt to provide the collective good than would be some other group with the same number of members. Earlier studies highlight the heterogeneity of interests and resources of a broader population of participants as impediments to standard development and diffusion (David and Greenstein, 1990; Markus et al., 2006). We offer novel insights by showing that this heterogeneity might be beneficial for the standardization effort by considering the extent of participants' interest in providing a standard, as well as the pattern of interrelations among the "critical mass" of especially interested and resourceful members (Marwell and Oliver, 1993) of the group of organizations engaged in standardization.

We extend earlier work of technology standardization scholars by empirically identifying and delineating three novel collective action trade-offs that dynamically affect the process of standardization: (1) flexibility vs. inclusion, (2) generalizability vs. completeness, and (3) investment vs. value capture. We show that these trade-offs exhibit strong mutual interrelations and embody crucial design and governance choices made by the relevant actors throughout the standardization processes in the two examined cases. We empirically develop our arguments through in-depth case studies of two major projects in the shipping industry established at different points in time, namely INTTRA and TradeLens. The cases of INTTRA and TradeLens are illustrative because both of these initiatives represent attempts to address an industry-wide technology standardization problem by developing platforms and collectively agreeing on standards to underpin those platforms, albeit with crucial differences in their respective approaches.

2. Technology standardization on an industry level: a collective action theory perspective

To make sense of the complexity and dynamics of the process of industry-level technology standardization, we rely on Olson's theorizing of the logic of collective action (Olson, 1965), as well as the work of other collective action scholars such as Marwell and Oliver (1993) and Hardin (1982). A common view among collective action scholars is that factors such as actors' level of interest in the collective good, resource availability, and group composition significantly affect the provision of collective goods. Further, collective action theory maintains that collective goods such as industry standards are defined with respect to a specific group, where some goods are collective goods to those in one group while at the same time being private goods to those in another because some organizations can be prevented from consuming them, and others cannot (Olson, 1965). To elaborate on the relationships between different types of groups and the nature of the collective goods they produce, Olson (1965) stresses that the choices related to the structure and governance of the group depend importantly on the "supply" of the benefits accruing from the collective good. With *inclusive* groups, the "supply" of the benefits from the collective good automatically expands as the group expands, a representative example of such a good being an industry standard (Olson, 1965). Inclusive collective goods are such that they are characterized by at least a considerable degree of jointness of supply[26], meaning that additional members of the group can enjoy the good with little or no reduction

[26] A good has "jointness of supply" if making it available to one individual organization means that it can be easily or freely supplied to others as well (Olson, 1965).

in consumption of the existing members (Olson, 1965). Although importantly, exclusion of consumption *within* the group is economically infeasible.

In analyzing whether or not a collective good such as an industry standard will be provided, it is necessary to consider not only the structure of the group with a common interest in providing the good but also the structure and the degree of interest in the collective good among the group's members. A group with inequality in the degree of interest in the collective good[27]is more likely to provide the good (Olson, 1965). While Olson argued that this scenario is most likely in smaller groups, Hardin (1982) and Marwell and Oliver (1993) extend Olson's arguments and show that with a good that enjoys a considerable degree of jointness of supply, and in a group characterized by inequality of interests, the good that benefits many others will be provided even in a large group thanks to especially interested and resourceful members. These members are referred to as the "efficacious subgroup" and "critical mass" by Hardin (1982) and Marwell and Oliver (1993), respectively. Echoing Olson's argument about inclusive collective goods, Marwell and Oliver (1993) show that when a good has jointness of supply, it is largely irrelevant to the benefits of those who contribute to the provision of the collective good how many other members there are who might also contribute. Marwell and Oliver (1993) argue that what matters here is the pattern of relations among the contributors in the "critical mass", not the relations among everyone in the larger group with a common interest in the collective good.

2.1. Standard development and standard diffusion

The literature has recognized that industry-wide benefits from technology standardization depend on two sets of factors: (1) successful development of standardized business grammars, processes, and protocols, and (2) successful diffusion of these standards and their subsequent adoption by firms, regardless of their size (Markus et al., 2006; Zhao and Xia 2014). These sets of factors have been broadly classified as two distinct collective action dilemmas: (1) the dilemma of standards development (Cargill, 1997; Foray, 1994; Uotila et al., 2017; Weiss and Cargill, 1992), and (2) the dilemma of standards diffusion (Kindleberger, 1983; Weitzel et al., 2006; Zhu et al., 2006).

[27] The greater the interest in the collective good of any single member, the greater the likelihood that this member is expecting to gain a portion of the total benefit from providing the collective good sizeable enough to justify possibly disproportionate costs to this member necessary to provide the good (Olson, 1965).

Several studies have applied the collective action lens to the study of collaborative technology standardization in several industry settings, such as the mortgage industry (Markus et al., 2006), road haulage industry (Saadatmand et al., 2019), and insurance, health care, and high technology industry (Keil, 2002; Zhao et al., 2011). This approach to industry standardization emphasizes collective action to achieve the goals of harnessing resources and capabilities of a relatively broad set of industry actors while co-opting their competitive impulses, reducing the appropriability of the developed standard, and encouraging broad interconnectivity between parties (Foray, 1994; Keil, 2002). Markus et al. (2006) examine vertical information systems (VIS) standardization and challenge the conception that technology standardization can be fully understood by analyzing either standard development or standard diffusion in isolation, arguing instead that successful standardization efforts must include a heterogeneous group of both vendors and users without fragmenting, thereby solving both standardization dilemmas simultaneously. In examining the theoretical basis for the emergence and classification of standard-setting consortia, Weiss and Cargill (1992) argue that, due to network externalities and the collective-good nature of standards, consortia and alliances that seek to establish standards should be considered an inclusive group in Olson's terminology. The reason is that, while there may be heterogeneity in interests and resource contribution among members, a strong incentive exists for such alliances to expand the membership pool as much as possible, as this may cause a bandwagon effect to form around the standard, leading to its adoption by the broader market (Farrell and Saloner, 1985).

In discussing standard development, Greenstein (1992) argued that, compared to standards promoted by dominant vendors, standards set by consortia of organizations are more likely to attract support from buyers and other vendors in the market. Such standardization consortia arise when actors share a common interest in developing and promulgating standards, but structural impediments prevent any single firm from sponsoring a standard that the others will adopt (Greenstein, 1992). Standard development consortia have an incentive to include all participants with a compatible preference structure to maximize the potential size of the standard adopter population. As Weiss and Cargill (1992) observe, this particularly refers to large firms that may have an outsized influence on others to adopt the standard. Furthermore, Farrell and Saloner (1988) suggest that combining resources and competencies of participant organizations with a compatible preference structure may mean that coordination within the consortium is easier to achieve. However, West (2006) cautions that when the number of actors involved becomes too large, it can become challenging to accommodate diverging interests of vendors who prefer proprietary solutions and users who prefer more open solutions.

Studies have claimed that the difficulty in creating a viable alliance to develop and promote an industry standard is that in the absence of a standard-setting authority that would mandate its use or a coordinating body to steer consensus-seeking among members (Markus et al., 2006; Zhao et al., 2014), there are limited incentives for an individual actor to take part in the development and negotiation process when a technical solution for a standard is being formulated (Foray, 1994). The reasoning behind these claims is that the effects of technology standardization (i.e., compatibility and interoperability) can have the nature of a collective good when introduced on an industry level (Kindleberger, 1983). However, as Marwell and Oliver (1993) and Olson (1965) show, in such a situation, when a collective good has a significant degree of jointness of supply, it is not the relations between all participants in the broader group that might benefit from the good that matter, but rather the relations among the participants with the highest level of interest in the good, or the "critical mass" in Marwell and Oliver's terminology.

Many authors treat collective goods as being plagued by the "free-rider problem" (Kindlberger, 1983), consequently making non-participation appealing to some actors. However, Marwell and Oliver (1993) argue that in situations where successive contributions to attaining a collective good yield progressively greater rewards, free-riding is not the crucial dynamic. Take, for example, an industry-wide standardized information exchange system. The first organizations that introduce a new standardized system benefit only from direct linkages while incurring potentially very high start-up costs. In such a situation, it is difficult to initiate collective action because the benefits to early contributors are primarily contingent on the subsequent contribution of others, be it through direct investments, granting access to data, or facilitating connections with additional partners (Monge et al., 1998). Additionally, in the early stages of a standardization process, it is not clear to potential adopters what those benefits will be, both in their level and nature (Monge et al., 1998). Thereby, their interests in supporting the effort are of a dynamic nature and may grow over time as the benefits of using the solution become more apparent (Browning et al., 1995; Monge et al., 1998). Ultimately, however, the best assurance and proof of intentions lie in other organizations' actual adoption of a standard. Thereby the tendency is often to wait for others to adopt first. This effect has been termed differently in the literature as an assurance game (Kollock, 1998) or penguin effects (Weitzel et al., 2006). The practical implication of this effect is that standard diffusion on an industry level tends to be slow and uncertain (Markus et al., 2006).

In summary, based on the literature review on technology standardization, we have a developing understanding of how the factors such as the free-rider problem and heterogeneity of interests among different types of participants (i.e., users and vendors) influence standard development and standard diffusion on an industry level. However, it is less clear how the two phases of standardization can be addressed simultaneously. Furthermore, it remains largely unknown how standardization evolves over time and how this process is affected by heterogeneity in the level of interest in the standard among participating organizations, where some could be both more willing and able to contribute to the standardization process. Further still, it remains unknown how the effects of those factors vary over time and what could be the causes of the changes. We leverage a combination of theoretical arguments about the importance of the inequality in the degree of interest within the larger group of organizations seeking to establish a technology standard and the pattern of relations among a smaller critical group of highly interested and resourceful organizations. We then study how these factors dynamically affect the process of technology standardization on an industry level.

3. Research design

This study aimed to examine the process of technology standardization on an industry level and identify crucial factors and dynamics related to it. The unit of analysis in our research question is the process of technology standardization, an industry-level phenomenon (Markus et al., 2006). In order to answer our research question, we collected data on two technology standardization attempts in the shipping industry, namely INTTRA and TradeLens, that appeared to be uniquely suited to our study's objectives. Although created at different points in time, the two projects espouse a comparable goal, that of creating a technology standard for improving information exchange in the shipping industry. Our case study approach allowed us to generate rich, field-based insights (Gioia et al., 2013) into how technology standardization processes on an industry level occur and unfold. The case study method is particularly suitable for exploring phenomena that cannot easily be separated from the context in which they occur (Yin, 2009). Empirical evidence derived from observing real-life cases can also help identify new facets and aspects derived from reality (Yin, 2009). We opted for a qualitative study, as qualitative data can provide rich, well-grounded descriptions and describe processes in identifiable local settings (Miles and Huberman, 1994). However, this type of data can raise concerns about the credibility of conclusions, data overload, and generalizability. Consequently, the manner in which qualitative data is collected and analyzed must be methodical and systematic (Miles and Huberman, 1994; Collis and Hussey, 2013). We attempted to mitigate these concerns by joint interviews, reviewing the results of the coding process between authors, asking respondents to review and provide clarification of interview transcripts, and adhering to a systematic and methodical process.

During data collection, it became apparent that even though numerous attempts at creating technological standards have been made in the past (e.g., INTTRA, GT Nexus[28], CargoSmart[29]), they have been only partially adopted by the actors in the shipping industry. At the same time, there seemed to be an overarching consensus among our respondents that common technology standards in the shipping ecosystem would bring about massive efficiencies for all parties involved. To address this apparent paradox, we focused on exploring two sets of factors that have been the topic of existing research on technology standardization through collective action: (1) factors influencing standard development (e.g., Cargill, 1997; Uotila et al., 2017) and (2) factors influencing standard diffusion (e.g., Kindleberger, 1983; Weitzel et al., 2006; Zhu et al., 2006). We further analyzed how these factors interrelate between the two phases of the standardization process. Based on the analysis of collected data, we found the literature on collective action (Olson, 1965; Marwell and Oliver, 1993) to be particularly promising for the analysis of our cases. Because standardization efforts in the shipping industry invariably involve coordinated action between industry rivals, this theoretical lens seemed especially useful for explicating the different aspects of standardization in these settings.

3.1. Data collection

We collected data from several sources: (1) in-depth semi-structured interviews; (2) participation at industry events; (3) secondary data, including INTTRA's and TradeLens' documentation, industry reports, and other practitioner-oriented literature such as books, industry conference presentations, news articles and press releases; and (4) informal talks with experienced individuals from the shipping industry.

Interviewees were selected based on their roles within their respective organizations and their involvement in either TradeLens or INTTRA. Whenever possible, we selected interviewees involved in both projects. In such instances, we asked the respondents to compare the two projects in terms of

[28] For more information see: https://www.gtnexus.com/
[29] For more information see: https://www.cargosmart.com/en/default.htm

the overall aims, the parties involved, governance mechanisms and how they changed over time to address different obstacles that arose during the phases of development and diffusion. We also asked our respondents about the specific actions taken at comparable stages of the two projects. Secondary data, as well as existing research that has examined TradeLens and INTTRA (e.g., Jensen et al., 2019), suggested that the most important actors that play a key role in such standardization efforts in the shipping industry include the biggest ocean carriers, port and terminal operators, and large exporters that ship hundreds of thousands of containers per year and collaborate with multiple large ocean carriers to facilitate their trade transactions. Accordingly, our data collection was focused on these groups of actors.

The examples of respondents that were involved in both initiatives include interviewees from large ocean carriers (Mærsk Line[30], Mediterranean Shipping Company (MSC)[31], and Pacific International Lines (PIL)[32]), a large customer experienced in using INTTRA and piloting TradeLens (AB InBev[33]), and a prominent shipping industry analyst (SeaIntelligence Consulting), who was also a former Mærsk representative at INTTRA. Additionally, we interviewed representatives from major container terminal operators APM Terminals, International Container Terminal Services Inc. (ICTSI), YILPORT Holding[34], Global Container Terminals (GCT), and Youredi, a systems integration specialist company that helps parties submit and consume data to and from TradeLens. These actors, as well as the respondent from IBM, were involved in TradeLens only but were nonetheless able to provide valuable insights on the pertinent issues of technology standardization in the shipping industry.

Our interviewees held senior positions within their organizations (e.g., CEO, CIO, CTO, VP, Head of Department). We chose respondents in senior positions because they could provide a high-level view of the most important decisions related to standard development (i.e., what are their most

[30] To ease the exposition, in the remainder of the paper Mærsk Line will be referred to simply as Mærsk. When referring to Mærsk Line's parent company we use the term Mærsk Group.
[31] The Chief Digital and Information Officer (CDIO) of MSC was also a chairman of INTTRA for nearly 18 years, and was able to provide detailed information on both projects.
[32] MSC, Maersk and PIL represent the first, second and twelfth largest ocean carriers in the world. Source: https://alphaliner.axsmarine.com/PublicTop100/
[33] With a yearly revenue of $52 billion and around 170 thousand employees, AB InBev represents the biggest drinks company in the world. Additionally, according to our respondent from AB InBev, the company exports in excess of 250 thousand containers per year, making it one of the most significant customers of large ocean carriers. Source: https://annualreport.ab-inbev.com/2019/assets/reports/2019-annual-report.pdf
[34] APM Terminals, a subsidiary of Maersk Group, ICTSI, and YILPORT Holding represent the fourth, the eighth, and the twelfth biggest global marine terminal operators in terms of equity-adjusted throughput, while GCT represents one of the most significant North American marine terminal operators and collaborates with most of the top 20 ocean carriers. Source: https://www.statista.com/study/24273/water-transportation-industry-statista-dossier/

important requirements when developing a standard), as well as standard diffusion (i.e., what would it take for them to adopt a standard). These respondents were also able to discuss important strategic considerations of their respective organizations at different points in time. Interviews were recorded and transcribed verbatim. Additionally, we took very detailed notes during and immediately following the interviews. In total, we conducted 19 semi-structured interviews.

The data collection took place from May 2018 to June 2021. Initial exploratory interviews were conducted at Mærsk in 2018 to understand the development process of TradeLens. During this data collection phase, we learned about INTTRA, another attempt at standardization in the industry, which went live 18 years before TradeLens. Although INTTRA initially seemed to work well, it never reached the anticipated levels of diffusion and failed to become an industry standard. At the same time, our findings from the initial data collection phase suggested that TradeLens was struggling with industry-wide diffusion. Consequently, we became interested in the decisions involved in developing both platforms, the reasons that could explain why INTTRA could not diffuse more widely, and why TradeLens was struggling with adoption. In turn, the questions regarding development choices and their impact on subsequent diffusion were included in our interview guide for the next rounds of interviews, conducted in 2019, 2020, and 2021. **Appendix A** provides an overview of the conducted interviews.

Apart from the formal interviews, we held several informal talks specifically regarding INTTRA and TradeLens at industry events with individuals knowledgeable about the shipping industry and standardization efforts more broadly. These included the CEO and Statutory Director of Digital Container Shipping Association (DCSA[35]), a standard-setting body whose membership includes nine of the ten largest ocean carriers, the Head of Digital Innovations at the Port of Rotterdam, the CIO of Hapag-Lloyd, the CEO of TradeLens, and an MIT Sloan Distinguished Professor of Management, who has published extensively on the formation of voluntary consensus standards, primarily in the U.S. In addition to the interviews and informal talks, we collected data by participating in industry conferences and live webinars[36]. **Appendix B** maps these events.

We were attentive to the data quality issues, which may arise because the two projects were carried out at different points in time. While INTTRA has been operational for nearly two decades, TradeLens could be considered a standard in the making. That meant that while we were able to

[35] For more information see: https://dcsa.org/
[36] Live webinars and virtual conferences replaced live industry events in 2020 and 2021 due to the COVID-19 pandemic.

collect data on how INTTRA's initial and subsequent diffusion unfolded, we are unable to evaluate with certainty whether TradeLens will ultimately become an industry standard. In addition, in 2018, INTTRA was sold to E2Open[37], a provider of cloud-based software solutions, and it is unclear how the platform will develop in the future. Nevertheless, we tried to minimize these concerns by focusing on the choices made during INTTRA's initial development and diffusion, comparable to the phases TradeLens was going through during the data collection. Additionally, these concerns were mitigated through our conceptual approach, where the standardization is understood and framed as an organized and ongoing process of sequences of standard development and diffusion (Botzem and Dobusch, 2012; Wiegmann et al., 2017). When conducting interviews, we encouraged respondents to describe the initial steps taken during the development of both platforms and how these decisions impacted diffusion and vice versa. Where relevant, we also asked informants to compare and contrast both projects. To mitigate retrospective bias, we carefully focused on the most material events during the standardization process (Miller and Salkind, 2002; Jovanovic et al., 2021).

Moreover, we used archival data to identify the primary factors and milestones during the phases of development and diffusion of both platforms. To verify our findings and interpretations, we conducted repeated interviews with a Digital Product Manager at Mærsk. Repeated interviews also allowed us to cross-check information collected from other respondents and secondary data. Inconsistencies between primary and secondary data further guided our data collection and analysis. Secondary data used in this study include INTTRA's and TradeLens' documentation, industry reports, industry conference presentations, news articles, and press releases. An overview of secondary data sources can be found in **Appendix C**.

3.2. Data analysis

We followed a thematic analysis approach to interpret our data. Thematic analysis provides a means to identify patterns in complex sets of data (Braun and Clarke, 2006) and accurately recognize empirical themes grounded in the case study context (Jovanovic et al., 2021).

We began our analysis by reading and re-reading the interview transcripts and highlighting the most common words and phrases. Where possible, we tried to corroborate the interview data with secondary data. This process involved a constant comparative method, where new data was constantly

[37] For more information see https://www.e2open.com/

compared to prior data in terms of categories and hypotheses (Browning et al., 1995). This process was repeated until theoretical saturation was reached, meaning that no new categories were emerging from the data (Strauss and Corbin, 1990; Glaser and Strauss, 2017). Initial coding produced fifteen first-level codes about factors that influence standardization efforts. We then further examined identified first-level empirical themes to find links and patterns between them (Gioia et al., 2013). Subsequently, these codes were aggregated into three high-level dimensions. We then iterated between emerging findings and relevant literature to determine whether our analysis yielded novel concepts (Corley and Gioia, 2011; Dattée et al., 2018). Consequently, we combined concepts from extant literature with our findings (Dattée et al., 2018) to propose three novel collective action trade-offs critical to the standardization efforts we examined. We constructed our narratives for each identified trade-off and included selected quotations from interview transcripts to illustrate our findings. These narratives form the analytical scaffolding for the findings presented in this study. Before presenting our findings, we describe the research context and provide a brief overview of both cases.

4. Research context

The study is situated in the context of the global shipping industry. The shipping industry is systemically important for the global supply chains. It accounts for roughly 60 percent of all seaborne trade, valued at $14 trillion in 2019[38]. The shipping industry is a mature industry that has seen significant expansion while becoming more consolidated since the early 2000s. The capacity in the industry steadily grew from 5 million TEU[39] in 2000 to close to 13 million in 2008 to the current estimates of over 25.5 million[40]. At the same time, in the year 2000, out of the top 100 ocean carriers, the top 25 held a market share of 81 percent, while the top 10 held 52 percent[41]. Following a series of mergers, acquisitions, and bankruptcies, the consolidation in the industry has increased

[38] Source: https://www.statista.com/topics/1367/container-shipping/

[39] A TEU or Twenty-foot Equivalent Unit is a unit of measurement used to determine cargo capacity for container ships and terminals. This measurement is derived from the dimensions of a 20ft standardized shipping container.

[40] Sources: https://unctad.org/system/files/official-document/rmt2000_en.pdf, https://unctad.org/system/files/official-document/rmt2008_en.pdf and https://alphaliner.axsmarine.com/PublicTop100/

[41] Source: https://unctad.org/system/files/official-document/rmt2000_en.pdf

dramatically[42]. According to 2020 figures, the top 10 biggest ocean carriers hold an 85 percent market share[43], corresponding to $170 billion in yearly revenue in a $200 billion industry[44].

INTTRA was founded as a joint venture of the world's largest ocean carriers[45] in late 2000, collectively representing 28 percent of the industry[46]. These shareholders collectively made the initial investment of $85 million, with Mærsk holding the largest stake of 35 percent, with some other members like Hapag-Lloyd and Hamburg Süd holding as little as 5-7 percent. The board of INTTRA was made up of the directors of the founding ocean carrier shareholders. The governance structure of INTTRA stipulated that all shareholders had equal voting rights. Each member carrier could only carry one vote and held veto rights.

INTTRA aimed to create an EDI-based information exchange platform that supports standard electronic bookings for the shipping industry. A catalyst for creating INTTRA was the rise of the internet. One of our respondents, a former Mærsk representative at INTTRA, noted:

"*INTTRA was created during the dot-com bubble. Carriers were afraid someone else would build a portal. And if that becomes successful, whoever owns that portal, suddenly owns the customer relationship. That would be disastrous for carriers. So a number of carriers got together and said: "Fine, if that is the threat, let's build a portal ourselves.*"

The initial idea behind INTTRA was to create a "hub-and-spoke" solution, which would simplify the container booking process, as customers would only need to set up and maintain a single EDI connection (i.e., with INTTRA) instead of having to manage separate EDI connections with several different ocean carriers. INTTRA's ambition was also to standardize shipping instructions and eventually move to standardize other documents, which would ultimately create value for the entire shipping industry. A former member of INTTRA's board of directors recalls:

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[42] There are several major examples of this trend directly related to the INTTRA and TradeLens cases. P&O Nedlloyd was acquired by Mærsk Line in 2005. Similarly, Hamburg Süd was acquired by Mærsk Line in 2016. Sources: https://investor.maersk.com/static-files/508935c1-3fc1-40bc-a814-e50ba4086993 and https://investor.maersk.com/static-files/39ddda94-f68b-45c3-9e27-de79da86b2a1. United Arab Shipping Company merged with Hapag-Lloyd in 2016, source: https://www.joc.com/maritime-news/container-lines/united-arab-shipping-uasc

[43] Source: https://alphaliner.axsmarine.com/PublicTop100/

[44] Sources: https://www.statista.com/study/13992/container-shipping-statista-dossier/ and annual reports of the top 10 ocean carriers.

[45] INTTRA's founding members were Mærsk Line, P&O Nedlloyd, Mediterranean Shipping Co., CMA CGM, Hapag-Lloyd, Hamburg Süd, and United Arab Shipping Company.

[46] Source: https://unctad.org/system/files/official-document/rmt2000_en.pdf

“*The idea there [behind INTTRA] was to bring some collaboration between the carriers,[...] to try to bring some standards to the basic shipping transactions. And so we did that, but it was really limited to the technology side. Let's create some EDI messages. Let's try and talk the same language, use the same codes.*”

Five years after its inception, INTTRA processed roughly 28 percent of global container bookings. Its membership in terms of participation in the platform steadily grew over the years to include 20 of the top 25 ocean carriers in 2008, representing roughly 74 percent of the global container capacity. Similarly, INTTRA saw an increase in revenue of 1372 percent from 2002 to 2006. By 2008, however, platform development reached an impasse. To move forward, INTTRA needed to adjust and expand its product offering to satisfy the needs of its existing clients and attract new ones. However, the efforts to further develop the product offering were crippled by INTTRA's ownership and governance structure and further exacerbated by financial difficulties caused by the 2008 financial crisis. Although INTTRA is still used for creating roughly 25 percent of global container bookings, our respondents repeatedly noted that the platform was ultimately unable to live up to its envisioned potential of becoming an industry standard.

TradeLens is a more recent attempt at creating a shared information infrastructure in the shipping industry, launched in early 2018. It is a supply chain platform underpinned by blockchain technology and jointly developed by Mærsk and IBM. TradeLens was designed to decrease transaction costs, allow secure exchange of inter-organizational information, and create transparency across global supply chains. In practical terms, TradeLens has a broader scope than INTTRA, which is apparent from its basic structure. Namely, TradeLanes consists of three major components. Firstly, the foundation of TradeLens is its business network or “the ecosystem”. This entails that TradeLens aims to integrate a population of partners that is more diverse (i.e., including ports and terminals, intermodal operators, customs authorities, financial service providers) and more numerous than the exporter-carrier oriented INTTRA. Secondly, “the platform” is based on Hyperledger Fabric blockchain technology and IBM cloud and enables parties to share operational information securely. The platform is further accessible via open-source APIs and leverages the existing standard UN/CEFACT data model and access control scheme. Thirdly, the open applications and services marketplace allows TradeLens as the platform sponsor and the third-party complementors to publish fit-for-purpose services atop the TradeLens platform. Existing applications developed by TradeLens include TradeLens Core and TradeLens electronic bill of lading (eBL). TradeLens Core is a digital freight management tool that can track shipments, develop dashboards that aggregate data through visualization tools, and enable document sharing between parties on the platform. TradeLens eBL enables a secure process for the issue, transfer, and surrender of original bills of lading, a key trade document, in a digital form among the platform members. Figure 1 illustrates the TradeLens architecture.

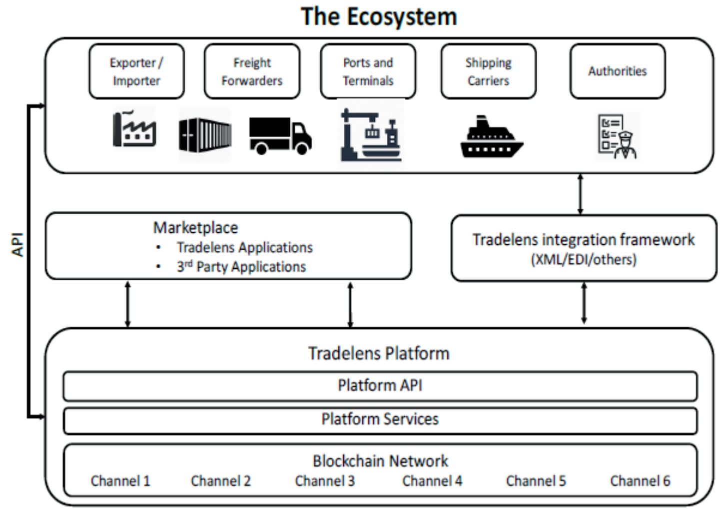

Figure 1: TradeLens architecture. Adopted from Jensen et al. (2019)

After announcing the platform in August 2018 and launching a commercial product offering in December 2018, Mærsk and IBM initially envisioned it as a joint venture between the two firms. This idea was quickly met with resistance from rival ocean carriers, who did not want to share their data through a platform created by one of their biggest competitors. Consequently, Mærsk and IBM moved away from the initially planned joint venture and positioned TradeLens as a platform developed through collaboration between IBM and GTD Solution, a subsidiary of Mærsk Group established specifically for this purpose. Additionally, the TradeLens Advisory Board was established to ensure that the decisions regarding platform development are transparent and aligned with other ecosystem members. Although the advisory board has no formal decision-making power, it provides a channel for ecosystem members to influence the future technical and governance direction of TradeLens (Jensen et al., 2019).

5. Findings

Companies engaging in collective action to create technology standards are likely to have diverging interests regarding the standardization process. Based on the analysis of collected data, we identify three trade-offs: (1) flexibility vs. inclusion, (2) generalizability vs. completeness, and (3) investment vs. value capture that were found critical for the standardization processes in the examined cases.

5.1. Flexibility vs. Inclusion

Flexibility vs. inclusion refers to the number and type of actors involved in the standardization effort. It represents a trade-off between focusing on flexibility and speed in decision-making by involving only a small number of actors with a high level of available resources and interest in the standard provision and the inclusion of additional stakeholders that would provide additional credibility to the standardization effort and expand the potential size of the adopter population. Several interviewees noted the relevance of this trade-off, although different respondents advocated different approaches to how it can be addressed. The Digital Product Manager at Mærsk, for instance, highlighted the benefits of flexibility:

"*Driving a new product or a new offering by a few strong partners is not a problem […] because someone has to bring it to life. And maybe that's easier with few select parties who really want to drive that agenda, as compared to saying to the world: "Let's build something brilliant, who wants to join?". Then you end up in endless discussions about this or that feature."*

The Global Head of Integration at APM Terminals, on the other hand, emphasized the need for inclusion:

"*Big customers such as IKEA and Nestlé use many different carriers, so they drive standards along with the carriers. The odds of success are higher if you engage stakeholders from the beginning.*"

While excluding a wider variety of stakeholders from the standard development phase may allow for higher flexibility and speed in decision-making, it can also hinder subsequent diffusion, as requirements of other relevant actors may not be met by the proposed solution. An example was given by the Chief Digital and Information Officer (CDIO) of MSC:

”If we use a standard that we’ve agreed to [only] between us... It’s basically not a standard it’s proprietary. So standards are created by adoption. Nothing else. Either by an option or because you have no choice. The difficulty is that if you take the shipping industry and you draw the supply chain [...], you’ll see [that] there’s a lot of partners. So of course, as a shipping line, we’re only a portion of that supply chain. Therefore, whatever we agree between ourselves is not sufficient. And then when you try to attract other parties, it’s quite, quite complex, because everybody has an interest.”

Even though both INTTRA and TradeLens espoused similar goals of eventually becoming a standard in the shipping industry, the two initiatives started on the opposite ends of the flexibility/inclusion spectrum. While INTTRA was started by some of the world’s largest ocean carriers, TradeLens was started by only one carrier, albeit the largest (Mærsk), and a technology provider (IBM). INTTRA’s foundational contract stated that every ocean carrier could only have one vote in the decision-making process. The governance structure further entailed that each member carrier held veto rights on the platform's development decisions. By 2005, however, Mærsk held 65 percent of the ownership shares of INTTRA[47], which the company accumulated over time through the acquisition of other ocean carriers. Despite holding most of INTTRA’s ownership shares, the governance model still treated Mærsk as a single carrier, meaning it only carried a single vote. Former Mærsk representative at INTTRA highlighted the governance issues as one of the main impediments to INTTRA ultimately becoming a true industry standard:

“*At some point, Mærsk owned 65% of INTTRA. Since it could only sell [shares] to other carriers, no one wanted to buy. But despite having 65%, it still got only one vote. INTTRA missed the boat. Because of the ownership structure between carriers, it was impossible to achieve anything.*”

This was just one glaring example of governance issues that have hindered the continuous development of INTTRA. Another challenge came with the financial crisis in 2008 when monetary concerns overshadowed the discussions regarding further updates and extensions to the standard that would accommodate emergent industry needs. A former member of INTTRA’s board of directors recalls:

[47] Source: A.P. Møller - Mærsk A/S Annual report 2005
https://investor.maersk.com/system/files-encrypted/nasdaq_kms/assets/2012/06/14/4-20-39/Annual_2005_uk.pdf

"*[…]Then came 2008, and there was a big crisis. And in 2008, INTTRA ran out of money. And the carriers didn't have the money to put back into the venture. And the board meetings we were having were all about money and revenue, but not about products. And so for many years we didn't develop the products. I think everybody was trying to continue to sell the same products or maybe to bring some new products, but nobody could agree on how to do that.*"

In contrast, TradeLens was initiated by a single ocean carrier and a technology provider. In that sense, Mærsk and IBM had the flexibility to proceed with the development phase quickly but ran into problems with the diffusion of their solution. Consequently, during the course of the present study, the governance structures for TradeLens have gone through several transformations. Initially, TradeLens consisted of separate initiatives sponsored by the CIO and CFO of Mærsk and by several organizational units within IBM. These initiatives were combined to form the project under the commercial name TradeLens, which represented a collaboration between the Mærsk IT division, an IBM consulting unit, and IBM research. In January 2018, Mærsk and IBM announced intentions to bring TradeLens to market by establishing a joint venture with a 51 to 49 percent ownership structure in favor of Mærsk. TradeLens became the official name of the new firm in August 2018. At that stage, the Mærsk development team was put in charge of running the business, while IBM contributed staff from their blockchain, cloud, and consulting units to drive the development of the technological solution. However, in mid-2018, Mærsk and IBM struggled to convince other ocean carriers to join their platform. Rival industry players cited the rights to intellectual property to which Mærsk and IBM have a full and equal claim as the main impediment to joining TradeLens, with some going as far as labeling TradeLens as "unusable" (Allison, 2018). The decision to develop a solution without the initial involvement of other ocean carriers was described by the Vice President of Blockchain Solutions at IBM. Similarly to several others, this interviewee implicitly pondered the trade-off between flexibility and early inclusion of other actors:

"Now, one of the big lessons that I learned is, in retrospect, maybe we should have gotten the buy-in from the top six carriers upfront before building the platform because [there is] a lot of delay in trying to bring the ecosystem together. […] However, somebody has to build a platform, [and] it's always easier to build a platform with a small group rather than with a committee of ten or twelve [members]. But you've got to talk about the platform and get some buy-in before engaging. Otherwise, here right now, we go through many challenges trying to explain why we made certain decisions in building the platform."

Consequently, TradeLens moved away from the initial joint venture structure in the fall of 2018. In addition to the issues with diffusion described above, the proposed joint venture faced legal obstacles. It needed to obtain permission from governments to operate in their jurisdictions, which represented a costly and time-consuming process for a global solution like TradeLens. To address the dual problem of industry competitors' unwillingness to join a platform operated by the Mærsk-IBM joint venture and the legal hurdles in numerous countries, Mærsk and IBM decided to change the ownership structure of TradeLens from a joint venture and establish a third-party entity called GTD Solution as a subsidiary within Mærsk Group[48], with IBM serving as the technology provider. This was deemed expedient as it automatically allowed the new entity to operate in all the countries in which Mærsk already operated and because it created a business unit operating at arm's length from Mærsk. This was described by the Head of Strategy and Operations at GTD Solution:

"So, basically what we did is within the Mærsk Group. There is a business unit that we have created called, literally just today, we are changing the name to GTD Solution, and it is a separate business unit that operates at arm's length from the rest of the Mærsk organization. So, when you interact with GTD, you are interacting with it as if it were its own company, even though it is part of Mærsk Group. And so, suddenly, you as a competitor to Mærsk no longer face the risk that the data you're giving to this platform will get in the hands of Mærsk itself because there is a separation of systems, separations of people, separation of legal constructs. So, that was one of the parts [of the effort to drive adoption], that we made it so that they [rival ocean carriers] were working with a much more neutral partner in this rather than with one of their competitors. And then the second thing is we made sure that whatever terms that would be offered to one network member in our ecosystem, regardless of who they were, those same terms would be made available to ocean carriers. So no matter what, everybody comes at this essentially with the same set of preconditions that allow them to get access to the platform under the same pretenses as everybody else."

Additionally, around the same time, to further limit the level of control Mærsk had over the platform, the TradeLens Advisory Board was established with the dual aim of incorporating inputs from a diverse set of industry actors, which would thereby partly shape the continuing development of

48 Mærsk Group is a publicly traded company hedquartered in Copenhagen with 83 thousand employees operating over 900 subsidiaries with $73 billion in total assets. Source: https://investor.maersk.com/static-files/47f6dd71-1125-4297-8709-043c5c0e2891

TradeLens, as well as building on the benefits of higher inclusion to drive the diffusion. The Head of Strategy and Operations at GTD Solution continued:

> *"[…] The other thing is we have created this customer advisory board whose job is to represent TradeLens customers, to ensure that the decisions we make are a result of collaboration. So, for example, around data standardization, the product roadmap, and things like that to make sure that what we're doing is aligned with the mission statements that we have for the company."*

In essence, our findings suggest that the trade-off between flexibility and inclusion entails the necessity of developing the ability to harness market forces to the standardization process while simultaneously preserving control and decision-making benefits of narrower committee-like structures involving key standard sponsors.

5.2. Generalizability vs. Completeness

The trade-off between generalizability and completeness refers to the extent and specificity of standardization solutions. In other words, a technology standardization effort needs to strike a crucial balance. On the one hand, this involves developing a solution that is technically complete enough for there to be a sufficient level of compatibility between parties. On the other hand, it requires keeping the solution sufficiently "system agnostic" for the solution to be generalizable enough to diffuse sufficiently to become an industry standard. Because actors involved in collective action often have diverging interests, including commercial considerations, only "incomplete standards" can often be agreed upon.

INTTRA started with a narrow scope. It was initially designed for moving shipping instructions between customers and ocean carriers. Despite dealing with many regulatory requirements, INTTRA was successful in standardizing basic shipping instructions. The problems arose when, due to customer requirements, certain ocean carriers wanted to upgrade INTTRA and make it more complete. Attaining higher levels of completeness, however, required both additional resources and ocean carriers in charge of INTTRA to reach an agreement on the extent of the upgrades. This presented a problem because some ocean carriers failed to recognize the value of the additional investments in the development of INTTRA. Former Mærsk representative at INTTRA described these issues:

"*The issue with INTTRA…they had standard electronic shipping instructions. But as the world developed, customers wanted to have added data fields and needed to upgrade the standard. Then they ran into problems, as individual carriers didn't want to spend time and resources on that. Other carriers did it, and they ended up with customized solutions for customers.*"

This respondent further suggested that INTTRA plateaued because it failed to expand its offerings to address the needs of smaller clients in the market in particular, which have traditionally been catered to by the freight forwarders:

"*INTTRA was a way to make it easier to maintain EDI connections. For large customers, it is much simpler to maintain one EDI connection [with INTTRA] instead of 20 [with each ocean carrier]. But that also means that only ones with EDI connections were large customers. Once that was up and running, INTTRA maxed out. Then you end up with a tool that means nothing to small guys. And that is a problem. Because the uptake in digital transformation is the largest with small and medium-sized customers. It is very expensive to serve little customers. But at the same time, small customers pay much higher freight rates. If you exclude smaller customers, then you are losing a lot of potentially most profitable sales.*"

In comparison, TradeLens started with a broader scope. The platform aims to connect the entire shipping ecosystem and digitize a plethora of relevant trade documents such as the bill of lading, packing list, and certificate of origin. As such, TradeLens was, by design, intended as a more complete solution than INTTRA. Respondents noted that engaging the entire ecosystem is a way to improve operational efficiencies for a number of actors within the industry. Vice President of Blockchain Solutions at IBM, for example, emphasized that such an approach can create value for customers that cooperate with several ocean carriers:

"*We learned one important lesson, and that is, to truly be valuable to an exporter like a Proctor and Gamble or a Walmart, it's not enough if they deal with this new way of doing things just for their containers that go on the Mærsk Line, but they want to do it for all containers [that they export]. Because if you don't, then you have this problem of [having] one system for one exporter, another for another shipping system.*"

TradeLens also aims to become a more complete solution in terms of documentation it intends to standardize and digitize. The digital product manager at Mærsk summarized this ambition as:

"*So what TradeLens is trying to do is to [...] get rid of everything that is paper-based, or pdf, or fax, or even EDI. [We] want to build next-generation data. It is all about [the] exchange of information, and if you are not able to standardize formats and the way you exchange this information, you will not solve the core problem.*"

Connecting many actors, digitizing several crucial trade documents, and automating multi-party interactions reflects TradeLens' ambition to become a complete industry standard, or the "internet of logistics" as referred to by the respondents from Mærsk and GTD Solution. However, some of the other interviewees warned that achieving high levels of completeness comes at the cost of increased complexity. Numerous exceptions that cannot be automated (e.g., ad-hoc agreements, local requirements) remain a pertinent issue in global supply chains. The CEO and Partner at SeaIntelligence Consulting, for example, considered the requirements from customs authorities as a particularly problematic area:

"*The moment you start including customs clearance and these types of rules… this will not be a global tool. Because customs rules are clearly not aligned and will never be aligned. TradeLens is global by nature, but these elements will have to be local in nature. [...] There is a high likelihood that in every individual country, there is some sort of customs charge. That will be different for all 150 countries.*"

High levels of complexity and numerous exceptions in the global trade environment imply that technology standards in the shipping industry, including those aiming for high levels of completeness like TradeLens, still need to maintain a certain level of generalizability. Relatedly, many interviewees see these exceptions as a potential competitive differentiator. Ocean carriers that can serve their customers better "when the unexpected occurs" enjoy a competitive advantage over their rivals that otherwise have access to the same standardized shared information infrastructure. This notion is encapsulated in a statement by CDIO of MSC:

"*We would probably still focus on our own [MSC's] apps. In the end, if you look at our business, I don't believe that technology is going to differentiate the carriers. So I think that some of the things we need to keep, the apps we need to keep because that's our way of communicating with the customer, for those who want to do that. [...] Maybe we could use some data from TradeLens to improve our apps.[...] There has to be a place where we can still provide a better service than [the competition]. And that service is what keeps you going, not the tech.*"

In other words, collaborative technology standardization supports innovation even in highly competitive industries, as the shared information infrastructure serves as a base upon which ecosystem participants develop their innovative solutions.

5.3. Investment vs. Value Capture

The final trade-off, investment vs. value capture, refers to the balance between investing in the standardization efforts and the distribution of value created by them. The level of contributions to developing a standard and the value that could be accrued from it are naturally important considerations for actors engaging in standardization efforts. As noted by the CEO and Partner of SeaIntelligence Consulting:

"*If a [shipping] platform is to take off, it should first be useful, and second, there should be a very clear identification – who pays for it, and who gets the money. […] If you have a large number of stakeholders involved, you end up with a classical problem. There is probably one company that foots the bill for developing it. The system as a whole generates value, but that value is relatively invisible. It is not necessarily the case that someone is getting an income stream out of it. Such a system and digitizing documentation would lead to enormous savings. But it is difficult to convince stakeholders that the savings are real. They will say "I'm not seeing any money". This is going to be a problem.*"

INTTRA was funded by some of the world's largest ocean carriers, who were considered the main beneficiaries of the value created by the platform. In order to incentivize customer participation in INTTRA, they were not charged for its use. A former member of INTTRA's board of directors put it this way:

"*[…] we said, "Okay, the carriers are going to benefit from this, so let's get the carriers to fund this". So that helped a little bit because customers were more inclined to use the system because they didn't have to pay for anything. They only made investments if they needed integration.*"

Because of concerns related to the governance structure of INTTRA and the financial crisis of 2008, the platform reached a stalemate. Former Mærsk representative at INTTRA described these developments:

"*INTTRA never turned a profit – it had to come up with ways to convince carriers to invest more money into it. It couldn't make money by selling shares to non-carriers because the foundational agreement said that only carriers were allowed to buy shares. […] By 2010, the carriers got tired of investing in INTTRA, and 51 percent was sold to a capital fund. Carriers were hands-off, and the fund could develop it [INTTRA] any way they wanted. A lot of money was invested, but they failed to prioritize and started to pursue too many ideas at once and never got anywhere. And since the fund was unable to sell it after five years, the management got fired, and two years later [in 2018], they sold it to E2Open.*"

Initially, the value proposition was unambiguous to the "critical mass" of ocean carriers that were sponsoring INTTRA. Similarly, the level of investment needed to achieve that value proposition was clearly defined within this group of actors, which facilitated INTTRA's initial diffusion. However, problems arose due to the technical nature of the standard developed by INTTRA (i.e., benefitting mostly large industry actors with the resources necessary to maintain EDI connections), as well as the ownership and governance structure that hindered INTTRA's ability to engage with a broader population of industry actors. Collectively, these issues created uncertainty among the "critical mass" of standard supporters about the future value that could be obtained from further investing in the platform, which ultimately hindered its continued development and broader diffusion.

TradeLens, on the other hand, was launched and financed by a single ocean carrier (Mærsk) along with a technology provider (IBM). Interviewees from Mærsk and IBM suggested they started TradeLens without involving other carriers for pragmatic reasons. The Vice President of Blockchain Solutions at IBM described it this way:

"*Mærsk and IBM invested a lot, but sometimes you have to do that to really get the ecosystem going.*"

Respondents from the two companies suggested that a widely-adopted solution would ultimately benefit everyone in the shipping ecosystem because the inefficiencies related to information sharing and moving documentation permeate the whole value chain. However, TradeLens' approach, which mostly resembled a commercial project involving a proprietary solution, quickly proved ill-suited to the alleged goal of creating a standard for the shipping industry. These issues were described by the CEO and Partner at SeaIntelligence Consulting:

“*TradeLens basically failed spectacularly in the first six to eight months because they essentially went out and said: “This is [a] Mærsk and IBM project”. And some of the other carriers then asked: “OK, if we participate, who owns the IP rights?”. To which they replied: “Well we [Mærsk and IBM] do”. No wonder no one wanted to join.*”

Such concentration of ownership presented a risk for competing ocean carriers, who became concerned that the two companies would reap most of the economic benefits and be able to use their power over the platform to compete unfairly by monetizing proprietary data. The sensitivity of handling shared data was highlighted by the President and CEO of Global Container Terminals:

“*The monetization of the data has to be done extremely carefully. Mærsk cannot monetize data that they don’t own.*”

Mærsk and IBM incurred the direct monetary costs for the initial development of the platform, but potential adopters still need to make investments to integrate TradeLens with their legacy systems. Although ocean carriers that adopt TradeLens do not need to pay to be allowed to use the platform, they still invest in the endeavor, albeit in an indirect and intangible manner. These investments come in the form of contributing proprietary commercial data and implicit expectations to leverage their relationships with large customers and other transaction partners to drive the diffusion of TradeLens. Respondents from Pacific International Lines (PIL) described this arrangement:

“From a carrier’s point of view, we do not expect to incur any costs from using any TradeLens modules. Based on the TradeLens’ business model, TradeLens’ services are not chargeable for carriers since they play a key role in bringing in physical cargo volume and onboarding customers to the platform. In return, carriers should be incentivized for onboarding more members to the ecosystem.”

Another important element to consider regarding this trade-off is the timing of payoffs. Even though most of our interviewees agreed that the industry-wide standardized solution could ultimately create enormous value for the ecosystem, they also indicated that it would take time to realize these benefits. As the Digital Product Manager at Mærsk opined:

“*For Mærsk, I think it was a matter of saying, okay, creating that infrastructure for the industry is something we cannot put a figure on now, let’s just put in the money and then see more or less what happens*”.

A similar sentiment was expressed by the Head of Strategy and Operations at GTD Solution when asked about the risks facing TradeLens:

"*The risk is that we are not actually building something that delivers the value that we believe is available. So that would be the risk. That the investment we are making here is not something that has a realizable return [...] So, we've been very careful in making sure that people know that they're getting into a strategic engagement here.*"

In October 2020, after more than a year of testing and negotiations and considerable investments in new API capabilities, MSC and CMA CGM announced that they had completed full integration with TradeLens. Additionally, this signaled a shift in the governance configuration of TradeLens, as MSC and CMA CGM became TradeLens "foundation carriers" with a role of expanding the ecosystem and platform operations through the TradeLens Advisory Board, leveraging their existing customer relationships and serving as "trust anchors" (i.e., validator nodes) in the TradeLens blockchain network. Following a similar process, in June 2021, Hapag-Lloyd and Ocean Network Express (ONE) joined the group of TradeLens foundation carriers, which meant that the membership of the group rose to include five of the top six ocean carriers in the world, accounting for approximately 60 percent of the market share in the industry.

The CDIO of MSC also emphasized the role of critical mass in generating value from an industry-wide technology standard:

"*TradeLens, for me, has a long way to live up to INTTRA. Because digitization in the shipping industry is very, very slow. Believe me, I've been in this for 40 years. So I think we'll start seeing value when we reach critical mass. You can't change processes until you have critical mass. Otherwise, you're still running two or three parallel processes, and that's actually more expensive. So I think we need to reach that critical mass. It will probably take, I would say, probably two or three years.*"

These quotes imply that rather than seeing a shared information infrastructure as a means to create immediate returns, it should be seen as a foundation upon which the ecosystem actors can build new value-adding services and innovative solutions. Further, these findings indicate that the level of interest of relevant actors to support the standardization process is dynamic and may change over time as the initial solution is refined, initial outcomes are observed, and the tangible benefits of using the solution are publicized. Nonetheless, to aid the diffusion of the solution, Mærsk and IBM will likely need to demonstrate the TradeLens' value to ecosystem participants in more tangible terms. The Digital Product Manager at Mærsk outlined these issues:

"*Collaborations [with large partners/rivals] are the toughest ones to nail because often there have been discussions about what's in it for me? What do I get out of submitting my information and giving away my data?*"

Additionally, the two founding companies also need to carefully consider when they can start capturing rents from the platform to justify their investments since extracting revenue in the early stages might stall TradeLens' diffusion. As noted by the Digital Product Manager at Mærsk:

"*For a platform to succeed, you need to generate value before you generate revenue. And often, what we focus on is: "How do we get to the revenue as fast as possible?"But it's kind of contradicting for adoption if you want to look at how fast you can price it. Because the thing is… if it's either cheap or free at the beginning, that will drive adoption, but it would not create a lot of revenue. But if you start with a high bill, a lot of people won't be joining at all.*"

5.4. Reciprocal relation between trade-offs and changing dynamics

While we have so far presented the analysis of the three trade-offs separately, the data indicate a reciprocal relationship between them. INTTRA was created with high levels of inclusion but low levels of completeness. When certain carriers wanted to include additional features and make the platform more complete, the governance structure of INTTRA often created gridlock because other carriers with a proportionally lower share in the venture were unwilling to invest in these extensions. Thereby, greater inclusion hindered the ambitions to make the platform more complete. Additionally, the reluctance of ocean carriers to further invest in INTTRA also points to the relation with the investment/value capture trade-off since several ocean carriers considered that higher levels of completeness would not result in sufficient gains to justify the investment that would be necessary to achieve them. Moreover, member carriers were acutely aware that the gains generated by INTTRA would be disproportionately captured by Mærsk, which further increased their reluctance to fund proposed projects. Namely, Mærsk's ownership share in INTTRA grew from the initial 35 percent to 40 percent in 2003 to 65 percent in 2005 through 2010, when the majority of shares of INTTRA were sold to a capital fund[49]. Thus, high inclusion and uncertainty about who and to what extent would capture the potential benefits from increasing platform completeness prevented INTTRA's continued development and broader diffusion.

With TradeLens, the two core partners opted for higher levels of flexibility, which accelerated the decision-making process in the development phase, but ran into problems with diffusion. In order to accelerate platform adoption, TradeLens started to engage the larger ecosystem by involving industry actors in the decisions regarding platform completeness. The Vice President of Blockchain Solutions at IBM noted this ambition:

"Today, the actual building of the platform is all done by IBM. So, the entire development is done by my team. Going forward, what happens? We expect the Advisory Board to expand from the foundation carriers to a much broader community. In some sense, once the community is big enough, I'd feel much better because then the community will decide what it needs. That's the place I want to be, as opposed to a small number of players determining what goes in there."

Consequently, higher inclusion levels will influence TradeLens' completeness as the platform develops. However, the decisions on completeness may, in turn, be contingent on monetary considerations. As noted by the Digital Product Manager at Mærsk:

"I think right now it's more about driving the adoption and getting the agreement - this is the infrastructure we want to see. Until now, it was more a question of who is going to bear the cost… and funnily enough, no one wants to join that game. So IBM and Mærsk have been paying up until now. And now when you see the adoption is coming, suddenly everybody sees the opportunity of joining…for the future. No one wants to pitch in for the investment that has already gone into it. So how are the two companies going to get that investment back? Of course, that has to be reflected in the ownership structure."

These findings imply that the trade-offs are not only interrelated but that these interrelations exhibit a dynamic nature. The Digital Product Manager at Mærsk further emphasized the importance of adaptability:

[49] Sources: https://investor.maersk.com/static-files/62cac8e4-a87a-4ce8-9329-7789f2e27c05 and https://investor.maersk.com/system/files-encrypted/nasdaq_kms/assets/2015/10/14/0-39-15/maersk_annual_report_2009.pdf

"I think it's very much about getting everybody to realize there's value in the ecosystem and in the standardization. And then what happens afterward? Don't get fixed on it too early because it can go so many ways. If you have a good foundation, a lot of stuff is possible. If you start comparing that to other industries, other platforms, there is a lot that will happen over time."

6. Discussion

This section draws on our empirical findings to explore the factors influencing technology standardization efforts through collective action. Moreover, we discuss the dynamics involved in the standardization process and how these factors interrelate.

6.1. Collective action Trade-offs

Employing a process-based approach, we scrutinized standard development and diffusion phases concurrently and found that organizations involved in collaborative standardization efforts face three distinct yet highly interrelated trade-offs. In the INTTRA case, the development and diffusion of standardized bookings were handled by involving six major ocean carriers in a board-like structure with decision-making powers. This board of directors consisted of representatives of shareholders and served as a dedicated interface (Reuer and Devarakonda, 2016) to guide their interactions and address contingencies and potential conflicts as they arose. Somewhat differently, TradeLens was initiated with a focus on flexibility and speed in development. Findings by Markus et al. (2006) suggest that widespread adoption can prove difficult when user groups essential to the diffusion of a standard are excluded from its development. In response to concerns similar to those described by Markus et al. (2006), the two founding companies of TradeLens made several changes to the governance configuration over time. The initially proposed joint venture between Mærsk and IBM was abandoned, a separate business entity was established to run the platform (GTD solution), and an advisory board led by four competing ocean carriers was created. Importantly, however, this body does not have explicit decision-making authority.

Nevertheless, it represents a part of the "administrative apparatus" (Williamson, 1991) that serves as a conduit for information regarding technical design choices and orchestrates coordinated adaptation between the core partners among the foundational carriers and the other ecosystem members for further development and diffusion of the standard. The structure of such a collaboration is described here as semi-open due to duality in approach according to the group of participating actors. While the core alliance of standard-sponsors is limited to a small group of firms with homogeneous and aligned interests and is thus considered "closed", a much larger group of adopting partners is open in the sense that any firm can freely adopt the standard if they so choose (Keil, 2002; van de Kaa and de Bruijn, 2015). Hence, this organizational configuration aimed to address the trade-off between flexibility and inclusion in a structural manner by combining control advantages of a closed alliance consisting of a limited number of partners with a disproportionately high level of interest and resourcefulness (Marwell and Oliver, 1993), with the market diffusion advantages of mobilizing a broader group of standard adopters.

Such considerations exhibit strong interrelations with other delineated trade-offs. For example, the inclusion of a wide variety of stakeholders impacts the completeness of the standard, as numerous actors try to reconcile their internal requirements and advocate for either higher generalizability or higher completeness. Here, collective action serves to adjust the standard to both current and anticipated requirements of actors involved in the standardization effort. In turn, the adaptation of the standard attracts new members, further increasing the diversity and size of the adopter population (Foray, 1994). Relatedly, monetization decisions impact how complete the standard can realistically become, as the value from a more complete standard accrues to some participants more than others, making the latter less inclined to fund and promote the standard continuously.

A standardized solution generally accepted by a broad population of actors may come at the expense of the solution's completeness. Although a wide range of documentation flows through global supply chains, INTTRA was initially only concerned with standardizing shipping instructions. Consequently, using INTTRA did not require significant changes in legacy systems of adopting organizations, which simplified adoption and facilitated its initial diffusion. Interestingly, lower levels of completeness were also the reason why INTTRA's subsequent diffusion was hindered. In comparison, the decision-making in the development stage of TradeLens was uncomplicated and rapid owing to the governance model where Mærsk and IBM made decisions about technical design, rights, and liabilities based on their respective knowledge of the shipping industry and technological possibilities. On the other hand, adopting TradeLens requires more extensive adjustments in the participants' often heavily customized legacy systems, which hindered initial diffusion.

As a response, a decision was made to engage in strategic openness (Alexy et al., 2017), where the key aspects of governance and decision-making were maintained within the organizational arrangement between GTD Solution and IBM, while Mærsk's major industry rivals were involved in leading the industry advisory board. Consequently, TradeLens moved towards higher inclusion by partly surrendering control over the future direction of the standard. Higher inclusion, in turn, influences the completeness of TradeLens, as the decisions on its future development need to be aligned with other ecosystem participants (notably ocean carriers) for them to continue contributing to the standardization effort.

Additionally, technology standards need to allow for technological diversity and functional variety. As a result, addressing the collective action trade-offs in standardization can involve specifying an "incomplete" standard. One that preserves the advantages of variety by allowing actors to maintain a certain level of specificity in their legacy systems and introduces mechanisms designed to assist the ex-post inclusion of different interests and disparate specifications within a widely adopted standardized "framework" (Foray, 1994). Thereby, similar to results reported by Jain (2012), our findings suggest that collective action standardization involving committee-like structures and market forces works best when the key actors understand the limits of their influence and accordingly adopt a satisficing approach that involves moving forward with a workable solution acceptable to the relevant parties, rather than striving to achieve an "optimal" outcome where a perfect standard and complete control can be achieved. Our findings offer additional insights by suggesting that the governance of a standard-sponsoring alliance needs to evolve as the adoption of the standard increases, and new structures (i.e., the industry advisory board) may need to be introduced to represent the interests of the increased user population. While our findings do not definitively determine whether governance adaptations need to involve bodies with decision-making power (e.g., steering committees), the need for such adaptations over time, and the consequences of their absence, are evident in both examined cases.

Technology standards are only truly valuable when they diffuse widely, meaning that potential standard adopters face significant uncertainties about the costs, benefits, and risks related to standard adoption (Markus et al., 2006). Hence, organizations have little incentive to contribute to developing a standard without a clear indication of what value they could obtain from it. In the case of INTTRA, several ocean carriers funded the development of the platform because they believed a standard would improve their operational efficiencies enough to justify their initial investment. Due to these credible commitments (Williamson, 1983), initial diffusion among ocean carriers and large customers was straightforward. However, the governance structure of INTTRA prevented the "critical mass" of standard sponsors from translating their level of interest in the standard into actual contributions over time. This resulted in a sluggish process of wider diffusion, further constrained by the failure to improve the completeness of the standard that contributed to INTTRA's inability to generate technical extensions to the standard more in touch with the needs of a broader user base.

With TradeLens, the entire burden of monetary investments rested on Mærsk and IBM. While respondents from Mærsk and IBM indicated that this approach was chosen to develop the solution that will benefit the entire ecosystem more rapidly, it was precisely the exclusive ownership structure that halted the initial diffusion. As in the case of INTTRA, an important part of TradeLens' value proposition was significant operational efficiencies enabled by the standardized shared information infrastructure. Further monetization of TradeLens partly depends on charging for the use of the applications on its marketplace. This ambition relies on the premise that developing a timely, salient and adaptable standard is of critical importance for fostering value-creating industry cooperation. It also relies on a joint strategy of maintaining the existing ownership structure while relinquishing enough control over the future direction of the standard to facilitate willingness among industry actors to participate in identifying ways in which the solution can be modified to accommodate emergent needs. **Table 1** summarizes the trade-offs identified in the analysis.

	Standard development	**Standard diffusion**
Flexibility vs. Inclusion	A small number of actors involved in standard development allows for higher flexibility and speed in decision making because lower numbers of potentially competing interests need to be aligned ex-ante. Conversely, a large number of actors involved in standard development greatly exacerbates the problem of interest alignment, resulting in slower standard development.	A standard developed by a small group is more difficult to diffuse because the interests of the adopter population may not be represented in the proposed standard. In contrast, a standard developed by a large number of actors is easier to diffuse, as the standard already reflects their specific needs.

Generalizability vs. Completeness	More generalizable standards are easier to agree upon and develop. However, they could entail that different systems conform to the standard, yet fail to sufficiently interoperate with systems of other organizations that also conform. More complete standards, on the other hand, are more complex and more difficult to develop but ensure a higher level of interoperability.	Generalizable technical standards are better at promoting diffusion because of their relative simplicity and low requirements for modifications to adopters' legacy systems. More complete standards are more difficult to diffuse and generally require higher monetary and non-monetary investments.
Investment vs. Value Capture	Interest alignment and a clear value proposition will make it more likely for actors to invest in standard development and vice versa. Additionally, because technology standards are considered an inclusive collective good, any firm in a group is able to consume it, even if it has made disproportionately small contributions to its development. On the other hand, an organization that has a great interest in, and expects significant benefits from a collective good, will gain from making sure the good is provided, even if it has to bear the disproportionately high cost to do so (Marwell and Oliver, 1993; Olsen, 1965).	While a technology standard will readily diffuse among standard sponsors, the diffusion among other organizations depends on both the costs they need to incur to adopt it and the perceived future value resulting from adoption. However, the value of a technology standard may not be clear in the early stages of the standardization process. Additionally, because standards are only useful when widely adopted, organizations may be motivated to delay adoption until they are assured that others will adopt.

Table 1: Trade-offs involved in standardization efforts through collective action

Table 2 shows how INTTRA and TradeLens were positioned during the standard development and diffusion phases in terms of the delineated trade-offs.

	INTTRA	
	Standard Development	**Standard Diffusion**
Flexibility vs. Inclusion	Started by seven major ocean carriers. Because of the need to align the interests of involved carriers, the development was slow.	Initial diffusion was successful, backed by contributions by the "critical mass" of standard sponsors. The governance structure hindered subsequent diffusion.
Generalizability vs. Completeness	Standardized shipping instructions being sent between ocean carriers and (large) customers.	An incomplete/generalizable standard facilitated initial diffusion. Subsequent diffusion was impaired by the carriers' inability to reach an agreement regarding higher completeness (adding additional data fields and involving smaller customers).
Investment vs. Value Capture	Jointly developed and funded by seven major ocean carriers. Customers did not have to pay to use the platform. The principal value proposition was a simplified booking process and the associated cost reductions and operational efficiencies.	Because the initial users of the platform were its sponsors and large customers, early diffusion was straightforward. Broader diffusion, however, was impaired by the ambiguous value proposition for smaller customers and other shipping ecosystem members and the ownership/governance structure.

	TradeLens	
	Standard Development	**Standard Diffusion**
Flexibility vs. Inclusion	Development was initiated by a single ocean carrier (Mærsk) and a technology provider (IBM). Because of flexibility in decision-making, the development phase was mostly straightforward.	Diffusion proved difficult because other ocean carriers were not involved in the development and because the two key actors had full claim over TradeLens' IP rights. To help promote diffusion, the ownership and governance structures were changed, and an advisory board consisting of representatives of other ecosystem members was created.
Generalizability vs. Completeness	Standardizing a range of documents and involving a broad range of ecosystem members (e.g., Carriers, Ports, Terminals, Customs authorities, Freight Forwarders).	Because TradeLens is a more complete standard (both in terms of the number of documents it aims to standardize and in terms of actors it aims to connect), it is also more complex and difficult to diffuse. Adopting TradeLens requires investments in integration, change management, and user training.
Investment vs. Value Capture	Funded by Mærsk and IBM. Other carriers do not have to pay for using the platform but invest indirectly by contributing their data and/or leveraging business relationships to aid diffusion. The primary source of revenue comes from charging customers (exporters) for using the platform. Additionally, TradeLens promises to decrease costs and improve operational efficiencies for participants through enhanced information exchange.	Initial diffusion was complex because the concentrated ownership threatened that the platform would disproportionately benefit Mærsk alone. A third-party entity (GTD solution) was established to aid diffusion, and the TradeLens advisory board was introduced. Although other ocean carriers need to incur the cost of integration, they are not charged for using the platform. On the other hand, they are implicitly expected to help onboard additional participants.

Table 2: Trade-offs involved in standardization efforts through collective action

Consistent with assumptions of collective action theory (Marwell and Oliver, 1993), our analysis reveals that what matters crucially to the provision of a standard is the pattern of interrelations among the contributors in the "critical mass", not the relations among all actors in the wider group of parties that would benefit from successful standardization. For example, while the "critical mass" of organizations involved in both INTTRA and TradeLens consisted of a small number of actors with a high level of interest and the ability to make contributions of money, time, and other resources toward the standardization effort, the governance structure of INTTRA prevented actors in the “critical mass” from exerting influence proportional to their level of interest in standard provision.

On the other hand, the two core partners in TradeLens made continuous adaptions to the governance structure. Thereby, while partially relinquishing control over the direction in which the standard develops to industry competitors to aid diffusion, they nevertheless maintained decision-making authority, which kept the levels of both critical collective action factors high. Even though the solution INTTRA developed diffused relatively quickly among the large ocean carriers, the momentum of the drive towards industry standardization was eroded because the governance issues progressively reduced the willingness of key actors to contribute resources toward supporting the standardization process, even though their level of interest in its provision remained high. This finding points to the importance of maintaining high levels of interest in the standard provision and the willingness to commit resources to support the continuing standardization process among the “critical mass” of standard sponsors. Further, it suggests that moving beyond the development phase and successfully diffusing the solution requires a flexible approach. One that would allow for adaptive equilibrium seeking by maintaining consistency in the governance architecture within the “critical mass” of actors such that the levels of both critical collective factors remain high while at the same time engaging in strategic openness (Alexy et al., 2017) to incentivize adoption.

7. Implications, limitations, and conclusions

Although studies in technology standardization have recognized the importance of simultaneously analyzing the phases of standard development and diffusion (Markus et al., 2006) and employed a new process-based perspective (Botzem and Dobush, 2012; Wiegmann et al., 2017), which has documented the dynamic nature of standardization (Jain, 2012; Wiegmann et al., 2017), the literature provides few insights about the specific interactions involved in these processes (Wiegmann et al., 2017). Consequently, our understanding of the standardization process where involved actors may, at different times, play different roles, have varying levels of interest in the standard provision, and employ different strategies to drive standardization remains limited. Our study contributes to the emerging literature on technology standardization through collective action by providing insights into the reciprocal relationship between particular governance configurations and participating actors’ level of interest and willingness to contribute resources to the standardization effort. Further, we provide evidence that these relationships exhibit variability through standard development and diffusion stages, giving the standardization process its dynamic nature. We capture these insights in the three delineated collective action trade-offs (i.e., flexibility vs. inclusion, generalizability vs. completeness, and investment vs. value capture). The trade-offs encapsulate not only strategic responses to economic and technical exigencies of organizations with commercial interests at stake but also explain how standardization evolves through the interplay between factors that simultaneously drive the phases of standard development and diffusion and are, in turn, shaped by them. In other words, we offer insights into how market forces can be harnessed to collectively address an industry need in the absence of a body with decision-making and coercive authority.

Further, our findings offer tentative insights relevant to an emerging perspective in standardization research that goes beyond the archetypes of the committee, market, and government-driven standardization and instead argues that a multi-mode approach will become increasingly prevalent due to the complexity of modern technological systems and the wide variety of actors involved in standardization efforts (Wiegmann et al., 2017). For example, both INTTRA and TradeLens engaged in standardization through committee-like structures to foster cooperation (Wiegmann et al., 2017) while at the same time relying, albeit in different ways, on the broader market to both refine and promulgate the standards.

These arguments further point to the implications of our findings for managerial decision-making in practice. Technological innovations and competitive forces have steadily reduced the costs of transacting beyond the boundaries of the firm, which has increased the value of inter-organizational collaboration by enabling firms with unique capabilities to combine their resources and drive innovation and value creation. This has further led to the development of large and complex systems (Constantinides and Barrett, 2015; Saadatmand et al., 2019), which critically rely on standards (Wiegmann et al., 2017). A key insight of our study is that managing such complex projects involves crucial trade-offs, where managerial, technical design, and governance decisions have both feed-forward and feed-back effects. Additionally, we highlight the importance of strategically engaging and re-engaging with different groups of industry actors that have a stake in the outcome of the standardization process. We describe how organizations need to strike a balance between maintaining the ability to exert decision-making influence proportional to their interest in standard provision and remaining attentive to market needs by introducing governance mechanisms that more directly engage other industry participants, collaborators, and competitors alike.

7.1. Limitations

This study is subject to several limitations. Firstly, our study is limited to examining the collective action of actors in two standardization efforts based on specific technological solutions within the shipping industry. Therefore, it remains an open question whether our findings can generalize more widely to IT product standardization besides inter-organizational information exchange systems (Rosenkopf et al., 2001; Uotila et al., 2017) or other types of organizational collective action such as the development of open-source solutions (Witzel et al., 2006). However, we do achieve generalization from empirical description to theory (Saadatmand et al., 2019) by employing a process approach that entailed an extensive analysis of existing standardization literature, both general and more specific to technology standardization, which has informed our analysis of the empirical material and vice versa. Accordingly, our results could be particularly useful for researchers seeking to understand complex industry-wide standardization and for practitioners in charge of managing collaborative efforts where technical and organizational solutions aimed at supporting mutually beneficial collective action need to be designed and dynamically adapted in a contested and competitive environment.

Secondly, we have collected data on two cases that exhibit some notable differences. While the primary data relating to INTTRA originate from key decision-makers with extensive knowledge of the relevant events that took place, and the processes that unfolded, they nevertheless represent respondents' retrospective accounts. Additionally, although our empirical approach entailed leveraging the knowledge of key decision-makers to gather insights concerning TradeLens over a three-year period since its inception, TradeLens is still an ongoing project. It can thus be considered a "standard in the making". Taken together, the data's diversity and sheer volume can raise concerns about the completeness and accuracy of the record (Saadatmand et al., 2019), especially in the case of INTTRA, where retrospective accounts from interviews were relied upon to a high degree. To address these concerns, we have applied several techniques, including repeated interviews with key actors to corroborate claims by other respondents and applying different lenses to our analysis (e.g., considering interactions between trade-offs within and across the phases of standard development and diffusion both from a theoretical and an empirical perspective).

We further recognize that it is likely that the collective action trade-offs we outline in this paper do not cover the full extent of factors that influence technology standardization processes. One of these factors could, for example, be the role of the national governments. Because of the global nature of the shipping industry, there will likely be political and legal tensions that influence technology standardization efforts, particularly because an industry-wide solution could imply the exchange of commercially and politically sensitive data. Finally, governmental authorities and standard-setting bodies, such as ISO or DCSA, will potentially influence the continuing development of the standardization processes we analyze in this paper. A way to "sidestep conflict" in a continuing standardization process involving industry rivals could involve borrowing and adapting specifications developed elsewhere, rather than creating extensions and new solutions from scratch (Jain, 2012).

Despite their limitations, observations from this study could provide important insights to organizations engaging in technology standardization. Furthermore, we do not see the possibility that our findings do not generalize beyond technology standardization processes in the shipping industry as an acute flaw of our study. Global supply chains that critically rely on container shipping play an essential role in economic growth, and overall human development and welfare worldwide, especially in the wake of the Covid-19 pandemic. The shipping industry accounts for the delivery of almost 90% of all goods (Klose, 2005), which were valued at close to $18 trillion in 2017[50]. Explicating standardization processes in container shipping is therefore arguably of great practical relevance.

Furthermore, future standardization studies could apply the three delineated trade-offs as analytical tools to explore technology standardization through collective action in other industries involving numerous actors with heterogeneous interests. Researchers could also continue following the TradeLens case as it develops further, and evaluate the impacts of each of the proposed trade-offs on the platform diffusion and continued development, as well as shifting dynamics within each trade-off and their respective effects. Finally, future research could explore how factors such as power, reputation, and credibility of involved actors influence the trade-offs delineated in our analysis and their implications for the standardization process.

7.2. Conclusions

Standards play a crucial role in supporting technological developments that enable ever more complex and innovative forms of collaboration across organizational boundaries. This study provides an in-depth exploration of the dynamics and factors that unfold and interrelate within a process of

[50] "World Trade Statistical Review 2018", World Trade Organization, available at: https://www.wto.org/english/res_e/statis_e/wts2018_e/wts2018_e.pdf

technology standardization. In doing so, we indicate how actors can overcome collective action challenges and delineate three novel collective action trade-offs. We further propose these trade-offs as analytical tools for investigating how technology standardization through collective action on an industry level arises and evolves. Our study extends the literature on technology standardization in several ways.

Firstly, we take a process perspective to gain a more nuanced understanding of how the interests of actors involved in standardization efforts evolve and interact over time. In other words, rather than approaching technology standard development and diffusion as problems of resource allocation based on heterogeneous interests (Monge et al., 1998; Markus et al., 2006), we seek to explicate the dynamics of the technology standardization process as they unfold. We suggest that the interactions among the "critical mass" of standard supporters and the governance choices that either constrain or enable the engagement with a wider population of standard adopters ultimately determine the direction in which a standardization process develops.

Secondly, we consider not only the heterogeneity of interests among involved actors (Markus et al., 2006) but also the extent of interest in the standard as a collective good, further refining our understanding of how technology standards emerge and evolve. We show that it is not essential that every party interested in standard provision participates in governance or decision-making. Inspired by theoretical insights of collective action theory (Olson, 1965), this finding suggests that an industry standard is an inclusive collective good where the benefits accrued by non-cooperators are not matched by corresponding losses to the cooperators. This insight contributes to the existing technology standardization literature by providing evidence that questions the importance of the "free-rider" problem that is often discussed by standardization scholars (e.g., Kindlberger, 1983, Markus et al., 2006; Weiss and Cargill, 1992). More broadly, our study highlights the need for an improved understanding of technology standardization as a dynamic process, which is proving to be increasingly important in the contemporary business environment. We hope future research can benefit from our insights and test them in other empirical settings.

References

Alexy, O., J., West, H., Klapper, and M. Reitzig. 2017. Surrendering control to gain advantage: Reconciling openness and the resource-based view of the firm. *Strategic Management Journal* 39(6): 1704-1727.

Allison, I. 2018. IBM and Mærsk Struggle to Sign Partners to Shipping Blockchain. Available at: https://www.coindesk.com/ibm-blockchain-Mærsk-shipping-struggling

Anderson, J.E., van Wincoop, E. 2004. Trade Costs. *Journal of Economic Literature* 42(3):691-751.

Axelrod, R., W., Mitchell, R. E. Thomas, D. S. Bennett, and E. Bruderer. 1995. Coalition formation in standard-setting alliances. *Management Science* 41:1493-1508.

Bala, H., and V. Venkatesh. 2007. Assimilation of Interorganizational Business Process Standards. *Information Systems Research* 18 (3):340-362.

Barua, A., and B. Lee. 1997. An economic analysis of the introduction of an electronic data interchange system. *Information Systems Research* 8(4):398-422.

Braun, V., and V. Clarke. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3(2):77-101.

Browning, L.D., J. M. Beyer, and J.C. Shelter. 1995. Building Cooperation in a Competitive Industry: SEMATECH and the Semiconductor Industry. *The Academy of Management Journal* 38(1):113-151.

Cargill, C.F. 1989. Information Technology Standardization: Theory, Process, and Organizations. Digital Press, Bedford, MA.

Cargill, C.F. 1997. Open systems standardization: A business approach. Prentice Hall.

Cargill, C.F. 2002. Uncommon Commonality: A Quest for Unity in Standardization. In Sherrie Bolin, ed., The Standards Edge, Ann Arbor, MI: Bolin Communications 29–39.

Chiao, B., J. Lerner, and J. Tirole. 2007. The rules of standard-setting organizations: an empirical analysis. *The RAND Journal of Economics* 38(4):905-930.

Collis, J., Hussey, R. 2013. Business Research: Practical Guide for Undergraduate and Postgraduate Students (4th ed.). Basingstoke: Palgrave Macmillan.

Constantinides, P., and M. Barrett. 2015. Information Infrastructure Development and Governance as Collective Action. *Information Systems Research* 26(1):40-56.

Dattée, B., O. Alexy, and E. Autio. 2018. Maneuvering in Poor Visibility: How Firms Play the Ecosystem Game when Uncertainty is High. *Academy of Management Journal* 61(2):466-498.

David, P.A. 1985. Clio and the economics of QWERTY. *American Economic Review* 75(2):332–337.

David, P.A. 1995. Standardization Policies for Network Technologies: The Flux Between Freedom and Order Revisited in Standards, Innovation, and Competitiveness: The Politics and Economics of Standards in Natural and Technical Environments, R. Hawkins, R. Mansell, J Skea (eds.), Science Policy Research Unit, University of Sussex.

David, P.A., and S. Greenstein. 1990. The Economics Of Compatibility Standards: An Introduction To Recent Research. *Economics of Innovation and New Technology* 1(1-2):3-41.

Farrell, J., and G. Saloner. 1985. Standardization, compatibility, and innovation. *The RAND Journal of Economics* 16:70-83.

Farrell, J., and G. Saloner. 1988. Coordination Through Committees and Markets. *The RAND Journal of Economics* 19(2):235-252.

Farrell, J., and C. Shapiro. 1992. Standard Setting in High-Definition Television. Brookings Papers on Economic Activity: Microeconomics:1–77.

Foray, D. 1994. Users, Standards and the Economics of Coalitions and Committee. *Information Economics and Policy* 6:269-293.

Gioia, D.A., K. G. Corley, and A. L. Hamilton. 2013. Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods* 16(1):15-31.

Glaser, B.G., and A. L. Strauss. 2017. Discovery of grounded theory: Strategies for qualitative research. Routledge.

Greenstein, S. 1992. Invisible Hands and Visible Advisors: An Economic Interpretation of Standardization. *Journal of the American Society for Information Science* 43(8):538-549.

Hardin, R. 1982. Collective Action. RFF Press.

Jensen, T., J. Hedman, and S. Henningsson. 2019. How TradeLens Delivers Business Value With Blockchain Technology. *MIS Quarterly Executive* 18(4):221-243.

Jain, S. 2012. Pragmatic agency in technology standards setting: The case of Ethernet. *Research Policy* 41(9):1643-1654.

Jovanović, M., D. Sjödin, and V. Parida. 2021. Co-evolution of platform architecture, platform services, and platform governance: Expanding the platform value of industrial digital platforms. *Technovation*:102218.

Katz, M.L., and C. Shapiro. 1985. Network externalities, competition, and compatibility. *American Economic Review* 75:424-440.

Keil, T. 2002. De-facto standardization through alliances: Lessons from Bluetooth. *Telecommunications Policy* 26:205–213.

Klein, R., A. Rai, and D. W. Straub. 2007. Competitive and Cooperative Positioning in Supply Chain Logistics Relationships. *Decision Sciences* 38(4):611-646.

Klose, A. 2015. The Container Principle: How a Box Changes the Way We Think. MIT Press.

Kindleberger, C. P. 1983. Standards as Public, Collective and Private Goods. *Kyklos* 36:377-396.

Kollock, P. 1998. Social Dilemmas: The Anatomy of Cooperation. *Annual Review of Sociology* 24:183-214.

Kostić, N., and T. Sedej. 2022. Blockchain technology, inter-organizational relationships and management accounting: A synthesis and a research agenda. *Accounting Horizons* (Forthcoming).

Leiponen, A.E. 2008. Competing Through Cooperation: The Organization of Standard Setting in Wireless Telecommunication. *Management Science* 54(11):1904-1919.

Markus, M.L., C. W. Steinfield, R. T. Wigand, R.T., and G. Minton. 2006. Industry-Wide Information Systems Standardization as Collective Action: The Case of the U.S. Residential Mortgage Industry. *MIS Quarterly* 30:439-465.

Marwell, G., and P. Oliver, P. 1993. The Critical Mass in Collective Action: A Micro-Social Theory. Cambridge University Press.

Miles, M.B., and A. M. Huberman. 1994. Qualitative Data Analysis (2nd ed.). London: Sage.

Miller, D.C., and N. J. Salkind. 2002. Handbook of research design and social measurement. Sage.

Monge, P.R., J. Fulk, M. E. Kalman, A. J. Flanagin, C. Parnassa, and S. Rumsey. 1998. Production of Collective Action in Alliance-Based Interorganizational Communication and Information Systems. *Organization Science* 9(3):255-433.

Narayanan, V.K., and T. Chen, T. 2012. Research on technology standards: Accomplishment and challenges. *Research Policy* 41(8):1375-1406.

Olson, M. 1965. The Logic of Collective Action: Public goods and the Theory of Groups. Harvard University Press, Boston, 1965.

Outila, J., T. Keil, and M. Maula. 2017. Supply-Side Network Effects and the Development of Information Technology Standards. *MIS Quarterly* 41(4).

Reuer, J., and S. Devarakonda. 2016. Mechanisms of Hybrid Governance: Administrative Committees in Non-Equity Alliances. *Academy of Management Journal* 59(2):510-533.

Rosenkopf, L., A. Metiu, A., and P. G. Varghese. 2001. From the Bottom Up? Technical Committee Activity and Alliance Formation. *Administrative Science Quarterly* 46(4):748-772.

Saadatmand, F., R. Lindgren, and U. Schultze. 2019. Configurations of platform organizations: Implications for complementor engagement. *Research Policy* 48(8).

Schloetzer, J.D. 2012. Process Integration and Information Sharing in Supply Chains. *The Accounting Review* 87(3):1005-1032.

Simcoe, T. 2012. Standard Setting Committees: Consensus Governance for Shared Technology Platforms. *American Economic Review* 102(1):305-36.

Steinfield, C., M. L. Markus, and R. T. Wigand. 2011. Through a glass clearly: Standards, architecture, and process transparency in global supply chains. *Journal of Management Information Systems* 28(2):75-108.

Strauss, A., and J. Corbin. 1990. Basics of qualitative research. Sage publications.

Tassey, G. 2000. Standardization in technology-based markets. *Research Policy* 29:587-602.

Thomas, L. D. W., and P. Ritala. 2022. Ecosystem Legitimacy Emergence: A Collective Action View. *Journal of Management* 48(3):515-541.

Van de Kaa, G., and H. de Bruijn. 2015. Platforms and incentives for consensus building on complex ICT systems: The development of WiFi. *Telecommunications Policy* 39(7):580-589.

Van den Ende, J., G. van de Kaa, S. den Uijl, and H. J. de Vries. 2012. The Paradox of Standard Flexibility: The Effects of Co-evolution between Standard and Interorganizational Network. *Organization Studies* 33(5-6):705-736.

Voorspuij, J., and H. Becha. 2021. Digitalisation in Maritime Regional and Global Supply Chains. In: Maritime Informatics. Eds: Lind, M., Michaelides, M., Ward, R., Watson, R. Th. Springer. https://doi.org/10.1007/978-3-030-50892-0

Wade, J. 1995. Dynamics of organizational communities and technological bandwagons: an empirical investigation of community evolution in the microprocessor market. *Strategic Management Journal* 16:111–133.

Weiss, M., and C., Cargill. 1992. Consortia in the standards development process. *Journal of the American Society for Information Science* 43(8):559-565.

Weitzel, T., D. Beimborn, and W. Koenig. 2006. A Unified Economic Model of Standard Diffusion: The Impact of Standardization Cost, Network Effects, and Network Topology. *MIS Quarterly* 30(Special Issue on Standard Making):489-514.

West, J. 2006. The Economic Realities of Open Standards: Black, White, and Many Shades of Gray. in Standards and Public Policy, S. Greenstein and V. Stango (eds.), Cambridge University Press.

Wiegmann, P.M., H. J. de Vries, and K. Blind, K. 2017. Multi-mode standardization: A critical review and a research agenda. *Research Policy* 46(8):1370-1386.

Williamson, O.E. 1991. Comparative Economic Organization: The Analysis of Discrete Structural Alternatives. *Administrative Science Quarterly* 36(2):269-296.

Williamson, O.E. 1983. Credible Commitments: Using Hostages to Support Exchange. *The American Economic Review* 73(4):519-540.

World Trade Organization. 2018. World Trade Statistical Review 2018. Available at: https://www.wto.org/english/res_e/statis_e/wts2018_e/wts2018_e.pdf

Yin, R.K. 2009. Case study research: Design and methods (5th ed.). Thousand Oaks, CA: SAGE

Zhao K., M. Xia, and M. J. Shaw. 2011. What Motivates Firms to Contribute to Consortium-Based E-Business Standardization? *Journal of Management Information Systems* 28(2):305-334.

Zhao, K., and M. Xia, M. 2014. Forming Interoperability Through Interorganizational Systems Standards. *Journal of Management Information Systems* 30(4):269-298.

Zhu, K., K. L. Kraemer, V. Gurbaxani, and S. X. Xu. 2006. Migration to Open-Standard Interorganizational Systems: Network Effects, Switching Costs, and Path Dependency. *MIS Quarterly* 30: 515-539.

Appendices

Appendix A: Overview of conducted interviews

Column labeled “Case” indicates which of the two analyzed cases was the focal point of a particular interview. Whenever possible, we have selected interviewees that were involved in both projects.

#	Date	Type	Position	Company	Case	Location
1	02.05.2018.	Interview	Digital product manager	Mærsk	TradeLens	Case site (Mærsk)
2	24.05.2018.	Interview	Lead IT architect	GTD/TradeLens	TradeLens	Case site (GTD/TradeLens)
3	14.06.2018.	Interview	Special consultant/Chief consultant	Ministry of Industry, Business, and Financial Affairs	TradeLens	Ministry of Industry, Business, and Financial Affairs
4	03.07.2018.	Interview	Digital product manager	Mærsk	TradeLens/INTTRA	Case site (Mærsk)
5	14.03.2019.	Interview	Digital product manager	Mærsk	TradeLens/INTTRA	Case site (Mærsk)
6	04.07.2019.	Interview	Global Head of Integration	APM Terminals	TradeLens/INTTRA	Case site (Mærsk)
7	10.10.2019.	Interview	CEO, Partner (SeaIntelligence Consulting), Former Mærsk representative (INTTRA)	SeaIntelligence Consulting/INTTRA	INTTRA/TradeLens	SeaIntelligence Consulting
8	21.10.2019.	Interview	Digital product manager	Mærsk	TradeLens	Case site (Mærsk)
9	30.03.2020.	Interview	Digital product manager	Mærsk	TradeLens/INTTRA	Online/Zoom
10	31.03.2020.	Interview	Head of Strategy and Operations	GTD/TradeLens	TradeLens	Online/Zoom
11	20.05.2020.	Interview	CDIO (MSC); Chairman (DCSA)/ Former member of board of directors (INTTRA)	MSC/DCSA/INTTRA	TradeLens/INTTRA	Online/Zoom
12	26.05.2020.	Interview	Project (Stream) Lead at the Global International team	Anheuser-Busch InBev	TradeLens/INTTRA	Online/Zoom
13	26.05.2020.	Interview	Vice President, Blockchain Solutions	IBM	TradeLens	Online/Zoom
14	03.06.2020.	Interview	Sloan Distinguished Professor of Management	MIT Sloan	Technology standardization general	Online/Zoom

15	10.06.2020.	Interview	President/CEO	Global Container Terminals Inc.	TradeLens	Online/Zoom
16	07.07.2020.	Interview	Various departments	Pacific International Lines	TradeLens	E-mail
17	03.09.2020.	Interview	CTO	Youredi	TradeLens	Online/Zoom
18	09.09.2020.	Interview	CIO	YILPORT holding	TradeLens	Online/Zoom
19	27.05.2021.	Interview	CIO	International Container Terminal Services, Inc.	TradeLens	Online/Zoom

Appendix B: Overview of conferences and webinars

#	Date	Type	Title	Organizer	Location
1	04.11.2017.	Conference participation	Nordic Blockchain conference	ITU Copenhagen	ITU Copenhagen
2	18.04.2018.	Conference participation	Blockchain conference and exhibition	Blockchain Expo World Series	Olympia London
3	18.6.2019 - 20.6.2019.	Conference participation	TOC Europe	TOC Events Worldwide	Ahoy, Rotterdam
4	11.11.2019.	Conference participation	SHIP TECH: Conference on the future of shipping	ShippingWatch/Relevent	Copenhagen
5	19.02.2020.	Webinar	Learning about DCSA's Track & Trace standards	DCSA	Online
6	12.05.2020.	Webinar	Digitalization and data standardization: time for the maritime industry to act	Maritime Optimization and Communications	Online
7	26.05.2020.	Webinar	Adjusting to the 'New' New Normal: The Impact of COVID-19	TOC Events Worldwide	Online
8	09.06.2020.	Webinar	Accelerating Digitalization: The role of start-up tech in post-COVID-19 supply chains	TOC Events Worldwide	Online
9	09.06.2020.	Webinar	Advancing Global Trade with Blockchain	IBM Blockchain	Online
10	03.07.2020.	Webinar	Where next for global shipping?	CBS Executive MBA in Shipping and Logistics	Online
11	14.07.2020.	Webinar	Global Overview of the Container Shipping Market	Intermodal Digital Insights	Online
12	15.07.2020.	Webinar	Global Smart Container Forum	Intermodal Digital Insights	Online
13	05.08.2020.	Webinar	An electronic bill of lading, considered the holy grail of the maritime industry	IBM Blockchain/TradeLens	Online
14	12.08.2020.	Webinar	How 3PLs and FFWs move from linear logistics to a platform business model	IBM Blockchain/TradeLens	Online

15	19.08.2020.	Webinar	BiTA + TradeLens: Alignment & Opportunities Moving Forward	FreightWaves	Online
16	16.12.2020.	Webinar	Youredi Now Offering Expert Services for Shippers Connecting to TradeLens	IBM Blockchain	Online
17	17.02.2021.	Webinar	The future for ship-shore community data sharing - a public highway or individual toll roads?	International Association of Ports and Harbors	Online
18	24.02.2021.	Webinar	The 4th Industrial Revolution in Ports. How the Terminal Industry is Setting the Standards	TOC Digital	Online
19	25.02.2021-03.03.2021.	Conference participation	TPM21: The premier conference for the trans-Pacific and global container shipping and logistics community	Journal of Commerce and IHS Markit	Online
20	17.03.2021.	Conference participation	Global Trade and Blockchain Forum – Accelerating Digitalization Through DLT	World Trade Organization and International Chamber of Commerce	Online
21	21.04.2021.	Webinar	Digital Transformation	TOC Digital and TOC Asia	Online
22	24.04.2021.	Webinar	One-to-One Conversation with CMA CGM	TOC Asia	Online
23	31.05-18.06.2021.	Conference participation	TOC Global Showcase	TOC Digital	Online
24	21.06-25.06.2021.	Conference participation	IAPH World Ports Conference 2021	International Association of Ports and Harbors	Online

Appendix C: Overview of the secondary data sources

Outlet	Webpage
INTTRA Webpage	https://www.inttra.com/
E2Open	https://www.e2open.com/
TradeLens webpage	https://www.tradelens.com/
TradeLens blog	https://www.tradelens.com/blog
TradeLens press releases	https://www.tradelens.com/blog/all-press-releases
TradeLens documentation	https://docs.tradelens.com/
GTD Solution webpage	https://www.gtdsolution.com/
Digital Container Shipping Association (DCSA)	https://dcsa.org/
JOC.com (Container shipping and trade news and analysis)	https://www.joc.com/
Coindesk	https://www.coindesk.com/
Ledger Insights	https://www.ledgerinsights.com/
LinkedIn posts	https://www.linkedin.com/
Twitter Posts	https://twitter.com/
IBM Blockchain	https://www.ibm.com/blockchain
Coin Telegraph	https://cointelegraph.com/
The Loadstar	https://theloadstar.com/
Container news	https://container-news.com/
SeaIntelligence consulting	https://www.seaintelligence-consulting.com/
Supplychain dive	https://www.supplychaindive.com/
Global Trade review	https://www.gtreview.com/
Globe newswire	https://www.globenewswire.com/en
Logistics Middle East	https://www.logisticsmiddleeast.com/
Seatrade Maritime News	https://www.seatrade-maritime.com/
Port Technology	https://www.porttechnology.org/
Express Computer	https://www.expresscomputer.in/
Container Management	https://container-mag.com/
The Maritime Executive	https://www.maritime-executive.com/
BTC Manager	https://btcmanager.com/
PR Newswire	https://www.prnewswire.com/
Splash247.com	https://splash247.com/
Business Blockchain HQ	https://businessblockchainhq.com/
Market Research Reports	https://www.marketresearchreports.com/maritime
Harvard Business Review	https://hbr.org/
MIT Technology Review	https://www.technologyreview.com/
The National Law Review	https://www.natlawreview.com/

Paper 3: Digital Infrastructure Development and Governance in Maritime Trade: The Role of Blockchain Technology and Standardization

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Abstract

Digital infrastructures enable the delivery of information-based services by providing a technical and organizational foundation for transacting and system integration. The development of digital infrastructure involves significant governance challenges, especially when its scope encompasses an increasing number of stakeholders and systems. Yet, there is a clear gap in our understanding of how the development of digital infrastructure can be governed in an inter-organizational environment and on a global level. This study examines the efforts to digitize the bill of lading, a key trade document. The analysis of rich qualitative data reveals three elements that were crucial in the development of digital infrastructure to support electronic bill of lading proliferation: (1) technology architecture, (2) technology interoperability, and (3) legal certainty. A polycentric governance theory lens is applied to identify novel and specific governance mechanisms and governing units that collectively form a nested governance configuration across a broad network of stakeholders operating at different levels.

1. Introduction

One of the most enduring ideas in research on information systems and their effects on organizations is the notion that introducing a new IT-based information system improves the effectiveness with which an enterprise can be managed (Nicolaou et al., 2011; Henfridsson and Bygstad, 2013). Yet, as information systems become interconnected, new interdependencies are introduced, and organizations face significant challenges in governing a complex architecture[51] of systems and technologies that are often introduced over an extended period of time and for varying purposes (Henfridsson and Bygstad, 2013; Hanseth and Rodon, 2021). Looking beyond the scope of singular systems, a growing body of literature has adopted the notion of digital infrastructure as a way of conceptualizing the interconnected networks that enable locally controlled and maintained systems to interoperate and interact more or less seamlessly (Edwards et al., 2007; Henfridsson and Bygstad, 2013). As such, they help to integrate heterogeneous information systems (Sahay et al., 2009; Tilson et al., 2010; Saadatmand et al., 2019), collect, store and make data available across those systems (Constantinides et al., 2018), and govern collaboration between partners (Malhotra et al., 2007; Andersson et al., 2008). Digital infrastructures can support or enable interconnectedness of systems within corporate entities but also do so in inter-organizational settings on a national, regional, or even a global level as they have no strict boundaries or a fixed set of functions (Tilson et al., 2010; Fürstenau et al., 2019).

A number of studies invoke the idea of tensions as a conceptual lens for understanding digital infrastructure development and evolution. For example, existing literature has highlighted a persistent tension between the "local" and the "global". Here, a tension exists between the need for standardization that would allow the digital infrastructure to span numerous organizations and the simultaneous need for it to adapt to "local" contexts, which both enables and constrains its development (Holland and Monteiro, 2002; Edwards et al., 2007; Hanseth and Lyytinen, 2010; Scott and Orlikowski, 2021). Similarly, researchers have noted a tension between dynamic flexibility and stability underlying the mechanisms that facilitate digital infrastructure development and evolution (Hanseth et al., 1996; Hanseth and Lyytinen, 2010; Tilson et al., 2010; Fürstenau et al., 2019). These tensions arise across layers of systems and processes and multiple actors such as developers, users,

[51] In information systems research architecture refers to the digital infrastructure's technical components (e.g., network devices, databases, software applications, APIs), the overarching structure and properties of the relationships among the components, their functions, and how they interact to provide the overall functionality of the system (Tiwana and Konsynski, 2010; Rodon and Silva, 2015; Hanseth and Rodon, 2021).

and regulators, making digital infrastructures difficult to govern[52] (Henfridsson and Bygstad, 2013; Constantinides and Barrett, 2015).

Several recent studies have adopted a hybrid approach that expands on the traditional top-down (Weill and Ross, 2004) and bottom-up (Sahay et al., 2009; Hanseth and Lyytinen, 2010) views on governing digital infrastructure development. In these studies, this process is considered a combination of bottom-up organic growth and adaptation and top-down managerial influences in single-organization run infrastructures in the airline (Henfridsson and Bygstad, 2013), industrial manufacturing (Zimmer and Niemimaa, 2020), and power grid industries (Osmundsen and Bygstad, 2021). This, however, leaves open questions about the governance of digital infrastructure development in inter-organizational settings. Furthermore, although some studies on digital infrastructures are situated in a global context, those studies are either not explicitly focused on digital infrastructure development (e.g., Scott and Orlikowski, 2021) or take a perspective of a single organization operating globally (e.g., Rolland and Monteiro, 2002). Similarly, studies in this research stream that involve multiple stakeholders focus on regional or national outcomes (e.g., Braa et al., 2007; Henfridsson and Bygstad, 2013; Constantinides and Barrett, 2015; Koutsikouri et al., 2018). Scott et al. (2017) studied the long-term effects of the adoption of SWIFT, a network-based digital infrastructure and set of standards for global interbank communication, and noted that the implications of the use of such systems for the global financial system have been fundamental. Namely, global digital infrastructures not only transform transaction processes but are also associated with shifting organizational boundaries (Scott and Walsham, 1998) and globalization of financial markets (Weber, 1994; Scott et al., 2017). Ozcan and Santos (2015) investigated the failed attempt at developing a global architecture for mobile payments and documented different dynamics at the global and the national level, where the country-level attempts were not sufficient to resolve disagreements between actors operating on a global level. Therefore, there is still a lack of understanding of how digital infrastructure development is governed in an inter-organizational environment with a global scope.

An emerging research stream treats technical architecture and governance as intrinsically related and analyzes how they interact to affect digital infrastructure development and evolution outcomes (e.g., Tiwana et al., 2010; Henfridsson and Bygstad, 2013; Rodon and Silva, 2015; Hanseth and Rodon, 2021). For example, layered modular architecture was found to be beneficial for the initial design

[52] In this context, governance broadly refers to the set of structures and mechanisms determining how decisions about digital infrastructures are made (Hanseth and Rodon, 2021).

(Hanseth and Lyytinen, 2010) and the evolution of digital infrastructure (Henfridsson and Bygstad, 2013), as it allows for accommodation of the growing need for openness and heterogeneity as the digital infrastructure develops. Relatedly, Tiwana and Konsynski (2010) demonstrate the importance of a certain level of rigidity in governing (e.g., by introducing standards) lower architectural levels (e.g., data structure and application interfaces) to achieve flexibility at higher levels (Star and Ruhleder, 1996). In recent years, research on digital infrastructures (e.g., Constantinides et al., 2018; Andersen and Bogusz, 2019) has examined blockchain technology as a novel architecture that allows independent organizations to transact, maintain records, and share data in a decentralized manner (Yermack, 2017; Ziolkowski et al., 2020; Kostić and Sedej, 2022). Concurrently, scholarly understanding of blockchain has evolved from being an enabler of cryptocurrencies (e.g., Bitcoin, Ethereum) to being a layered and modular (Xu et al., 2017; Rauchs et al., 2018; Zachariadis et al., 2019) architectural configuration that holds promise to reduce transaction hazards and improve production and logistics networks in global supply chains (Andersen and Bogusz, 2019; Chod et al., 2020; Babich and Hilary, 2020). Researchers have theorized about the potential impact of blockchain technology at the "intersection of IT and organizational design" (Tilson et al., 2010, quoted in Lumineau et al., 2021), namely on the governance of large-scale economic activities (Beck et al., 2018) and inter-organizational collaborations (Lumineau et al., 2021; Kostić and Sedej, 2022). However, these valuable initial conceptual contributions remain wedded to assumptions of reduced transaction costs and coordination problems without providing supporting empirical evidence, mainly due to the limited level of blockchain adoption in most enterprise settings. At the same time, we know little about issues related to the interaction of blockchain with the existing installed base. Therefore, our understanding of how blockchain as an "architectural innovation" (Lumineau et al., 2021, p.503) plays a role in large-scale digital infrastructure development remains embryonic.

Accordingly, this study poses the following research question: How can digital infrastructure development in a heterogeneous inter-organizational environment on a global level be governed?

This study builds on the literature that ascribes to a hybrid view of digital infrastructure development and leverages theory on polycentric governance (Ostrom et al., 1961; Ostrom 1990; 2010a) to make sense of complex dynamics involved in governing the development of digital infrastructure to support the digitization of crucial documentation in maritime trade. The polycentric governance lens has roots in collective action research (Ostrom, 1990). It connotes several "localized" centers of decision making formally independent of each other with the ability or mandate to create norms (e.g., standards) within specific domains while retaining the ability to engage in cooperative undertakings and having recourse to mechanisms of conflict resolution that allow them to function as a "system" capable of addressing global issues (Ostrom et al., 1961; Ostrom, 2010a).

The study documents the development of a global infrastructure intended to enable the digitization of the bill of lading (BL)[53], a crucial trade document, and related information flows. While there is no single definition of an electronic bill of lading (eBL), in broad terms, it is understood as an electronic record that has functional equivalence[54] to an original paper BL (Law Commission of England and Wales, 2021). An eBL, therefore, is not simply an electronic version of a paper BL; rather, it represents a combination of technology and a legal framework that can replicate the functions of a traditional tangible BL (DiMatteo, 2017).

The complex effort of developing a global infrastructure to support eBLs that is the focus of this study involved the relevant actors in the container shipping industry and the broader trade ecosystem (e.g., cross-industry bodies promoting free trade, financial institutions, international regulatory and legislative bodies) involved in trade transactions. It unfolded at a time when the COVID-19 pandemic created unprecedented incentives for organizations and authorities to look for ways to develop a universally accepted digital alternative to BLs, as they faced the impossibility of moving physical documents through and between most countries in the world. This additionally converged with blockchain becoming recognized as a mature technology (Stratopoulos et al., 2021) capable of solving precisely the kind of problems posed by dematerialization, exclusive ownership, and establishing a reliably observable audit trail of a digital instantiation of the BL. In this context, the need for innovative technical solutions, standards, and broad inter-organizational collaboration was equally strong.

The analysis of rich qualitative data revealed three key elements: (1) technology architecture, (2) technological interoperability, and (3) legal certainty, which were found crucial for the development of digital infrastructure to support the digitization of the eBL. Based on these findings, further theorizing leveraged the polycentric governance lens to understand how a global digital infrastructure is developed in a complex inter-organizational, technological, and legal environment. In sum, the

[53] The bill of lading is a document of title to the goods in transport that serves three main functions: (1) As a *document of title* it facilitates the transfer of property rights to the goods such that a receiver can exchange the BL for the goods but also dispose of the goods through endorsment and delivery of the BL to another party; (2) *Evidence of the contract of carriage*, including terms and conditions; (3) As *evidence of delivery* it identifies the shipper (seller), the carrier and the receiver, further specifying details about the cargo including type, quantity and the condition of the goods (Schmitz, 2011).

[54] The notion of functional equivalence refers to a holder of an eBL having the same legal and commercial rights as the holder of a paper BL, not necessarily to the requirement that an eBL has to mirror precisely the operation of a paper BL.

paper explains the important role that individual firms, industry and inter-industry standard-making bodies, technology platforms, and legislative bodies need to play in setting up organizational and inter-organizational structures to develop and promote standards that leverage new technology architecture to develop a global digital infrastructure.

2. Theoretical background

This paper is related to the literature on digital infrastructures and the nascent but rapidly growing literature on the financial, operational, and (inter)organizational impact of blockchain technology in supply chains.

2.1. Digital infrastructure development and governance

Digital infrastructures[55] are considered technical systems and network resources that enable wide-scale organization by coordinating routines and maintaining standards, processes, and governance structures (Tilson et al., 2010; Constantinides and Barrett, 2015; Constantinides et al., 2018). They consist of basic information exchange technologies and organizational and inter-organizational structures necessary for an enterprise or an industry to function (Tilson et al., 2010; Constantinides et al., 2018). Digital infrastructures render industries and products increasingly information-based and reshape industrial organization and services as industries undergo comprehensive digitalization (Tilson et al., 2010). Further, when they reside in inter-organizational settings, these large-scale systems exhibit high degrees of complexity, are characterized by a large number of interconnections and interdependencies between different technical and organizational factors, and tend to develop through more or less loosely coordinated actions of numerous autonomous actors (Hanseth and Rodon, 2021).

The concept of governance concerning digital infrastructures became prominent with the emergence of a new archetype of governance residing outside of large organizations with an established IT function, where its scope began spanning organizational boundaries (Tiwana et al., 2013). It was further shaped by the sharing of IT assets (Hanseth and Lyytinen, 2010) and new business logics

[55] In the existing literature, the terms such as digital infrastructure, information infrastructure, IT infrastructure, and e-infrastructure are often used interchangeably to capture this phenomenon. This study adopts the term *digital infrastructure* as proposed by Tilson et al. (2010). Since the Tilson et al.'s (2010) call for infrastructure research, the concept of digital infrastructure has gained predominance in the relevant literature.

(Tilson et al., 2010; Gregory et al., 2018). Existing research on digital infrastructures recognizes governance as a collection of structural, procedural, and relational components (Tallon et al., 2013; Hanseth and Rodon, 2021). Structural practices refer to the structures that determine the locus of decision making, with decisions emanating from committees, working groups, task forces, and/or other structures for policy determination (Tallon et al., 2013). Procedural practices identify how governance is executed, potentially at different levels, and include industry standards, laws, regulations, contracts, group norms, and policies (Tallon et al., 2013; Hanseth and Rodon, 2021). Relational practices refer to the development of a common set of values related to the system among involved actors and can include support services for users, help-desk services, IT operations centers, hackathons, and an e-newsletter to support users (Koutsikouri et al., 2018; Hanseth and Rodon, 2021).

The literature has traditionally relied on conceptualizations of top-down and bottom-up approaches to address challenges in governing digital infrastructure development. Studies that advocate for a top-down approach have argued for a clear IT governance framework to guide digital infrastructure development, which is supposed to provide guidelines for who makes decisions and what decisions will ensure effective IT governance (Well and Ross, 2004). In highlighting the limitations of top-down approaches for digital infrastructure development involving numerous organizations (see also: Dean and Shaframan, 1996; Devaraj and Kohli, 2003), Constantinides and Barrett (2015) note that such frameworks were developed with top executives or unit managers in mind, which assumes a high level of control that is most often not attainable or effective for digital infrastructures in inter-organizational settings. Relatedly, a body of research that has become the dominant perspective in digital infrastructure studies supports a bottom-up, operationally driven approach to governing digital infrastructure development, one that acknowledges the dynamic complexities involved in accommodating increasingly varying interests, needs, and resources of a broad and often quickly expanding user population (Sahay et al., 2009; Hanseth and Lyytinen, 2010; Constantinides and Barrett, 2015; Rodon and Silva, 2015; Koutsikouri et al., 2018).

Researchers have proposed technical design principles and rules to address initiation and adaptation problems in digital infrastructure design (Hanseth and Lyytinen, 2010) and offered evidence to support the viability of a bottom-up approach characterized by multiple governance units at different levels to support digital infrastructure development and scalability, as opposed to governance through a single coordinating or governing body (Constantinides and Barrett, 2015). Building on this line of thought, several recent studies have adopted a hybrid approach, emphasizing the need for a combination of top-down influences and bottom-up adaptations, mostly in studies of digital infrastructure evolution (Henfridsson and Bygstad, 2013; Constantinides et al., 2018; Osmundsen and Bygstad, 2021). According to this perspective, initiatives originating at the top level, driven by strategic considerations, can create favorable environments for digital infrastructure evolution (Henfridsson and Bygstad, 2013; Osmundsen and Bygstad, 2021) but at the same time rely on value-creating interactions among multiple stakeholders that need to be coordinated collaboratively (Constantinides et al., 2018; Hanseth and Rodon, 2021).

This study builds on the governance and collective action stream of digital infrastructure literature (Constantinides and Barrett, 2015; Gregory et al., 2018) to understand how governance mechanisms can be developed and implemented across stakeholders with potentially diverging interests and on multiple levels in a global inter-organizational environment. The study thus responds to recent calls by Constantinides et al. (2018) and Fürstenau et al. (2019) for research on digital infrastructures to explain these issues in digital infrastructure development processes.

The concept of polycentricity was first introduced by Ostrom et al. (1961) to understand governance issues around the usage of public natural resources that involved an array of public and private agencies. According to this perspective, polycentric systems are characterized by multiple governing authorities, which exercise considerable independence to make norms and rules within a specific domain (e.g., a firm, local government, region, industry) (Ostrom, 1999). Participants in a polycentric governance system have the advantage of being able to apply domain-specific knowledge to their rule-making activities and policy decisions (Ostrom, 2010b). Accordingly, a key advantage of polycentric governance is that rules can be written in a general form and thereafter be tailored to local circumstances. This further implies that more actions tailored to local arenas can be authorized under a polycentric governance structure than in a monocentric one attempting to establish uniform rules for all settings (Ostrom, 1996; Constantinides and Barrett, 2015). Research on digital infrastructure development and governance has further explored the concept of nesting, where governance is nested in a series of layers, thereby distributing responsibilities and incentives across stakeholders, with each layer dealing with related issues on a progressively larger scale (Ostrom, 1990; Constantinides and Barrett, 2015). Nesting thus represents a mechanism for linking together smaller-scale interactions to develop collective action outcomes on a large scale by addressing horizontal and vertical assurance problems[56] (Constantinides et al., 2018). This, in turn, helps smaller governance units to become a

[56] Assurance problems are often discussed in literature on standardization and refer to a lack of incentives for any individual agent to "get the bandwagon rolling" (e.g., adopt a standard) (Farrell and Saloner, 1986).

part of a more inclusive system addressing a global problem without giving up their autonomy (Constantinides, 2012; McGinnis, 1999).

2.1.1. The role of governance mechanisms in digital infrastructure development

Studies on digital infrastructure development and governance sought to understand how to manage the tension between stability and flexibility to deal with local demands for adaptability and global concerns of consistency and commonality (Scott and Orlikowski, 2021). Perhaps the most effective and prominent means of coordinating and deploying IT capabilities in digital infrastructures to address these tensions are industry standards (Hanseth et al., 1996; Hanseth and Lyytinen, 2010; Egyedi and Spirco, 2011; Scott and Orlikowski, 2021). Standards are technical specifications developed through a voluntary process of consensus building and approved by a recognized body, intended for repeated use (Egyedi and Spirco, 2011; ISO, 2019). In the literature that treats digital infrastructure as a focal concept, several contributions have been made by providing evidence on the importance of standards to digital infrastructure development and evolution.

Hanseth et al. (1996) study the tension between standardization and flexibility and emphasize the need for balance to be established between the two in digital infrastructure development over time. Similarly, Braa et al. (2007) examine the development of health information infrastructure and propose the concept of flexible standardization as a crucial process that enables the infrastructure to accommodate both the global needs of infrastructure scalability and local needs of adaptability to idiosyncrasies and frequent changes in different contexts. In these studies, the standardization efforts refer to technical standards for protocols that govern the communicative patterns (Hanseth et al., 1996), and represent gateways that allow computer systems to interact and integrate to form an "information highway" (Hanseth et al., 1996; Braa et al., 2007).

In this literature, industry standards are conceptualized as a key governance mechanism in the sense that they represent authoritative norms within an industry that guide actions, manage the flow of transactions and determine how connectivity is achieved (Yates and Murphy, 2019; Scott and Orlikowski, 2021). Other examples of such mechanisms include exchange agreements (e.g., SWIFT rules for financial transactions), statutes (e.g., SEC requirements for financial reporting), certifications, accreditations, laws, conventions, and international treaties (Scott and Orlikowski, 2021). As such, industry standards and other governance mechanisms coordinate and regulate the industry and cross-industry-wide activities and relations by specifying collective rules (Scott and Orlikowski, 2021).

Such rules are designed to correspond with the particular materialization of the phenomena that are to be coordinated and regulated. For example, David (1985) shows that the design of the standard layout for the QWERTY keyboard materially corresponded with the typewriters in the late 19th century. Similarly, international standards for shipping containers were specified to correspond with particular dimensions that could be accommodated by trucks, railroads, and ships in the 1960s and 1970s (Yates and Murphy, 2019; Scott and Orlikowski, 2021). The role of governance mechanisms is particularly salient when digitalization allows for the transformation of physical or analog functionalities into equivalent digital materializations (Tilson et al., 2010). In a study of the international standard book number (ISBN), a long-standing standard in the book industry, Scott and Orlikowski (2021) find that as successive waves of digitalization transform core business activities and the materialization of the regulated phenomenon (i.e., the book and its various subsequent digital formats), they also result in changes to the standards that structure and regulate those phenomena.

2.2. Blockchain-based architecture in inter-organizational settings

The study additionally builds on the growing body of literature that investigates (inter)organizational and financial impact of blockchain technology in inter-organizational settings. The first successful use case for blockchain technology was Bitcoin, a digital currency based on a peer-to-peer network and cryptographic tools (Nakamoto, 2008). Bitcoin and similar early instantiations demonstrated that blockchain allows its users to engage in secure exchanges of non-duplicable digital tokens carrying monetary value in a potentially adversarial environment consisting of independent actors (Kostić and Sedej, 2022). In inter-organizational settings, blockchain technology enables verifiability of transactions involving digital assets or business-relevant information (e.g., orders, receipts, payments, invoices) between organizations through a tamper-resistant distributed ledger (Chod et al., 2020; Kumar et al., 2020).

Rauchs et al. (2018, 24) define blockchain as "[…] A system of electronic records that enables a network of independent participants to establish a consensus around the authoritative ordering of cryptographically-validated ("signed") transactions. The shared result of the reconciliation/consensus process—the 'ledger'—serves as the authoritative version for these records". Blockchain technology embodies the architecture and processes necessary for a consensus to be generated across participants in a network (Chen et al., 2020). Therefore, one critical feature of blockchain architectures is their ability to allow decentralized record-keepers to maintain a uniform view on the state of things and the order of events — a decentralized consensus (Cong and He, 2019). Economists have long recognized the concept of consensus as the informational basis for agents of divergent preferences and beliefs to agree on the states of the world or behave according to a common set of protocols (Chen et al., 2020).

Many blockchain projects we observe today result from collaboration among actors on an industry or even cross-industry level (Jensen et al., 2019; Mattke et al., 2019; Zavolokina et al., 2020). Rival companies interconnect disparate proprietary information systems (Mattke et al., 2019; Lacity and Van Hoek, 2021a), intending to address operational inefficiencies in their supply chains. A few recent studies have taken initial conceptual steps toward explicating the role of blockchain in the emergence of digital infrastructures (e.g., Constantinides et al., 2018; Andersen and Bogusz, 2019; Zachariadis et al., 2019). Constantinides et al. (2018) analyze blockchain technology in the context of digital infrastructures and platforms. They highlight the potential of blockchain architecture to improve transactional efficiencies and asset exchange in a digital environment and note that extant research largely (and uncritically) focuses on technical attributes of blockchain technology. This leads the authors to observe that there has been a neglect of research on blockchain's managerial and organizational impact, which would be particularly relevant for research on digital infrastructures (Constantinides et al., 2018). Zachariadis et al. (2019) build on the literature on digital infrastructure governance (Constantinides and Barrett, 2015; Constantinides et al., 2018) to analyze key governance issues in blockchain-based financial infrastructure. One of the critical issues identified concerns interoperability and standards. A tension exists between open and proprietary standards initiatives, leading to a tendency of blockchain consortia to fragment standardization efforts where multiple standards and protocols continue to co-exist (Zachariadis et al., 2019). Accordingly, Zachariadis et al. (2019) call for further research into the role of standards for blockchain proliferation, as well as tools and mechanisms that would enable interoperability between different blockchain platforms and protocols.

Blockchain has been hailed as a radical innovation for transacting in a multi-party setting, which could revolutionize the recordkeeping of financial transactions and ownership of data (Abadi and Brunnermeier, 2018). More recent studies have argued for blockchain's potential in the international trade setting through the expansion of the pool of potential collaborators in inter-organizational relationships (Kostić and Sedej, 2022) and by furnishing the ability of firms seeking capital to efficiently run operations through blockchain-enabled improvement in the transparency of supply chains (Chod et al., 2020). In other words, in the existing literature on blockchain applications in inter-organizational settings, the focus has predominantly been on the innovative and disruptive characteristics of the technology and their (inter)organizational effects. At the same time, little attention has been paid to explaining how blockchain-based solutions can build on the installed base of existing (legacy) information systems and organizational structures. Especially notable in its absence has been the examination of the role of standards and other governance mechanisms that guide actions, structure interactions, and manage the flow of transactions between parties.

3. Research method

The analysis in this paper relies on a longitudinal case study in the container shipping industry and the associated trade ecosystem. Relatedly, recognizing the paucity of in-depth field studies on governing the development of digital infrastructure in an inter-organizational setting and on a global scale, a case study approach that can be characterized as “revelatory” (Yin, 2014) was used to collect in-depth evidence. A case study approach is considered appropriate for research involving an empirical investigation of a particular phenomenon in depth and within its real-life setting, where the boundaries between the phenomena in focus and their context are not clearly evident (Yin, 2014). Additionally, such an approach enables the researcher to make sense of the observations by moving between data and theory (Yin, 2014).

The study did not begin with the intention of exploring digital infrastructure development. Instead, the initial focus was on investigating the efforts to standardize data flows through collective action in the container shipping industry. However, as the study unfolded, the notion of electronic transferable documents in general and the eBL, in particular, became increasingly prominent. There, it became apparent that the issue of the eBL is critically related not only to the exchange of data between participants in the maritime trade ecosystem but also to governance mechanisms such as technical and legal standards governing the rights and obligations of the trading parties, and the promise of blockchain technology to solve a persistent problem of establishing exclusive possession over digital documents. Therefore, an understanding and appreciation of the process to migrate from paper to electronic documents of title as a paradigmatic example of digital infrastructure development gradually emerged and matured.

3.1. Setting

The research setting for this study is the global digital infrastructure that was in the process of emergence to support the digitization of crucial documentation in maritime trade, with a particular focus on the eBL. The analysis is based on a field study in the container shipping industry and the associated broader trade ecosystem. In terms of value, global container shipping trade is estimated to account for around 60 percent of all seaborne trade, which was in turn valued at around $14 trillion in 2019[57]. Container shipping is a mature and consolidated $200 billion industry (in terms of yearly revenue), with the ten largest carriers representing an 84.6 percent share[58] of the market in terms of TEU[59] capacity and approximately $170 billion in yearly revenue in 2020[60]. Further, as ocean carriers issue bills of lading (both paper and electronic) upon the receipt of cargo subject to a trade transaction, the actors in the container shipping industry play a key role in the processes that are the focus of the present study. At the same time, the study aims to explicate governance issues around developing a global digital infrastructure to support the digitalization of this key trade document. This necessitated that a broader ecosystem involved in executing and regulating trade transactions be considered.

In line with Tilson et al. (2010), who argued that research on digital infrastructures needs to go beyond analyzing the technical interaction between information systems to produce richer conceptualizations of IT uses that cut across multiple contexts and involve elucidation of additional factors relevant to digital infrastructure research, such as those of governance, the study distinguishes between different levels at which relevant actors operate. These levels include the (1) local level, (2) industry level, (3) inter-industry level, and (4) global level. Firstly, the local level includes individual firms such as ocean carriers and eBL solution providers that produce private legal governance mechanisms that govern rights and liabilities on a given eBL platform. Secondly, the industry level involves industry

[57] Source: https://www.statista.com/topics/1367/container-shipping/
[58] Numbers as of January 18th 2022, source: https://alphaliner.axsmarine.com/PublicTop100/
[59] A TEU or Twenty-foot Equivalent Unit is a unit of measurement used to determine cargo capacity for container ships and terminals. This measurement is derived from the dimensions of a 20ft standardized shipping container.
[60] Source: https://www.statista.com/study/13992/container-shipping-statista-dossier/ and annual reports of the top 10 ocean carriers.

associations (e.g., DCSA[61], IG P&I Clubs[62], BIMCO[63]) that produce and promulgate technical standards and other governance mechanisms such as accreditations and industry contractual and liability standards. Thirdly, the inter-industry level involves organizations that serve an orchestrating role of promoting standards and setting up governance structures, and includes cross-industry bodies (e.g., ICC DSI[64]) and financial institutions (e.g., SWIFT). Finally, the global level involves inter-governmental organizations (e.g., UNCITRAL[65], G7[66]) and lawmakers and government advisory bodies (e.g., Law Commission of England and Wales[67]) that develop public legislative standards, policy recommendations, international guidelines and pass laws. Table 1 maps the relevant actors across the four levels.

[61] Digital Container Shipping Association is a neutral non-for-profit standard-making association founded in 2019 by 9 of the top 10 ocean carriers collectively representing 73% of the container shipping market in terms of TEU capacity and approximately $140 billion in yearly revenue. For more details see: https://dcsa.org/about/

[62] International Group of Protection and Indemnity Clubs is an umbrella organization of thirteen insurance underwriter clubs that collectively provide marine insurance for more than 90% of the world's ocean-going tonnage. P&I covers a wide range of ocean carrier liabilities such as injuries to crew, cargo loss, oil pollution, and dock damage (DiMatteo, 2017).

[63] Baltic and International Maritime Council Baltic and International Maritime Council (BIMCO) is the world's largest international shipping association, with over 1900 members in more than 130 countries, representing over 60% of the world's ocean-going tonnage. Its global membership includes ship owners, operators, managers, brokers and agents. BIMCO is a non-for-profit and standard-setting organization.

[64] International Chamber of Commerce Digital Standards Initiative is a neutral body focusing on developing collaboration between industry actors, standard-making bodies, and legislators. See more at: https://www.dsi.iccwbo.org/

[65] The United Nations Commission on International Trade Law (UNCITRAL) is a subsidiary body of the U.N. General Assembly responsible for helping to facilitate international trade and investment. UNCITRAL's official mandate is "to promote the progressive harmonization and unification of international trade law" through conventions, model laws, and other instruments.

[66] The Group of Seven (G7) is an inter-governmental political forum consisting of Canada, France, Germany, Italy, Japan, the United Kingdom and the United States. As of 2020, the G7 nations account for 32 to 46 percent of global gross domestic product, and about 770 million people or 10 percent of the world's population. Source: https://www.g7uk.org/what-is-the-g7/

[67] In England and Wales, the Law Commission is an independent law commission set up by Parliament to keep the law of England and Wales under review and to recommend reforms. See more at: https://www.lawcom.gov.uk/

Actor type / Level	Ocean carrier	Solution provider	Industry association	Cross-industry body	Financial institution	Inter-governmental organization	Lawmakers and government advisory body
Local	MSC, Mærsk, CMA CGM, Hapag-Lloyd, ONE, Evergeen Line, HMM Co., Yang Ming, ZIM	Bolero, essDOCS, WAVE BL, CargoX, TradeLens, edoxOnline[68]					
Industry			DCSA, BIMCO, IG P&I Clubs				
Inter-industry				ICC DSI	SWIFT		
Global						UNCITRAL, G7	Law Commission of England and Wales[69]

Table 1: Overview of relevant stakeholders

This setting is attractive for this paper's research purposes for several reasons.

First, the nascent digital infrastructure that would allow the proliferation of eBLs was emerging in a global trade environment that traditionally relied on a complex existing infrastructure of customs, laws, and inter-organizational arrangements developed collaboratively over several centuries. The BL is uniquely valuable in inter-firm transacting because it is recognized by law as not only being evidence of the rights described on it but rather as *embodying* those rights (Law Commission of

[68] Four of the six major eBL solution providers run blockchain-based eBL platforms, namely WAVE BL, CargoX, edoxOnline and TradeLens.

[69] Although ostensibly merely national in character, the work on the reform of the common law in England and Wales is considered here to be global in its *impact* since "the law of England and Wales currently enjoys a pre-eminent status as the law of choice in global commerce". Source (p.2): https://s3-eu-west-2.amazonaws.com/lawcom-prod-storage-11jsxou24uy7q/uploads/2021/04/Electronic-trade-documents-CP.pdf. This was further pointed out by several respondents. The latest estimate by the Law Commission and industry actors that contributed to the process of drafting a legislative proposal regarding the treatment of electronic transferrable records puts the percentage of global trade and shipping documentation being conducted under the law of England and Wales at between 50 and 80 percent. Source (p.233): https://s3-eu-west-2.amazonaws.com/lawcom-prod-storage-11jsxou24uy7q/uploads/2022/03/Electronic-Trade-Documents-final-report-ACCESSIBLE-1.pdf

England and Wales, 2021). In other words, mere possession of a BL can confer rights on its possessor. In commercial practice, this means that BLs have an intrinsic value as security to banks that finance the sale of the underlying goods in a transaction, and they entitle their legitimate holders to initiate new transactions while the goods are in transit by virtue of the transfer of the BL (Dubovec, 2006). As such, the BL has been developed as one of the prime means for financing international commercial transactions (Schmitz, 2011).

Secondly, this setting is appropriate because it allows for observation of a nascent global digital infrastructure in the making and, therefore, also for identifying factors and mechanisms that play a crucial role in digital infrastructure development.

3.2. Data sources

Data collection was carried out during a period of over four and a half years, from late 2017 to March 2022. Data were collected from several sources: (1) in-depth semi-structured interviews, (2) fieldwork and observations at industry events, and (3) archival data.

Data collection began with an exploratory phase in late 2017 and early 2018 with an extensive search of archival sources (e.g., online journals and portals, press releases) intending to identify the key actors driving digitalization and blockchain use in the container shipping industry, as well as relevant industry events where those actors interacted and shared latest developments. During this phase, it became apparent that the momentum was shifting from broad discussions of topics such as better operational efficiencies and collaboration on data sharing through shipping industry platforms (e.g., TradeLens[70]) to more focused efforts on the dematerialization of crucial trade documents, among which the BL was the most significant. See Table 2 for a summary of data sources and their use in the analysis. A complete list of conducted interviews can be found in Appendix A, while the list of industry conferences and other events can be found in Appendix B.

[70] See more at: https://www.tradelens.com/about

Data sources	Use in analysis
Interviews (25 semi-structured interviews)	
Phase 1: July 2018 – October 2019 3 interviews	Exploratory interviews aimed at examining the issues related to digitalization in the container shipping industry and previous attempts to introduce eBLs vis-à-vis the most recent ones involving blockchain technology, from an inter-organizational and technical perspective. Identifying key stakeholders in the container shipping industry and the broader trade ecosystem involved in major trade digitalization initiatives.
Phase 2: March 2020 – September 2020 8 interviews	To capture the technical and organizational complexities around the development of a maritime trade ecosystem-spanning blockchain-based information exchange platform from the perspective of relevant ecosystem members. Identification of the bill of lading, the legal and commercial document used as a base around which digital infrastructure would be developed to enable trade digitalization.
Phase 3: July 2021 – January 2022 14 interviews	With a focus on boundary spanners, the aim was to develop an understanding of additional governance and legal complexities related to the digitalization of trade documents of title, where the eBL was particularly prominent. To understand the roles and interactions among relevant stakeholders able to produce governance mechanisms (e.g., technical and private legal standards developed by industry standard developing organizations (SDOs), public legislative standards, laws), and formal and informal governance units (e.g., industry associations, advisory boards, working groups) that enable collaboration of these independent centers of decision-making. To understand the role of individual firms that provide eBL solutions, ocean carriers as issuers of bills of lading and other key players in the maritime trade ecosystem. To capture how these interactions and mechanisms contribute to the development of a digital infrastructure to support eBLs.
Fieldwork and conference participation	
November 2017 – January 2022 Participation at 33 industry conferences and webinars	To observe and understand broad trends in the container shipping industry and the broader trade ecosystem, stay up to date with the most recent developments and plans for the future. To identify boundary-spanning individuals in charge of making decisions in inter-organizational settings. To directly engage with these individuals and establish initial contacts for interviews.
Archival data	
November 2017 – March 2022 Drafts and final technical and legal standards published by the DCSA, the UNCITRAL Model Law for Electronic Transferable Records (MLETR) and framework agreements, ministerial declaration and roadmap for reform by G7, consultation paper, report, and draft legislation for legislative reform in England and Wales and Singapore, industry and cross-industry body whitepapers, policy briefs and business cases for legal reform, other business publications, internet sources, corporate materials, minutes from meetings of a cross-	To attain background and explanatory information that informs, supports or clarifies, and ultimately extends evidence collected from other data sources, primarily interviews. To get familiarized with the content and scope of published governance mechanisms such as standards, as well as to obtain primary data on the formation of relevant governance bodies, including their membership, overall aims, and governance structures.

industry governance body, presentations, DCSA quarterly newsletters, videos	

Table 2: Overview of data collection

The COVID-19 pandemic had a crucial impact on the execution and availability of industry events, as they needed to be converted into an online-only format, with some events adopting a hybrid online and in-person approach in late 2021. Anecdotal observations from conference participants and online publications[71] indicate that the online-only format of these events was generally observed as having benefits that far outweigh the downsides. Between June 2018 and January 2022, 25 in-depth interviews were conducted with various informants. Additionally, 33 industry conferences and similar events were attended (See appendices A and B for details).

The data collected from the interviews were valuable in identifying key stakeholders involved in maritime trade digitalization (first phase); major inter-organizational and technological complexities related to the rollout of major digitalization initiatives based on blockchain technology, and additional legal complexities related to the digitalization of the bill of lading as a first step in making maritime trade truly digital (second phase). Based on insights from the first two phases, the data collected during the third phase clarified the roles and interactions between individual organizations (e.g., ocean carriers, eBL solution providers), industry associations they formed or formally collaborated with (e.g., DCSA, BIMCO), inter-governmental and lawmaking bodies (e.g., UNCITRAL), and an inter-industry body (e.g., ICC DSI) that was formed specifically to orchestrate this collaboration through advocacy and a newly formed governance structure[72]. These data revealed how governance was nested across several levels at which actors could independently develop governance mechanisms, which in turn collectively contributed to the development of a nascent digital infrastructure.

In the third phase, the informants predominantly held senior positions (i.e., C-level or equivalent). Since the focus of the study was to explicate the interaction and dynamics involved in global digital information infrastructure development, the emphasis was on interviewing boundary spanners

[71] For an example see: https://www.europeanbusinessreview.com/the-pros-and-cons-of-using-online-meeting-technology/

[72] Operating under the auspices of the ICC and the governance board of the ICC DSI, the Industry Advisory Board, formed in the Fall of 2021, offered a global, cross-industry neutral governed venue for senior stakeholders from SDOs, inter-governmental institutions and large firms from various industries including container shipping to collaborate toward developing and promoting standards that enable trade digitalization.

(Dekker, 2016), individuals who are in charge of decision-making in inter-organizational settings. Additionally, focusing on boundary spanning individuals as the primary source of interview data in the third phase was deemed appropriate as boundary spanners concurrently need to balance the strategic objectives of their organization with the objectives of the broader collaborative effort in the industry (Thambar et al., 2019), which added further nuance to the empirical findings.

The insights about the appropriate respondents came from two sources. First, they were based on interactions and observations at industry events, where individuals in senior positions often assumed speaker roles on behalf of their respective organizations. Second, they were based on a snowball sampling or networking approach (Collis and Hussey, 2013). Respondents were asked to recommend individuals who held senior positions in key stakeholder organizations and played an active role in establishing and governing different bodies working on the digitalization of the BL.

In addition to interviews and field data, during the period of more than four years, large amounts of archival data were accessed (see Table 2). Archival data often served as the primary source of evidence such that they revealed relevant events, contents of standardization and lawmaking activities, memberships, governance configurations, principles, and sources of funding of industry and inter-industry bodies. Archival data also complemented the evidence obtained through interviews and fieldwork. For example, since many events and developments were documented through different sources, the data collection efforts allowed for triangulation and cross-validation (Yin, 2014). Additionally, during three repeat interviews (all during phase three), the respondents were asked to reflect on insights provided in previous interviews and reflect on the current state of the analysis and the latest version of the developing theoretical framework at the time when the interviews were performed. This led to several corrections (e.g., positioning of lawmakers and government advisory bodies on a global level in terms of the impact of the governance mechanisms they enact instead of their legal remit, which is national in scope; clarifying membership and governance mechanisms in the ICC DSI Industry Advisory Board, and working groups involving eBL solution providers under the auspices of DCSA), which enriched and sharpened the findings.

3.3. Data analysis

Data analysis was based on a thematic analysis approach, which provides ways to identify and match patterns in large, complex data sets (Braun and Clarke, 2006). This approach allows for the effective and accurate identification of empirical themes grounded in the case study context (Jovanovic et al., 2021).

Interview transcripts were coded following the constant comparative analysis approach (Corbin and Strauss, 1990; Glaser and Strauss, 2017). As the study progressed, previously identified categories were continuously adjusted as existing and newly collected data were juxtaposed and compared. In cases when new data produced new insights, information contradictory to existing findings, or offered additional clarification for already existing categories, the categories were revised to take these into account. This process was performed in an iterative fashion until theoretical saturation was reached (Corbin and Strauss, 1990; Glaser and Strauss, 2017).

Another element of the comparative analysis approach involved the triangulation of data by cross-referencing statements by different informants and verifying them against secondary data when possible. Through a series of iterations and comparisons, empirical themes were grouped into conceptual categories. Finally, the conceptual categories were clustered into aggregate dimensions (Gioia et al., 2013). Therefore, a three-step process similar to that described in the existing literature (Braun and Clarke, 2006; Gioia et al., 2013) was taken. The first step in the data analysis was an in-depth analysis of the raw data (e.g., the interview transcripts). This analysis consisted of reading interview transcripts and highlighting phrases and passages. By coding common words, phrases, terms, and concepts discussed by respondents, empirical themes that reflected the respondents' views in their own words were identified. The second step of the analysis involved further examining the empirical themes to detect links and patterns between them. This iterative process yielded six conceptual categories where empirical themes were combined through axial coding (Corbin and Strauss, 1990). The third step involved the aggregation of conceptual categories into three aggregate dimensions: (1) technology architecture, (2) technological interoperability, and (3) legal certainty. The data structure that was developed through this iterative process of analysis is presented in Figure 1.

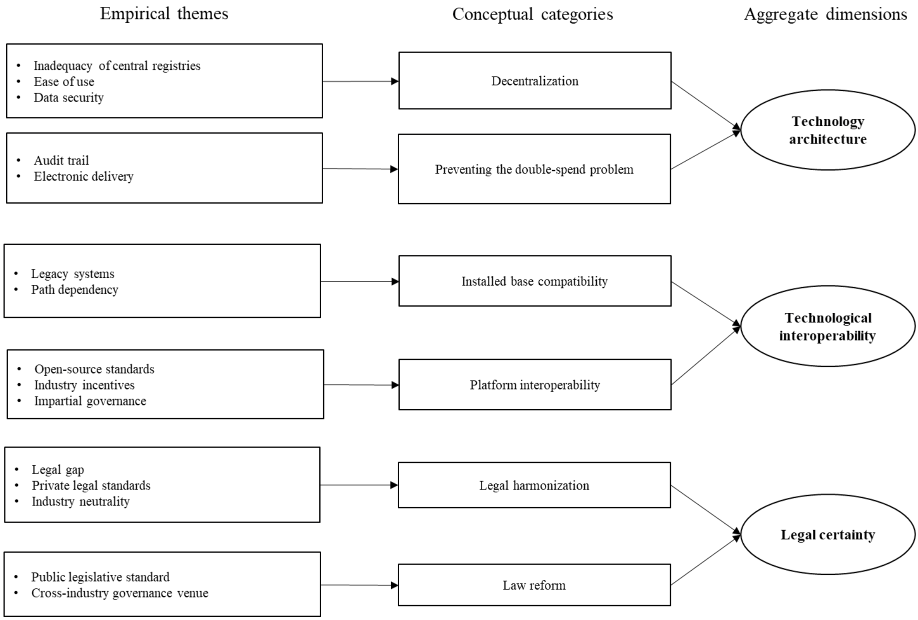

Figure 1: Data structure

The following section discusses each of the dimensions in detail.

4. Findings

The process of trading goods across borders requires a complex underlying infrastructure that consists of a fine net of procedures and documentation and involves a multiplicity of actors, including trading parties, authorities, as well as transportation, insurance, supply chain finance, and logistics service providers (Dubovec, 2006). This infrastructure rests upon processes and laws stemming from practices incrementally developed by merchants over several centuries (Murray, 1983). The BL has come to represent a device that enables organizations transacting across international borders to efficiently communicate, form contracts, allocate risk and protect their interests while dealing with counterparties whose interests might be opposing and which are often not under the same legal structure (Beecher, 2006). In addition to being a transport document, the BL is used as collateral for financing trade transactions by banks and as a requirement for insurance (DCSA, 2020). As such, the

BL is a document that anchors contractual liabilities and obligations of the parties and confers contractual rights and remedies (Dubovec, 2006).

4.1. Technology architecture

The first aggregate dimension, technology architecture, reflects how key technical characteristics of blockchain technology enable the development of the architectural component of the digital infrastructure to support eBLs.

As an electronic record, an eBL essentially represents a piece of data that has legal rights and obligations attached to it. That being the case, for an eBL to be legally and commercially effective, it must be unique and secure. Additionally, there must be only one holder at any moment, and that holder must be able to transmit the eBL in a manner that can be independently verified. In other words, a robust *audit trail* has to be established. Despite all the downsides associated with paper BLs, one crucial characteristic that affects their universally harmonized treatment in maritime trade that was repeatedly emphasized by informants, as well as relevant literature (e.g., Pagnoni and Visconti, 2010), is the inherent **decentralization** that paper enables due to its innate tangibility. An electronic alternative including a blockchain-based solution needs to be at least as good as the solution it is replacing for it to be widely accepted, making **decentralization** a key issue to be addressed.

Finally, there must be only one version of the eBL in circulation where a notion of exclusive control[73] is maintained. This means that, upon transfer of an eBL, the transferring party relinquishes its status as a holder and the receiving party unequivocally gains that status. Put differently; an eBL solution has to be able to **prevent the double-spend problem** often associated with digital assets.

4.1.1. Decentralization

One complication in developing a technical infrastructure to support eBLs was that initial technological solutions relied on proprietary systems requiring costly and time-consuming user onboarding. The first system of such kind that gained prominence, called the Bill of Lading Electronic Registry System Organisation (BOLERO), was introduced in 1998 by SWIFT and the Through Transport Club. In this setup, eBLs were issued on the Bolero system, and the issuer would be

[73] The notion of exclusive control of an electronic transferable record is used as an equivalent to the notion of possession of an original paper document, see article 11 of the UNCITRAL Model Law on Electronic Transferable Records: https://uncitral.un.org/sites/uncitral.un.org/files/media-documents/uncitral/en/mletr_ebook_e.pdf

provided with a set of private keys that enabled access to the document. The Bolero system enabled secure transfers of electronic messages that registered the rights and obligations of trading parties. It further centrally maintained a primitive audit trail of transactions through checks and logs of each such message for historical reference and to enable conflict resolution.

The Bolero system crucially relied on the membership status of prospective trading parties, both from the legal and the security points of view (Goldby, 2008). However, several severe drawbacks to this model were recognized. Trading parties needed to make (1) significant relationship-specific investments related to integrating the Bolero system into their operations; while at the same time (2) relinquishing the opportunity to leverage the efficiencies of eBL use with non-member trading parties. These drawbacks illustrated the *inadequacy of the central registry model* for eBLs. An expert in international maritime law and a consultant to UNCITRAL and the Law Commission of England and Wales explained the sentiment in the industry and legal implications of central registry systems:

> "*Having to sign up to a system that was under central control held back systems such as Bolero. Basically, there was a lot of nervousness about having a central counterparty for everything, absolutely everything. You had a central point of control, you had a central point of failure.*"

By demonstrating that it was possible to transfer eBLs successfully, Bolero and other early central registry-based platforms such as essDOCS (founded in 2005) raised expectations about BLs becoming digital on a wide scale. Prominent container shipping actors began testing these solutions and running proofs of concept in real trade scenarios involving shippers, consignees, and banks, in addition to ocean carriers and eBL solution providers. However, a key complication for further developments towards adopting these eBL solutions was the centralized model using proprietary software that was expensive to use and not conducive to integrating a large number of trade partners. The Chief Digital and Information Officer (CDIO) of the Mediterranean Shipping Company (MSC) explained:

> "*We as MSC, we saw the value of the eBL for many years, but there wasn't a solution out there which was easy to implement. [...] we had tested of course with Bolero and essDOCS, and other solutions, but they basically require you to install software. We don't want to install software, deploy certificates, have dongles or two factor authentications on the smart phone. We just wanted something simple. If you look at the computer systems, they have always been relatively centralized. We said no to putting everything on the [central] database. We want everyone to maintain control over their data.*"

Because dozens of organizations might be involved in handling a single eBL transfer (e.g., ocean carrier, solution provider, buyer and seller's banks, importer, customs authorities), the industry actors were eager to adopt eBL solutions that were *easy to use* and which did not suffer from scalability issues associated with earlier central registry eBL platforms. Since 2018, blockchain has been a prominent topic in the container shipping industry, with major information sharing industry platforms such as TradeLens (Jensen et al., 2019; Sedej, 2021) seeing wide adoption[74]. Although major container shipping industry actors initially expressed skepticism about the usefulness of blockchain technology for eBLs, successful trials of blockchain-based eBL solutions during 2020 and early 2021 initiated by major ocean carriers such as MSC demonstrated blockchain's potential beyond that of earlier central registry solutions and led to production-level implementation. The Head of Contracts and Clauses at the Baltic and International Maritime Council (BIMCO) described these developments:

"The industry wanted to digitize [bills of lading] in some way, but they didn't necessarily know the way forward. Initially, blockchain was thrown out there as being the solution to all problems, and people were thinking: "Ok, but how exactly? How do we apply this technology to our business?" [...] And I think in the background, some smart people working on blockchain have come up with platforms and solutions that are very, very easy to use as their offering to the industry. Because they've appreciated that the older platforms [i.e., Bolero and essDOCS] haven't been as successful as they should have been."

Because blockchains are tamper-evident, they enable firms on a blockchain network to identify potential opportunistic behavior. Put differently, blockchain-based eBL platforms deploy modular architectures that can transfer digital documents of title while maintaining *data security*. Namely, the title to the eBL is transferred on-chain, and the content that can include commercially sensitive data can remain "on-premise" in the trading party's local IT system or hosted on a cloud, depending on the preferred configuration by the users. The benefits of being able to transfer a document of title in a decentralized ecosystem while preserving the security of proprietary information were highlighted by several respondents. An expert in international maritime law and a consultant to UNCITRAL and the Law Commission of England and Wales, for instance, noted:

[74] On March 24th 2021 TradeLens became the seventh eBL solution provider to receive approval from the International Group of P&I Clubs. Additionally, the TradeLens platform processes more than 700 million shipping events and 6 million documents per year as of January 2022. Source: https://www.tradelens.com/ecosystem

"*Blockchain has got everybody very excited because a blockchain service provider can provide you with a service you need without having access to your documents at all. Basically, they just have the hash value. They can confirm the validity of the transaction without having access to any data at all about the transaction itself.*"

4.1.2. Preventing the double-spend problem

Blockchains were originally designed to **prevent the double-spend problem** for digital currency. In other words, blockchains are intended to provide a reliable record to ensure that a digital asset sent from one party to another: (1) is unique in the sense that it has not already been spent elsewhere, (2) is subject to reliable *electronic delivery* where a change of possession occurs (i.e., if A transfers a digital asset to B, A can no longer claim possession over the asset), and (3) leaves an *audit trail* of previous transactions.

In contrast to the paper BL where the content (e.g., information about the type, quantity, and quality of the cargo), the title to the document, and the endorsement chain[75] itself are embodied in its tangible paper instantiation, blockchain-based eBL solutions essentially separate these core elements that are in turn handled in different ways. The trading parties retain control over the content that may contain sensitive commercial information, while the title of the document and the endorsement chain are tracked on the blockchain. Several respondents have emphasized the importance of the *audit trail* that enables parties to keep track of the transfers of title to an eBL in trading scenarios. Communication on a blockchain network occurs directly between participants. Users generate transactions by placing raw data into a standardized format, including a cryptographic signature for authentication, and broadcast it to other nodes in the blockchain network. The signature, created by a private key, serves as the users' authorization for the system to request an entry for the corresponding transaction. A valid signature presents the cryptographic guarantee that the initiator of the transaction is authorized to execute a given ledger entry (Rauchs et al., 2018). At the same time, this technical architecture places control over an electronic document such as an eBL exclusively in the hands of the entity with the knowledge of a relevant private key. Combined with the previously

[75] In scenarios when goods are sold during transit, transfers of BLs must also occur. Namely, the shipper can "endorse" the BL to a subsequent titleholder by putting the titleholder's name on it. With paper BLs this involves writing the name of a subsequent titleholder and the signature on the back of the document. As this process is repeated, a chain of signatures, known as the endorsement chain, is created (DCSA, 2022).

described functionalities of decentralized consensus and tamper-resistance of the records, blockchain enables reliable transfers of possession of electronic documents. This crucial functionality was described by the co-founder and CEO of WAVE BL:

"*All the communication mechanisms, protocols, technologies are all built on the same concept. I'm not* ***sending*** *it [digital information] to you. I'm* ***replicating*** *the information from my computer to your computer. And this goes for SWIFT, email, and any other protocol. Blockchain, when used in the right way [being fully decentralized], allows you for the first time to* ***deliver*** *something. Blockchain allowed us, for the first time to have an* ***electronic delivery****. So when it [an eBL] is sent from me to you, I can't take it. It's not in my hands anymore. This is what the blockchain brought to you; it first brought it in Bitcoin.*"

4.2. Technology interoperability

The infrastructure developed over centuries of commercial practice has enabled a nearly unanimous treatment of paper BLs across all maritime nations and organizations involved in maritime trade transactions. Therefore, the paper BL represents a technology that, although rudimentary and prone to causing inefficiencies and risks, enables unparalleled **interoperability** between trading parties. Based the findings of this study, two major factors were observed in this context. First, just like paper BLs, eBLs are issued by ocean carriers who receive the cargo to be shipped. Those actors' mature and sometimes cumbersome legacy systems represent an installed base in the industry. Achieving **compatibility with that installed base** is the first major challenge that an eBL solution needs to overcome. Second, the sheer size of the maritime trade ecosystem entails that trading parties need to maintain numerous inter-organizational relationships. For example, DCSA estimates that the largest ocean carriers maintain over twenty thousand EDI connections with various business partners in the maritime trade ecosystem. This naturally includes actors that have varied preferences in terms of solution providers. Therefore, if there is an insufficient level of technical **interoperability between platforms** that provide eBL solutions, a potential adopter of any given eBL solution faces potential sunk costs if their chosen platform fails to "take-off" or would need to make several platform-specific investments to maintain the flow of transactions in their supply chain.

4.2.1. Compatibility with installed base

The container shipping industry has a reputation for being a laggard in terms of digitalization. According to a cross-industry survey cited by DCSA[76] and related research (e.g., Gandhi et al., 2016), the container shipping industry is in the bottom third of the examined industries on the digital maturity curve, behind the likes of healthcare and construction. According to several respondents, this is the case, at least in part, because ocean carriers run very complex bespoke *legacy systems*. On the other hand, the respondents further explained that such systems serve many purposes, only one of which is generating BLs. Other purposes include but are not limited to operational information exchange, processing of invoices, payments, and receivables. The CDIO of MSC described the importance of legacy systems to large ocean carriers:

"[As an ocean carrier] I can do an eBL. I use the blockchain, and it's fantastic. [...] but maybe internally, which is not the case in MSC, I have a lot of people in the service center just typing up data. And that's what happens in our business. And I want to try to avoid that, but what that means is that we have to be able to upgrade our systems continuously. And that's the difficult part. We all have, people talk about legacy [in a negative context], but legacy for me means production because that's the system you're using and you can't change the system every year because it's, you know, of size."

Previous studies have suggested that a firm's ability and incentive to adopt new technologies are largely a function of its level of related experience with existing technology. This is often referred to as *path dependency* (Cohen and Levinthal, 1990; Zhu et al., 2006). Similarly, the findings of this study suggest that *path dependency* in the container shipping industry can have positive effects, as firms with mature legacy systems often have both the requisite skills to implement new solutions and have developed a deep understanding of the organizational and economic impact of such solutions. One way in which these positive effects have manifested themselves was the formation of DCSA in April 2019.

[76] Source: https://7703b98d-a40e-40b5-9a19-2340c0e85ea4.filesusr.com/ugd/0b6be5_f5614cf4128c4a74a713290234d40f8e.pdf?index=true

As a not-for-profit industry SDO financed by the nine-member group of ocean carriers[77], DCSA was founded to develop open-source standards that would enable the interoperability of technology solutions across the container shipping industry. In December 2020 and June 2021, respectively, DCSA published standards that deal with data and process elements of eBL issuance, transfer, and surrender, as well as an eBL interface standard aimed at ensuring agreement on the specifications that need to be followed to streamline data exchange across organizational boundaries and enhance inter-organizational cooperation based on shared requirements. Several respondents have reported that although DCSA does not have formal authority to mandate the use of its standards, even among member carriers, it assumed the role of an orchestrator[78] that governs the processes of development and promulgation of eBL standards in container shipping.

Before standards are published, subject matter experts from member carriers as well as eBL solution providers formally engage through working groups under the auspices of DCSA. Additionally, in June 2021, an informal governance mechanism called the "DCSA Adopter Programme" was introduced. It enables solution and service providers to validate the adoption of DCSA standards based on a self-certification checklist, reflecting requirements for integrating DCSA standards. By reporting their standard compliance to DCSA, container shipping industry actors can simplify the process of partner selection for industry and broader trade ecosystem actors seeking interoperable standards-based eBL solutions. The co-founder and CEO of WAVE BL, a major eBL solution provider, described the effects of these developments in the container shipping industry:

"[The] Data is being standardized. And DCSA [...] is doing amazing work. We know that DCSA will be the winner when it comes to data standardization. And we are already working based on this standard in multiple activities, it's good for everyone."

4.2.2. Platform interoperability

The actors in the container shipping industry have long recognized the benefits of technical standardization, at least in principle. Traditionally, however, the approach to designing information

[77] The members of DCSA include nine of the top ten largest ocean carriers in the world, which collectively represent close to 70 percent of the container shipping industry. See more at: https://dcsa.org/about-us-our-work-and-what-we-do-dcsa/members/

[78] The term is used in line with Tiwana et al. (2014) who refer to orchestration as the ability of an entity to exert influence on those entities it does not directly control.

systems seen as a key to achieving competitive advantage represented a battleground in which a well-designed proprietary system that can deliver better quality information to the customers or do it more quickly than competitors should prevail. Several informants have expressed this view of the industry and highlighted that this trend was evident both with large global companies such as ocean carriers and with eBL solution providers that have made sizable investments in developing their proprietary systems.

Opting for collaboration with a particular solution provider to issue and transfer eBLs meant that ocean carriers and other trade ecosystem actors faced a difficult choice between potential sunk costs if their chosen platform failed to "take off" and making several platform-specific investments to facilitate the flow of transactions with their partners. Unsurprisingly, such an approach has yielded very little success in terms of eBL usage in the container shipping industry. Market research by DCSA[79] has found that ocean carriers alone issued 16 million original BLs annually, for which an industry incurs a cost of $11 billion. Yet, less than 1.2 percent of BLs were issued in electronic form as of early 2022. Emphasizing foregone benefits caused by such low adoption of eBLs, this research further highlighted that the container shipping industry alone could expect yearly savings in excess of $4 billion if 50 percent eBL adoption was achieved[80].

Relatedly, many key industry actors have realized that the lack of standards has created critical obstacles for eBLs to become widely accepted. As the industry actors have seen these obstacles seriously affect their internal digital transformation strategies, a consensus has emerged that the only way to bring a level of uniformity to the complex container shipping industry and the broader trade ecosystem is through *open-source standards* covering both technical and legal aspects of the eBL. During the present study, DCSA has assumed a leading role in governing the development of these standards.

However, the standardization efforts that would ultimately lead to interoperability between eBL platforms were met with initial reservation because such developments were, to some extent, at odds with the business models of established eBL solution providers aiming to attract as many customers as possible to their specific platforms. Accordingly, credible commitments to accepting and

[79] Source: https://dcsa.org/wp-content/uploads/2020/12/20201208-DCSA-P4-DCSA-Standard-for-Bill-of-Lading-v1.0-FINAL.pdf
[80] This projection is based on an estimated global economic growth rate of 2.4% through 2030, as forecasted by the OECD. Source: OECD Economic Outlook: Statistics and Projections database

implementing standards to achieve interoperability relied not only on the quality and comprehensiveness of standards but also on *industry incentives*.

Several respondents noted that their clients' needs to a large degree, influence their digital transformation strategies. Beyond the container shipping industry, the trade ecosystem includes some of the world's largest companies with tens of billions of dollars in annual revenue. Such actors, in many cases, possess market influence such that even large ocean carriers need to pay close heed to their preferred ways of doing business to preserve profitable inter-organizational relationships. The CDIO of MSC provided an example:

"I think, again, the eBL, in my opinion, the real benefit is for the customers. Because for us [a large ocean carrier] there isn't a big difference. I think the change is really on the customer side, [including] the banks, the customs authorities. And so we thought that it was a good idea [to help develop standards for eBLs] because there are so many parties involved and because we can help so many of them that it made sense."

The co-founder and CEO of WAVE BL summarized the importance of industry incentives from the perspective of a major eBL solution provider:

"Interoperability is a very expensive mission. We try it because our clients ask, and they ask ***really nicely****. The same thing happened when [big client] asked their bank to start doing something. So the industry creates incentives, and then it may work, or it may not work. [...] if the industry insists on it, so it will happen. If they don't, it [interoperability between eBL platforms] might not happen."*

Further incentives to participate in standard development and adopt standards for eBLs were created by DCSA that took an ecosystem view and aligned their standards with major actors outside the container shipping industry. The standards themselves were developed through a collaborative process governed by DCSA, where subject matter experts from ocean carriers, SMEs, and eBL solution providers participated in working groups. Further, through a formal review and approval processes, DCSA eBL standards were aligned globally with the IG P&I Clubs, a body representing carrier liability underwriters ensuring over 90 percent of all ocean-going tonnage.

Respondents who participated in this process emphasized the importance of the *impartiality of governance* mechanisms in this network of stakeholders, as attempts to disproportionally benefit some actors over others can lead to the fragmentation of the standardization effort. The Chairman of DCSA explained that an important part of the strategy of a neutral industry SDO is engaging with the stakeholders not only to improve the quality of the standards, but also to improve the chances for their adoption:

"I think the push [to standardize] is coming mostly from the carriers today. When you look at it, the DCSA was created by carriers. And the only reason that we did that was because we all had the same problems. And we said to ourselves, you know we are nine carriers [representing roughly 73% of the container shipping industry], it's going to be easy to make decisions. [...] And then of course, when we started to create standards, we knew very well that the key was for us to find a way to promote that and to get adoption."

4.3. Legal certainty

Historically, BLs acquired their ability to transfer rights to delivery of the goods embodied in them through mercantile practice, with only limited top-down legislative direction by nation-states. For several centuries BLs have enabled trading parties to communicate their rights and obligations and form contracts effectively, thereby making the BL one of the key mechanisms for financing international commercial transactions (Beecher, 2006; Dubovec, 2006). Importantly, BLs became a part of mercantile law that transcended national boundaries, allowing this key document to become universally understood as being capable of achieving the same effects through its transfer in jurisdictions the world over through eventual recognition in domestic laws of countries that followed (Goldby, 2011). This complex legal framework has provided the international trade community with **legal certainty**, which is critical for business activities because it allows trading parties to allocate risks and make strategic and operational decisions reliably. In the absence of **legal reform** that would introduce substantive law on eBLs in major maritime jurisdictions, private actors in the maritime trade ecosystem have developed tools to achieve **legal harmonization** such that the trading parties can reliably exchange and treat eBLs as equivalent to their paper counterparts.

4.3.1. Legal harmonization

With the increase in the pace and complexity of international trade, the physical movement of the original paper BL between trading parties and traders' banks lags behind the movement of the goods themselves. A problem caused by the delay in transmission of paper documents is that the original paper BL will often not be available for presentation to the carrier by the time the vessel reaches the discharge port. Wider adoption of eBLs would help address this problem, granted that the eBL has a legal status equivalent to that of an original paper BL (DCSA, 2020). Therefore, the industry actors have strong incentives to develop mechanisms and tools that would enable legal recognition of eBLs.

In an attempt to address the *legal gap* in the treatment of eBLs, multipartite private law agreements (hereafter: rulebooks) have been developed over the past decade by eBL solution providers. These mechanisms based on private law frameworks represent multilateral contracts that create rights and obligations between its signatories.[81] In essence, by signing up to a rulebook, organizations that use a given eBL system form a contractual "club" within which rights and obligations attached to eBLs can be exercised. The Co-CEO and COO of essDOCS explained this mechanism:

> *"You've got this legal framework [of state laws] that governs paper [bills of lading] and almost invariably it ignores electronic [bills of lading], and sometimes specifically excludes electronic [bills of lading]. So, by definition, in order to do eBLs you need something to bridge that gap. […] We've all [eBL solution providers] adopted the same approach to how we recreate contractually the rights and obligations of users of eBLs [that exist] in paper. […] If someone outside of the club gets the eBL it's worthless to them, it's not actually a bill of lading. It's a piece of data. […] We have a bill of lading construct, this concept that we've labeled the bill of lading, but really it's a piece of data to which we've attached some legal rights and obligations. And the way that we then created that is through this [private law] legal framework.*"

For a better part of the last two decades, since it became technologically feasible to issue eBLs, the only form of eBL *private legal standards* de facto acknowledged by trading parties has been the certification of eBL providers' systems and legal frameworks issued by the International Group of Protection and Indemnity (IG P&I) Clubs. Approval from IG P&I Clubs attained its governance mechanism status due to the long-standing structure of relations and sources of risk in international trade. The IGP&I consists of thirteen clubs that ship owners, operators, freight forwarders, and

[81] According to the co-CEO and COO of essDOCS, the essDOCS rulebook had approximately 7500 signatories as of July 2021.

warehouse operators can join to mutually provide insurance, information, and representation for various risks in maritime shipping, where traditional maritime insurers do not offer coverage. Through the unique Group structure, the member Clubs, while remaining individually competitive, collectively share in large loss exposures, and leverage each other's knowledge and expertise on related matters. The IG P&I Clubs' rulebook states that the carrier liability would not be covered unless an eBL system approved by the Clubs is used. The BL is a document that needs to be signed and issued by an ocean carrier, meaning that unless liability coverage through IG P&I Clubs is assured by way of eBL solution approval, the eBL would not be issued in the first place. To acquire approval from IG P&I Clubs, an eBL solution provider needs to demonstrate that their eBL solution can fulfill all three major functions of the traditional paper BL. IG P&I Clubs govern this process through a working group for electronic commerce, which performs the formal assessment of the technical and legal aspects of the eBL trading systems. To date, seven eBL solution providers have been approved.[82]

The first such approval was issued in 2010 to Bolero as a result of a uniquely comprehensive legal survey involving twenty major maritime nations. The process further used English law, the pre-eminent law in international commerce, as a basis. This was followed by the approval of essDOCS' platform in 2013. These early solutions utilized a centralized repository client-server architecture. No new eBL solutions were approved until 2019 when a new generation of eBL solutions developed and matured. These solutions leveraged blockchain technology to enhance the security and trustworthiness of document transfer channels while further enabling decentralized handling of eBLs. As a result, four blockchain-based eBL platforms were approved between 2019 and 2021, namely edoxOnline, WAVE BL, CargoX, and TradeLens. An approval provides ocean carriers and other trade ecosystem members with the assurance that eventual liabilities involved in trade transactions will be covered and that an approved eBL solution is compliant with functions traditionally associated with paper BLs. Additionally, this mechanism provides an essential signal that guides actions in the container shipping industry, as participation in standard-developing activities governed by DCSA involves only eBL solution providers approved by the IG P&I Clubs.

While the development of this governance mechanism was an important step that demonstrated the feasibility of eBLs, a crucial feature of the contractual model involving private law rulebooks is that

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[82] Source: https://www.ukpandi.com/news-and-resources/circulars/2021/uk-club-circular-0221-electronic-paperless-trading/. As of January 2022, according to the program director for eDocumentation at DCSA, enterprise blockchain consortium R3 that in 2020 acquired the IG P&I Clubs approved legal and technological framework of E-Title decided not to go ahead with the intended project. Consequently, there remain six approved eBL solution providers.

any party to the transaction that is not a signatory to the multipartite contract would not be able to transfer eBLs because rights and obligations agreed upon within the group of signatories are not actionable outside it of that group. This means that strictly speaking, eBL solutions could not interoperate from a legal point of view because liabilities could not be transferred from one contractual group to another. Several interviewees have highlighted the lack of legal "interoperability" between eBL solution providers as one of the primary reasons for the low adoption of eBLs. As the Chairman of DCSA commented:

"And I remember with WAVE BL as with others [eBL solution providers], you have to get those rulebooks adopted by the P&I Clubs, but the funny thing is, there was no standard rulebook. So [the] first thing that came up when we [the DCSA] discussed interoperability [with eBL solution providers] was: "My rulebook is better than yours". I'm not sure what that means, but what I know is that certain platforms that are working on the eBL don't have the rulebook that everybody wants."

Recognizing the need for an industry-level response to the issue of **legal harmonization,** DCSA has engaged in the creation of a standard legal rulebook to address title registry and transfer of possession regarding eBLs. This effort aims for trading parties to incorporate an open-source standard set of legal terms into their existing commercial agreements. The standard rulebook developed by DCSA as a *neutral industry body* defines the roles and responsibilities of trading parties and enables eBLs to move across the supply chain underpinned by a set of open-source, technology-agnostic and independent rules. Legal Officer and Secretary of the UNCITRAL Working IV for Electronic Commerce described the importance of IG P&I Clubs' approval and the need for a wide-ranging standardized approach to digitizing BLs:

"The real stumbling block here, the one that has always been seen as a stumbling block, was the approval of the P&I Clubs. Now, it would be really good to have some industry standards about assessing the reliability of electronic transferable record (ETR)[83] management systems and service providers [i.e., the eBL solution providers]. But again, these would be an evolution of the standards

[83] According to the UNCITRAL Model Law on Electronic Transferable Records (MLETR), the electronic record contains the information that would be required to be contained in a transferable document or instrument transferred using a reliable method capable of being subject to control from its creation until it ceases to have any effect or validity, and to retain the integrity of that electronic record. This refers to commercial documents and instruments such as BLs, bills of exchange, promissory notes, warehouse receipts, and letters of credit. Source: https://uncitral.un.org/sites/uncitral.un.org/files/media-documents/uncitral/en/mletr_ebook_e.pdf

for trust service providers. So I think this is needed because for instance, in Paraguay we're adopting a law where they [the eBL solution providers] must be accredited totally."

In late August 2021, DCSA formed a working group involving IG P&I Clubs-approved eBL solution providers, which serves as a venue for the development of a standard rulebook that would ensure interoperability between eBL platforms. As of March 2022, two formal rounds of negotiations between the DCSA and eBL solution providers were held within the DCSA working group. Additionally, DCSA held follow-up "one-on-one" meetings with each solution provider. This process yielded a standard rulebook that would enable legal interoperability between eBL platforms. At the time of writing, the DCSA standard rulebook was in the late stages of assessment by IG P&I Clubs, with approval expected in the first half of 2022.

4.3.2. Law reform

For many years, the discussion on **law reform** regarding BLs and other trade documents has been relegated to academic debates among legal experts and researchers with little urgency on the part of the legislators on the state level despite known and documented downsides of paper BLs. The first major change in this trend occurred in 2017 when UNCITRAL, a subsidiary body of the UN General Assembly and the core legal body of the UN in the field of commercial law, adopted the Model Law on Electronic Transferable Records (MLETR). Working Group IV of the UNCITRAL developed MLETR through an inclusive and deliberative process involving 60 states between 2011 and 2016. MLETR represents a *public legislative standard* containing a set of legal principles intended to provide a basic legal framework for national legislatures to enable the use of electronic transferable records (ETRs), including eBLs, both domestically and across borders. Although technology-neutral, MLETR specifically addresses and supports the use of blockchain and smart contracts to achieve the intended purposes of establishing a reliable data pipeline and paperless trade[84]. Legal Officer and Secretary of the UNCITRAL Working IV explained the key intentions behind MLETR:

"[...] we knew that we had some fundamental principles like functional equivalence [of paper-based and electronic documents]. And we knew there was a gap to fill. [...] but at the same time, we didn't foresee the impact that this [developing MLETR] would have. Because in itself, this is just a way to have the electronic equivalence of commercial documents and instruments, but nobody knew

[84] This topic is addressed in the Explanatory Note of the MLETR: https://uncitral.un.org/sites/uncitral.un.org/files/media-documents/uncitral/en/mletr_ebook_e.pdf

that it was possible to trigger the digital transformation of the whole process. In a way now, we understand it and we foresee that everything will be fully digital. […]MLETR happens to be the missing cornerstone in the digital building, because from [the publication of] MLETR onwards there's no excuse not to go fully digital."

During the course of the present study, several major milestones for MLETR adoption were observed. In March 2021, Singapore became the first major maritime jurisdiction to adopt MLETR, thereby legally enshrining functional equivalence between paper BLs and eBLs. At the same time, the Law Commission of England and Wales published a report to the Parliament with draft legislation for law reform that would recognize ETRs, including eBLs. The adoption of an MLETR-compliant law in England and Wales is expected in early 2022[85]. Another important development indicating a dramatic increase in urgency from the legislators to facilitate the digitalization of trade documents as part of a broader set of measures for economic recovery was the ministerial declaration by digital and technology ministers of the G7[86] countries to promote MLETR and encourage their member states to adopt equivalent local laws. The declaration was followed by the publication of G7 trade ministers' digital trade principles that further outline a series of action points that together form an implementation framework to govern cross-border data use and digital trade. The managing director of ICC DSI expressed optimistic expectations regarding MLETR adoption in the near future:

"We know France is coming, we know Germany is coming. We know that Italy through the G7, we know all of that is coming. We know that the Commonwealth is busy building the business case there, so long story short, we know that the conversation on legal reform will no longer be topical in two years."

These developments have concurrently been supported by the maritime trade ecosystem. According to one respondent, MLETR first received notable traction with the publication of a report on the legal status of eBLs commissioned by the ICC Banking Commission (ICC, 2018). In 2021, efforts to promote the adoption of MLETR by states across the world, concurrently with the cross-industry alignment of technical and legal standards for eBLs were formalized by the ICC through a *neutral cross-industry governance unit* called the Industry Advisory Board. The Industry Advisory Board

[85] Currently, six jurisdictions have adopted MLETR-compliant laws. In addition to Bahrain, which adopted MLETR in 2019, five jurisdictions including Singapore, Paraguay, Belize, Kiribati and the Abu Dhabi Global Market adopted MLETR during 2021. See more at: https://www.dsi.iccwbo.org/policymakers

[86] For more details see: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/981567/G7_Digital_and_Technology_Ministerial_Declaration.pdf

operates under the oversight of the ICC DSI Governance board, which sets the strategic direction for the DSI, and was established in August 2021. This cross-regional and cross-industry body was intended to support B2B and B2G processes standardization through a neutral governing body. The members include SDOs from the shipping (e.g., DCSA, BIMCO) and related industries, financial institutions (e.g., SWIFT), and several large corporates[87].

5. Discussion

This paper sought to explore the crucial factors in digital infrastructure development in a heterogeneous inter-organizational environment on a global level and how such an effort can be governed. The study offers a holistic perspective that encompasses technical architecture considerations on an organizational and industry level and efforts involving establishing multiple decision-making bodies with the ability to develop mechanisms that collectively govern the development of an emerging digital infrastructure. In line with existing conceptualizations in the literature (Tilson et al., 2010; Constantinides and Barrett, 2015; Hanseth and Rodon, 2021), the preceding empirical narrative is considered to be a case of digital infrastructure development since it concerns the technical, organizational and governance foundations for a set of essential information services and legal structures necessary for issuing, transferring and surrendering an electronic version of a document that underpins international trade transactions.

Based on evidence from an in-depth case study, the analysis demarcates three elements of digital infrastructure development in the examined case: (1) technology architecture, (2) technological interoperability, and (3) legal certainty.

First, the *technology architecture* dimension pertains to the technical underpinnings of a digital infrastructure to support eBLs. It focuses on the blockchain-enabled decentralization and prevention of the double-spend problem associated with transfers of digital assets. The findings suggest that both of these elements are necessary to create legal and commercial certainty in the context where an eBL as a de-facto digital asset replaces an inherently decentralized but inefficient and risk-prone paper BL. Second, the *technological interoperability* dimension relates to achieving compatibility between eBL solutions and the installed base in the container shipping industry. This additionally includes

[87] Source: https://www.dsi.iccwbo.org/_files/ugd/0b6be5_d4386789c9fe425b90563065e4d67b57.pdf

technical interoperability between the eBL solutions themselves. The findings suggest that these factors are driven by open-source technical standardization and incentives created by industry and inter-industry actors to promote and adopt standards. Finally, the *legal certainty* dimension addresses an understudied legal aspect of digital infrastructure development. It provides insights into how "localized" efforts led by private industry actors to fill a gap in the legal treatment of eBLs both drive and benefit from standardization on an industry level that, in turn, creates an environment that demonstrates the necessity of state law reform to recognize eBLs in a way that a truly global digital infrastructure can emerge and be leveraged by trading parties. The relationships between the delineated factors are illustrated in Figure 2.

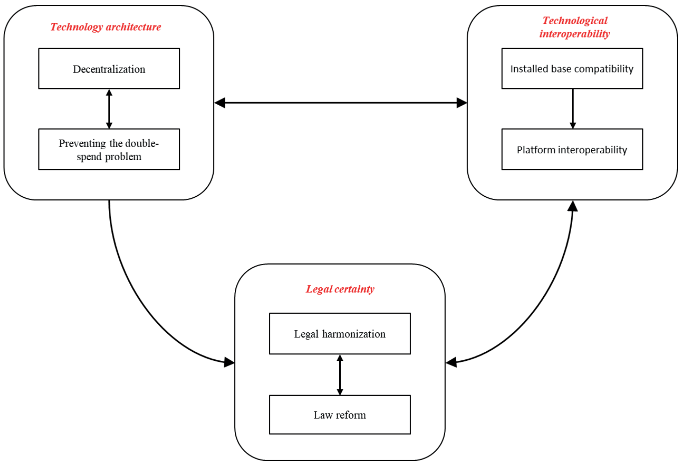

Figure 2: Relationships between digital infrastructure development factors

The findings further demonstrate clear interaction patterns between actors at different levels. Given the competitive nature and commercial sensitivity of interactions between trading parties and the openness and uniformity required to change how critical documentation materializes (Scott and Orlikowski, 2021), it proved impossible for a single entity to assume a dominating role in governing the development of the digital infrastructure to support eBLs. Instead, the emerging digital infrastructure was governed through an interplay between individual organizations at the "local" level (e.g., ocean carriers, eBL solution providers), SDOs at the industry level (e.g., DCSA), inter-industry bodies (e.g., ICC DSI), and inter-governmental and lawmaking entities (e.g., UNCITRAL) operating with a global remit. In reflecting on the findings presented above, literature on polycentric governance (Ostrom, 1961; Ostrom, 1990) proved helpful in understanding and articulating the interaction patterns between stakeholders and decision-making bodies with interests and spheres of influence that at some points overlapped and complemented each other and at others diverged.

According to the existing literature, a polycentric approach is characterized by multiple "governing units" operating at different levels (Ostrom, 1990; McGinnis, 1999). In a polycentric system, these governing units represent organizations (e.g., eBL solution providers and ocean carriers) or other entities (such as container shipping industry SDOs, inter-industry and inter-governmental bodies, and lawmakers) that exercise considerable independence to create and apply (e.g., through a legal mandate, use of incentives) governance mechanisms such as standards, rules, mandates or authoritative norms within their respective domains (Constantinides and Barrett, 2015). The study further builds on the concept of "nesting" of governance (McGinnis, 1999), which maintains that governance mechanisms are linked to one another in a series of "layers" such that smaller units of governance become a part of a larger "system" without necessarily giving up their decision-making authority (McGinnis, 1999; Constantinides, 2012).

Constantinides and Barrett (2015) argue that the value of nesting is closely related to the horizontal and vertical assurance problems that arise when governance is multilayered. The introduction of higher layers of governance alleviates vertical assurance problems of lower level stakeholders to the extent that the stakeholders at lower levels maintain the autonomy to enact governance mechanisms, while the adequate representation of lower-level stakeholders at higher governance levels alleviates horizontal assurance problems (Ostrom, 1999; Constantinides and Barrett, 2015). The findings of the present study are consistent with this prior work and support the argument made by Constantinides and Barrett (2015) that the nesting of governance across different layers establishes legitimate links across both horizontal and vertical axes in a way that addresses the tension between the "local" demands for adaptability and the "global" concerns of commonality and consistency in digital infrastructure development (Hanseth and Lyytinen, 2010; Scott and Orlikowski, 2021). Building on the polycentric governance approach and the case findings, this study contributes additional insights by identifying distinctive governance units and governance mechanisms that contribute to the development of digital infrastructure on a global level. The study further contributes by documenting a successful pattern of nesting in which governance mechanisms developed at lower levels serve as "inputs" for the formation of higher-level governance units and mechanisms. Table 3 summarizes governance mechanisms and governing units identified in the analysis.

In line with existing literature, the analysis drew upon the conceptualizations of governance in digital infrastructure development as a collection of structural, procedural, and relational components (Tallon et al., 2013; Hanseth and Rodon, 2021). Firstly, structural components refer to the structures that determine the locus of decision-making, which are here in line with literature on polycentric governance conceptualized as governing units and include industry associations, committees, and working groups. Secondly, procedural components shape how the interactions of parties are enacted and, in the examined case, include multipartite contractual frameworks, industry technical and legal standards, a public legal standard, certification, digital trade principles, and laws. Finally, relational components are related to developing a common set of values related to the emerging digital infrastructure among involved actors. The findings document relational components such as support services for users, quarterly and yearly newsletters by DCSA and ICC DSI, DCSA adopter program, hackathons, reference user programs, business cases quantifying potential gains from BL digitization for world trade and SMEs in particular commissioned by the ICC, policy reform guides and roadmaps by ICC DSI and ministerial declaration by G7 ministers.

The analysis shows that the polycentric governance approach is dependent on structured interactions between governing units and progressive nesting of governance mechanisms that the governance units enacted in their own "domains". For instance, in an attempt to address a legal gap in the treatment of eBLs the eBL solution providers developed private contractual frameworks that governed the transactions on their respective platforms, whose market acceptance, in turn, crucially depended on formal approval by the IG P&I Clubs, an industry level association of insurance underwriters. However, the scalability of those solutions was severely hampered by the "closed club" legal nature of these frameworks and the lack of uniformity regarding data formats and interfaces for handling transfers of eBLs. The establishment of DCSA as a neutral non-profit SDO represented an industry-level response to these issues. DCSA leveraged its nine founding ocean carriers' collective expertise, credibility, and industry presence to develop standards specifically tailored to enable technical interoperability and legal harmonization of eBL solutions. The solution providers themselves were included in the collaborative standard-developing process through working groups under the auspices of DCSA, although notably, only those whose systems were approved by IG P&I Clubs were involved. As a result, DCSA standards were perceived as neutral and representative of the industry. Relatedly, as a cross-industry governing unit, the ICC DSI served as a conduit between legislative efforts by UNCITRAL and national legislatures on the legal facilitation of eBL adoption through advocacy and formalized collaboration with actors in the container shipping industry to ensure the harmonious development of different elements of the emerging digital infrastructure.

Therefore, it is suggested here that allowing for adaptations between multiple centers of decision-making that exercise considerable independence to create governance mechanisms within specific domains is needed to overcome disagreements and turf wars that might prevent digital infrastructure emergence. This insight highlights that the development of digital infrastructure represents a continuous process that is neither top-down nor bottom-up in nature but rather a combination of both (cf. Osmundsen and Bygstad, 2021). In this perspective, the digital infrastructure is developed through the interaction of governing units at different levels, mediated by independently enacted but mutually supporting governance mechanisms.

Element	**Classification**	**Level**	**Focus**
Governance mechanisms			
Private law rulebooks	Multiparty contractual arrangement	Local	• Enabling the execution of transactions involving eBLs in a private inter-organizational setting
IG P&I Club Approval	Certification	Industry/Global	• Independent appraisal and approval of eBL solutions • Credible signal of the viability of approved eBL solutions
Restricted access to industry SDOs	Partner selection mechanism	Industry/local	• Mitigation of coordination problems in standard development • Reducing search costs by leveraging a prior formal evaluation procedure of eBL solutions
DCSA standards	Technical and legal industry standards	Industry	• Establishing standards for secure transfer of eBLs across eBL platforms • Enabling technical and legal interoperability between eBL platforms
DCSA Adopter Programme	Self-certification	Industry/local	• Enabling self-certification of DCSA standard adoption based on a checklist developed by DCSA • Simplifying partner selection for the container shipping industry and trade

			ecosystem actors seeking standards-based eBL solutions
MLETR	Public legal standard	Global	• Enabling legal use of essential commercial tools such as the BL in electronic form both domestically and across borders • Facilitating electronic commerce, improving speed and security of trade transactions • Enabling paperless trade
Governing units			
DCSA	Industry SDO — membership (funding) by major ocean carriers	Industry/local	• Developing technical and legal standards for eBLs • Engaging with industry and inter-industry associations and bodies to drive standard adoption • Advocacy for digitalization in the container shipping industry
DCSA working groups	Collaborative structure for standard development	Industry/local	• Developing and refining technical and legal standards for eBLs based on industry needs and input of relevant stakeholders in the container shipping industry
IG P&I Clubs	Industry association	Industry	• Minimizing risks and liabilities collectively underwritten by the Clubs • Ensuring that the commercial platforms enable the technologically trustworthy and robust transfer of eBLs between parties • Ensuring legal validity of private law rulebooks developed by eBL solution providers to reduce the "legal gap" in recognition of eBLs

ICC DSI	Standard promoting body/orchestrator — Public-private membership and funding	Inter-industry	• Multifaceted coordination between SDOs, businesses, and public bodies • Promotion of DCSA standards for eBLs • Orchestrating efforts of other governance units • Working with UNCITRAL, inter-governmental political forums (e.g., G7), and state governments to align laws
ICC DSI Industry Advisory Board	Neutral governed venue for SDOs, private and public actors	Inter-industry	• Providing a neutral venue for active involvement of a wide range of stakeholders in standard adoption and legal reform • Establishing mechanisms for coordination and conflict resolution
UNCITRAL	United Nations body for trade facilitation through legal means	Global	• Development of non-binding standard legal mechanisms to guide law reform on a state level
Law Commission of England and Wales	Government-appointed body for legal reform	Global	• Formulation of draft legislation that would recognize the equivalence of electronic (i.e., intangible) trade documents, including eBLs and their paper counterparts • Explanation of the benefits of leveraging blockchain technology in the context of the legal treatment of transfers of contract-based intangible assets such as eBLs, while maintaining technology neutrality

Table 3: Polycentric governance in digital infrastructure development

The study offers several contributions to the existing literature. First, the paper contributes to the literature on digital infrastructure development and governance (Ribes and Finholt, 2009; Yoo et al., 2012; Henfridsson and Bygstad, 2013; Constantinides and Barrett, 2015). The predominant view in digital infrastructure research is that digital infrastructures cannot be designed in a top-down fashion (Hanseth and Lyytinen, 2010; Bygstad and Øvrelid, 2020) but rather evolve organically and unpredictably, "drifting" outside of management control (Ciborra, 2001; Grisot et al., 2014) and achieving unbounded scalability (Hanseth and Lyytinen, 2010) through generative mechanisms (Henfridsson and Bygstad, 2013). The present study extends this research by building on the recent work that offers a more nuanced perspective on digital infrastructure development through a combination of top-down influences and bottom-up adaptations (Osmundsen and Bygstad, 2021) between managerial levels in a single organization and a polycentric governance perspective (McGinnis, 1999; Constantinides and Barrett, 2015) to explain interactions of different stakeholders operating on multiple levels in a global inter-organizational setting. This allowed novel insights into governing digital infrastructure development to be generated in an understudied and unique inter-organizational and global setting. The study documents a high level of interdependence among organizations within the container shipping industry and the associated trade ecosystem and between industry bodies and legislators that are simultaneously developing the technical and legal aspects of the nascent digital infrastructure. The findings document specific governance mechanisms and governing units operating at different levels and describe a pattern of nesting of governance that allowed smaller "subunits" to deal with a global problem of digital infrastructure development by reconstituting themselves such that they represented vital interests at the higher levels in a polycentric governance configuration.

Second, although the analysis placed less emphasis on the particular technological design of the underlying architecture (e.g., the consensus mechanisms used by blockchain-based eBL platforms), the present study nevertheless provides evidence of one of the most mature and large-scale deployments of blockchain technology in a commercial environment to date. The study thus contributes to the growing literature on the inter-organizational implications of blockchain technology (Kumar et al., 2020; Lumineau et al., 2021; Kostić and Sedej, 2022). In particular, previous studies have argued that blockchain has limited applicability in inter-organizational transacting due to the issues related to data endo/exogeneity. Namely, blockchain only has fully effective enforcement capabilities regarding endogenous data (i.e., internal data references within the boundaries of the blockchain system) (Lumineau et al., 2021). Similarly, in the context of the present study, the physical transport and attributes of assets represented on eBLs (e.g., timely delivery, quality) are not affected by blockchain. Interestingly, however, the findings indicate that blockchain-based solutions reliably enable the transfer of the eBL as a document which by virtue of (digital) possession confers ownership over physical assets, thereby offering novel insights into how blockchain impacts inter-organizational transacting beyond the strictly digital domain.

6. Conclusion

The study was motivated by the need not just to recognize that digital infrastructures play an increasingly important role in complex inter-organizational settings on a global scale, but also the need to understand the crucial factors and governance arrangements that make digital infrastructure development possible in such an environment. The delineation of particular governance mechanisms and structures that make up an inter-connected governance configuration improves our understanding of how organizations, industry, and inter-industry associations and governments can collaboratively contribute to developing a digital infrastructure that can potentially bring about enormous economic benefits.[88]

This study is subject to several limitations that call for further research. Even though case-based research and qualitative data can facilitate the investigation of complex phenomena, they also restrict the statistical generalizability of findings (Yin, 2014). While data has been collected over a period of more than four years, digital infrastructure development is a lengthy process that is still ongoing. At the time of writing, the outcome of several processes discussed above, such as industry standardization efforts and legal reform, is still unknown. Therefore it is not possible to fully evaluate the impact of the three demarcated factors contributing to digital infrastructure development. Further, this study does not suggest that the three outlined dimensions fully explain all aspects of the complex process of digital infrastructure development that involves numerous actors on both organizational and state levels. A myriad of factors will likely play a role in actors' decision-making process, including commercial interests and political factors. Future studies could apply a longitudinal process-based approach to track the progress over time in each of the three dimensions outlined in this study.

The three identified dimensions could also be applied to explore the dynamics of building blockchain-based platforms in similar settings, such as the digitalization of other trade-related documents that

[88] Research by the International Chamber of Commerce estimates that digitalizing the trade documentation could increase trade across the G7 countries by nearly $9 trillion or nearly 43% based on 2019 values by 2026. Source: https://www.iccgermany.de/wp-content/uploads/2021/10/Creating-a-Modern-Digital-Trade-Ecosystem-G7.pdf

have a direct financial component (e.g., letters of credit). The proliferation of blockchain-based trade documentation would open several possible avenues for research across various disciplines, such as management accounting, innovation, strategy, international business, and operations management.

References

Abadi, J., and M. Brunnermeier. 2018. Blockchain economics. *National Bureau of Economic Research*. https://scholar.princeton.edu/sites/default/files/markus/files/blockchain_paper_v7a.pdf

Andersen, J. V., and C. I., Bogusz. 2019. Self-Organizing in Blockchain Infrastructures: Generativity Through Shifting Objectives and Forking. *Journal of the Association for Information Systems* 20(9):1242-1273.

Andersson, M., R., Lindgren, and O., Henfridsson. 2008. Architectural knowledge in inter-organizational IT innovation. *The Journal of Strategic Information Systems* 17(1):19-38.

Babich, V., and G. Hilary. 2020. Distributed Ledgers and Operations: What Operations Management Researchers Should Know About Blockchain Technology. *Manufacturing & Service Operations Management* 22(2):223–240.

Beck, R., C. Müller-Bloch, and J.L. King. 2018. Governance in the Blockchain Economy: A Framework and Research Agenda. *Journal of the Association for Information Systems* 19(10):1020-1034.

Beecher, S. 2006. Can the Electronic Bill of Lading Go Paperless? *The International Lawyer* 40(3):627-647.

Besen, S.M., and J. Farrell. 1994. Choosing How to Compete: Strategies and Tactics in Standardization. *Journal of Economic Perspectives* 8(2):117–131.

Braa, J., O., Hanseth, A., Heywood, W., Mohammed, and V. Shaw. 2007. Developing Health Information Systems in Developing Countries: The Flexible Standards Strategy. *MIS Quarterly* 31(2):381-402.

Braun, V., and Clarke, V., 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3(2):77–101.

Bygstad, B., and E. Øvrelid. 2020. Architectural alignment of process innovation and digital infrastructure in a high-tech hospital. European Journal of Information Systems 29(3):220-237.

Catalini, C., and J. S. Gans. 2020. Some Simple Economics of the Blockchain. *Communications of the ACM* 63(7): 80-90.

Chen, L., L. W., Cong, and Y., Xiao. 2020. A Brief Introduction to Blockchain Economics. In: Information for Efficient Decision Making: Big Data, Blockchain and Relevance (ed.) K. Balachandran. World Scientific Publishers. 1-40.

Chiu, J., and T. V., Koeppl. 2019. Blockchain-Based Settlement for Asset Trading. *The Review of Financial Studies* 32(5):1716–1753.

Ciborra, C.U., and Associates. 2000. From Control to Drift: The Dynamics of Corporate Information Infrastructures. *Oxford University Press*.

Cohen, W. M., and D. A. Levinthal. 1990. Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly* 35(1):128-152.

Collis, J. and Hussey, R. 2013. Business Research: Practical Guide for Undergraduate and

Postgraduate Students (4th ed.). Basingstoke: Palgrave Macmillan.

Cong, L.W. and Z. He. 2019. Blockchain Disruption and Smart Contracts. *The Review of Financial Studies* 32(5):1754–1797.

Corbin, J. M., and A. Strauss. 1990. Basics of qualitative research: Grounded theory procedures and techniques. Sage Publications, Inc.

Chod, J., N., Trichakis, G. Tsoukalas, H., Aspergren, and M., Weber. 2020. On the Financing Benefits of Supply Chain Transparency and Blockchain Adoption. *Management Science* 66(10):4359-4919.

Constantinides, P. 2012. Perspectives and Implications for the Development of Information Infrastructures. *IGI Global*.

Constantinides, P., and Barrett. 2015. Information Infrastructure Development and Governance as Collective Action. *Information Systems Research* 26(1):40-56.

Constantinides, P., Henfridsson, O., Parker, G.G., 2018. Introduction—Platforms and Infrastructures in the Digital Age. *Information Systems Research* 29(2):381–400.

David, P.A., 1985. Clio and the economics of QWERTY. *American Economic Review* 75(2):332–337.

Dean, J., and M. Sharfman. 1996. Does decision process matter? A study of strategic decision-making effectiveness. *Academy of Management Journal* 39(2):368-396.

Dekker, H.C. 2016. On the boundaries between intrafirm and interfirm management accounting research. *Management Accounting Research* 31(2016):86-99.

Devaraj, S., and R. Kohli. 2003. Performance impacts of information technology: Is actual usage the missing link? *Management Science* 49(3):273-289.

DiMatteo, L.A. 2017. International Business Law and the Legal Environment: A Transactional Approach (3rd ed.). Routledge.

Digital Container Shipping Association. 2020. Standard for the Bill of Lading: A roadmap towards eDocumentation. https://dcsa.org/wp-content/uploads/2020/12/20201208-DCSA-P4-DCSA-Standard-for-Bill-of-Lading-v1.0-FINAL.pdf

Digital Container Shipping Association. 2022. Standard for the Bill of Lading: A roadmap towards eDocumentation (BETA release 2.0, April 2022). https://dcsa.my.salesforce.com/sfc/p/#2o000000YvHJ/a/7T000000bnvz/uliMKNmUOPewLwK2K5SdERjg7WSS8C7Fs7v8UYQiPTg

Dubovec, M. 2006. The problems and possibilities for using electronic bills of lading as collateral. *Arizona Journal of International and Comparative Law.* http://arizonajournal.org/wp-content/uploads/2015/11/Dubovec-note.pdf

Edwards, P. N., S. J. Jackson, G. C. Bowker, C. P. Knobel. 2007. Understanding infrastructure: Dynamics, tensions, and design. Report, History and Theory of Infrastructure: Lessons for New Scientific Cyberinfrastructure workshop, University of Michigan, Ann Arbor. http://hdl.handle.net/2027.42/49353.

Egyedi, T., and J. Spirco. 2011. Standards in transitions: Catalyzing infrastructure change. *Futures*

43(2011):947-960.

Farrell, J., and G. Saloner. 1986. Installed Base and Compatibility: Innovation, Product Preannouncements, and Predation. *The American Economic Review* 75(5):940-955.

Gandhi, P, S. Khanna, and S. Ramaswamy. 2016. Which Industries Are the Most Digital (and Why)?. *Harvard Business Review*.

Gioia, D.A., Corley, K.G., Hamilton, A.L. 2013. Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods* 16(1):15-31.

Glaser, B.G., Strauss, A.L., 2017. Discovery of grounded theory: Strategies for qualitative research. Routledge.

Hanseth, O., and K., Lyytinen. 2010. Design theory for dynamic complexity in information infrastructures: The case of building Internet. *Journal of Information Technology* 25(1):1-19.

Hanseth, O., and J., Rodon. 2021. The Dynamics of Architecture-Governance Configurations: An Assemblage Theory Approach. *Journal of the Association for Information Systems* 22(1):130-155.

Hanseth, O., E., Monteiro, and M., Hatling. 1996. Developing Information Infrastructure: The Tension Between Standardization and Flexibility. *Science, Technology, and Human Values* 11(4):407-426.

Henfridsson, O., and B. Bygstad. 2013. The Generative Mechanisms of Digital Infrastructure Evolution. *MIS Quarterly* 37(3):907-93.

Goldby, M. 2008. Electronic bills of lading and central registries: what is holding back progress? *Information & Communications Technology Law* 17(2):125-149.

Goldby, M. 2011. Legislating to facilitate the use of electronic transferable records: A case study. *UNCITRAL Colloquium on Electronic Commerce*. http://9jalegal.com.ng/downloads/Articles/International%20Trade/Legislating_to_facilitate_the_use_of_electronic_transferable_records_-_a_case_study__2.pdf

Grisot, M., O. Hanseth, and A. A. Thorseng. 2014. Innovation Of, In, On Infrastructures: Articulating the Role of Architecture in Information Infrastructure Evolution. *Journal of the Association for Information Systems* 15(4):197-219.

International Chamber of Commerce. 2018. The legal status of electronic bills of lading. https://iccwbo.org/content/uploads/sites/3/2018/10/the-legal-status-of-e-bills-of-lading-oct2018.pdf

International Organization for Standardization. 2019. Glossary of Terms. https://www.iso.org/sites/ConsumersStandards/1_standards.html

Jensen, T., J. Hedman, and S. Henningsson. 2019. How TradeLens Delivers Business Value With Blockchain Technology. *MIS Quarterly Executive* 18(4):221-243.

Kostić, N., and T., Sedej. 2022. Blockchain technology, inter-organizational relationships and management accounting: A synthesis and a research agenda. *Accounting Horizons* (forthcoming)

Koutsikouri, D., R. Lindgren, O. Henfridsson, and D. Rudmark. 2018. Extending Digital Infrastructures: A Typology of Growth Tactics. *Journal of the Association for Information Systems* 19(10):1001-1019.

Kumar, A., R. Liu, and Z. Shan. 2020. Is Blockchain a Silver Bullet for Supply Chain Management? Technical Challenges and Research Opportunities. *Decision Sciences* 51(1):8-37.

Lacity, M. 2018. Addressing Key Challenges to Making Enterprise Blockchain Applications a Reality. *MIS Quarterly Executive* 17(3):201-222.

Lacity, M., and R. Van Hoek. 2021a. What We've Learned So Far About Blockchain for Businesses. *MIT Sloan Management Review*.

Law Commission of England and Wales. 2021. Electronic Trade Documents Report and Bill. https://s3-eu-west-2.amazonaws.com/lawcom-prod-storage-11jsxou24uy7q/uploads/2022/03/Electronic-Trade-Documents-final-report-ACCESSIBLE-1.pdf

Malhotra, A., S. Gosain, and O. A., El Sawy. 2007. Leveraging Standard Electronic Business Interfaces to Enable Adaptive Supply Chain Partnerships. Information Systems Research 18(3):260-279.

Mattke, J., C. Maier, A. Hund, and T. Weitzel. 2019. How an Enterprise Blockchain Application in the U.S. Pharmaceuticals Supply Chain is Saving Lives. *MIS Quarterly Executive* 18(4):245-261.

McGinnis, M. 1999. Polycentric Governance and Development: Readings from the Workshop in Political Theory and Policy Analysis. University of Michigan Press.

Murray, D. E. 1983. History and Development of the Bill of Lading. *University of Miami Law Review* 37(3):689-732.

Nakamoto, S. 2008. Bitcoin: A peer-to-peer electronic cash system. Available at: https://bitcoin.org/bitcoin.pdf

Nicolaou, A. I., K. L Sedatole, and N.K. Lankton. 2011. Integrated Information Systems and Alliance Partner Trust. *Contemporary Accounting Research* 28(3):1018-1045.

Osmundsen, K., and B. Bygstad. 2021. Making sense of continuous development of digital infrastructures. *Journal of Information Technology* (Forthcoming)

Ostrom, E. 1990. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, New York.

Ostrom, E. 1996. Crossing the great divide: Coproduction, synergy and development. World Development 24(6):1079-1087.

Ostrom, E. 2010a. Beyond Markets and States: Polycentric Governance of Complex Economic Systems. *American Economic Review* 100(3):641-672.

Ostrom, E. 2010b. Polycentric systems for coping with collective action and global environmental change. *Global Environmental Change* 20(4):550-557.

Ostrom, V., C. M. Tiebout, and R. Warren. 1961. The Organization of Government in Metropolitan Areas: A Theoretical Inquiry. *American Political Science Review* 55(4):831-842.

Ostrom, V. 1999. Polycentricity (Parts 1 and 2). In: McGinnis, M. (Ed.), Polycentricity and Local Public Economies: Readings from the Workshop in Political Theory and Policy Analysis. University of Michigan Press, Ann Arbor, pp. 52–74, 119–138.

Ozcan, P. and F.M. Santos. 2015. The Market that Never Was: Turf wars and failed alliances in mobile payments. *Strategic Management Journal* 36(10):1486-1512.

Pagnoni, A., and A., Visconti. 2010. Secure electronic bills of lading: Blind counts and digital signatures. *Electronic Commerce Research* 10:363-388.

Rauchs, M., A. Glidden, B. Gordon, G. Pieters, M. Recanatini, F. Rostand, K. Vagneur, and B. Zhang. 2018. Distributed Ledger Technology Systems: A Conceptual Framework. *Cambridge Centre for Alternative Finance, Cambridge Judge Business School.* https://www.jbs.cam.ac.uk/faculty-research/centres/alternative-finance/publications/distributed-ledger-technology-systems/#.XkwjwihKj-h

Ribes, D., and T.A., Finholt. 2009. The Long Now of Technology Infrastructure: Articulating Tensions in Development. *Journal of the Association for Information Systems* 10:375398.

Rodon, J., and L. Silva. 2015. Exploring the Formation of a Healthcare Information Infrastructure: Hierarchy or Meshwork? *Journal of the Association for Information Systems* 16(5):394-417.

Rolland, K. H., and E. Monteiro. 2002. Balancing the Local and the Global in Infrastructural Information Systems. The information Society 18(2):87-100.

Saadatmand, F., Lindgren, R., and U., Schultze. 2019. Configurations of platform organizations: Implications for complementor engagement. *Research Policy* 48(8):1-17.

Sahay, S., E., Monteiro, and M. Aanestad. 2009. Configurable politics and asymmetric integration: Health e-infrastructures in India. *Journal of the Association for Information Systems* 10(5):399-414.

Schmitz, T. 2011. The bill of lading as a document of title. *Journal of International Trade Law and Policy* 10(3):250-280.

Scott, S. V., and W. Orlikowski. 2021. The Digital Undertow: How the Corollary Effects of Digital Transformation Affect Industry Standards. *Information Systems Research* (forthcoming).

Scott, S. V., J. Van Reenen, and M. Zachariadis. 2017. The long-term effect of digital innovation on bank performance: An empirical study of SWIFT adoption in financial services. Research Policy 46(5):984-1004.

Scott, Susan V., and G. Walsham. 1998. Shifting boundaries and new technologies: a case study in the UK banking sector. In: In Proceedings of the International Conference of Information Systems, Helsinki, Finland:177–187.

Sedej, T. 2021. Blockchain Technology and Inter-organizational Relationships. Copenhagen Business School PhD Series No. 24.2021.

Star, S., and K., Ruhleder. 1996. Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces. *Information Systems Research* 7(1):111-134.

Stratopoulos, T. C., V. X. Wang, and H. J. Ye. 2021. Use of Corporate Disclosures to Identify the Stage of Blockchain Adoption. *Accounting Horizons* (forthcoming)

Tallon, P. P., R. V. Ramirez, and J. E. Short. 2014. The Information Artifact in IT Governance: Toward a Theory of Information Governance. *Journal of Management Information Systems* 30(3):141-177.

Taniverdi, H., P. Konana, and L., Ge. 2007. The Choice of Sourcing Mechanisms for Business Processes. *Information Systems Research* 18(3):280-299.

Thambar, P.J., D.A. Brown, and P. Sivabalan. 2019. Managing systemic uncertainty: The role of industry-level management controls and hybrids. *Accounting, Organizations and Society* 77(August).

Tilson, D., K., Lyytinen, and C., Sorensen. 2010. Digital Infrastructures: The Missing IS Research Agenda. *Information Systems Research* 21(4):685-687.

Tiwana, A. 2013. Platform Ecosystems: Aligning architecture, governance, and strategy. San Francisco: Morgan Kaufmann.

Tiwana, A., and B. Konsynski. 2010. Complementarities Between Organizational IT Architecture and Governance Structure. *Information Systems Research* 21(2):288-304.

Tiwana, A., B. Konsynski, and N. Venkatraman. 2014. Special Issue: Information Technology and Organizational Governance: The IT Governance Cube. *Journal of Management Information Systems* 30(3):7-12.

Weber, B. W. 1994. Information technology in the major international financial markets: In: Deans, Candace P., Karwan, Kirk R. (Eds.), In Global Information Systems and Technology: Focus on the Organization and Its Functional Areas. IGI Publishing:132–166.

Weill, P., and J. Ross. 2004. IT Governance: How Top Performers Manage IT Decision Rights for Superior Results. Harvard Business School Press.

Xu, X., I. Weber, M. Staples, L. Zhu, J. Bosch, L. Bass, C. Pautasso, and P. Rimba. 2017. A taxonomy of blockchain-based systems for architecture design. *In 2017 IEEE International Conference on Software Architecture (ICSA)*: 243-252. https://ieeexplore.ieee.org/document/7930224

Yates, J., and C. N. Murphy. 2019. Engineering Rules: Global Standard Setting Since 1880. Johns Hopkins University Press, Baltimore.

Yermack, D. 2017. Corporate Governance and Blockchains. *Review of Finance* 21(1):7-31.

Yin, R. K. (2009). *Case study research: Design and methods* (6th ed.). Thousand Oaks, CA: SAGE.

Yoo, Y., R. J. Boland Jr., K. Lyytinen, and A. Majchrzak. 2012. Organizing for Innovation in the Digitized World. *Organization Science* 23(5):1398-1408.

Zachariadis, M., G., Hileman, and S. V. Scott. 2019. Governance and control in distributed ledgers: Understanding the challenges facing blockchain technology in financial services. *Information and Organization* 29(2):105-117.

Zavolokina, L., R. Ziolkowski, I. Bauer, and G. Schwabe. 2020. Management, Governance and Value Creation in a Blockchain Consortium. *MIS Quarterly Executive* 19(1):1-17.

Zhu, K., K.L. Kraemer, V. Gurbaxani, and S.X. Xu. 2006. Migration to Open-Standard Interorganizational Systems: Network Effects, Switching Costs, and Path Dependency. *MIS Quarterly* 30(August):515-539.

Zimmer, M. P., and M. Niemimaa. 2020. Cultivating a 'Digital Jungle': Toward a Hybrid Governance Perspective on Infrastructure Evolution. June 2020 *Conference: 24th Pacific Asia Conference on Information Systems (PACIS)*.

Appendices

Appendix A: Overview of conducted interviews

Phase	#	Date	Type	Position	Organization
Phase 1	1	14.06.2018.	Joint Interview	Special Consultant/Chief Consultant	Ministry of Industry, Business and Financial Affairs Denmark
	2	06.07.2018.	Interview	Head of Data and Business Development	Danish Maritime Authority
	3	10.10.2019.	Interview	CEO, Partner; Leading Expert in the Container Shipping Industry	Vespucci Maritime
Phase 2	4	31.03.2020.	Interview	Head of Strategy and Operations	TradeLens
	5	20.05.2020.	Interview	CDIO; Chairman	Mediterranean Shipping Company (MCS); Digital Container Shipping Association (DCSA)
	6	26.05.2020.	Interview	Vice President, Blockchain Solutions	IBM/TradeLens
	7	03.06.2020.	Interview	Sloan Distinguished Professor of Management; Expert on Standardization	MIT Sloan Business School
	8	10.06.2020.	Interview	President; CEO	Global Container Terminals Inc.
	9	07.07.2020.	E-mail interview	Various departments	Pacific International Lines
	10	03.09.2020.	Interview	CTO	Youredi
	11	09.09.2020.	Interview	CIO	YILPORT Holding
Phase 3	12	14.07.2021.	Interview	Head of Contracts and Clauses	BIMCO
	13	15.07.2021.	Joint interview	Managing Director; Deputy Director	Digital Standards Initiative (DSI) at the International Chamber of Commerce (ICC)
	14	19.07.2021.	Interview (repeat)	CDIO; Chairman	MSC; DCSA
	15	22.07.2021.	Interview	Co-Founder and CEO	WAVE BL
	16	02.08.2021.	Interview	CTO	CargoX
	17	04.08.2021.	Interview	Co-Founder and Director of Regulatory Affairs	Bolero
	18	05.08.2021.	Interview	Professor of Shipping and Commercial Law; Expert Consultant	Queen Mary University of London; Law Commission of England and Wales and the United Nations

					Commission on International Trade Law (UNCITRAL)
	19	05.08.2021.	Interview	Co-CEO and COO	essDOCS
	20	13.08.2021.	Interview (repeat)	CEO, Partner; Leading Expert in the Container Shipping Industry	Vespucci Maritime
	21	27.08.2021.	Interview	Deputy CEO	CargoX
	22	03.09.2021.	Interview	Senior Analyst and Blockchain Lead, Economic Research Department; Member of the Governance Board	World Trade Organization (WTO); DSI at ICC
	23	14.09.2021.	Interview	Legal Officer Working Group IV (Electronic Commerce)	UNCITRAL
	24	14.09.2021.	Interview	Program Director for eDocumentation	DCSA
	25	11.01.2022.	Interview (repeat)	Program Director for eDocumentation	DCSA

Appendix B: Overview of conferences and webinars

#	Date	Type	Title	Organizer	Location
1	4.11.2017.	Conference participation	Nordic Blockchain Conference	IT University of Copenhagen	IT University of Copenhagen
2	18.4.2018.	Conference participation	Blockchain Conference and Exhibition	Blockchain Expo World Series	Olympia, London
3	18.6.2019 - 20.6.2019.	Conference participation	TOC Europe	TOC Events Worldwide	Ahoy, Rotterdam
4	11.11.2019.	Conference participation	SHIP TECH: Conference on the Future of Shipping	Shipping Watch/Relevent	Copenhagen
5	19.2.2020.	Webinar	Learning about DCSA's Track & Trace standards	DCSA	Online
3	12.5.2020.	Webinar	Digitalization and data standardization: time for the maritime industry to act	Maritime Optimization and Communications	Online
7	26.5.2020.	Webinar	Adjusting to the 'New' New Normal: The Impact of COVID-19	TOC Events Worldwide	Online
8	9.6.2020.	Webinar	Accelerating Digitalization: The role of start-up tech in post-COVID-19 supply chains	TOC Events Worldwide	Online

9	9.6.2020.	Webinar	Advancing Global Trade with Blockchain	IBM Blockchain	Online
10	3.7.2020.	Webinar	Where Next for Global Shipping?	CBS Executive MBA in Shipping and Logistics	Online
11	14.7.2020.	Webinar	Global Overview of the Container Shipping Market	Intermodal Digital Insights	Online
12	15.7.2020.	Webinar	Global Smart Container Forum	Intermodal Digital Insights	Online
13	5.8.2020.	Webinar	An Electronic Bill of Lading, Considered the Holy Grail of the Maritime Industry	IBM Blockchain/TradeLens	Online
14	13.10.2020.	Webinar	Digital Standards Initiative ICC at Trade Finance Special Interest Group	Hyperledger Trade Finance Interest Group	Online
15	17.2.2021.	Webinar	The Future for ship-Shore Community Data Sharing - A Public Highway or Individual Toll Roads?	International Association of Ports and Harbors	Online
16	25.03.2021-03.03.2021.	Conference participation	TPM21: The Premier Conference for the Trans-Pacific and Global Container Shipping and Logistics Community	Journal of Commerce and IHS Markit	Online
17	17.03.2021.	Conference participation	Global Trade and Blockchain Forum – Accelerating Digitalization Through DLT	World Trade Organization and International Chamber of Commerce	Online
18	31.03.2021.	Webinar	MPA Singapore Maritime Trade Digitalisation Seminar – Electronic Bills of Lading	Maritime and Port Authority of Singapore	Online
19	13-14.04.2021.	Webinar	UNCITRAL Webinar on "International experiences with the dematerialization of negotiable transport documents"	United Nations UNCITRAL	Online
20	21.04.2021.	Webinar	Digital Transformation	TOC Digital and TOC Asia	Online
21	24.04.2021	Webinar	One-to-One Conversation with CMA CGM	TOC Asia	Online
22	27.04.2021.	Webinar	MLETR Legal Principles and Implementation & Singapore Trade Trust	Hyperledger Trade Finance Special Interest Group	Online

23	31.05-18.06.2021.	Conference participation	TOC Global Showcase	TOC Digital	Online
24	02.06.2021.	Webinar	Virtual Knowledge Sharing on "UNCITRAL Texts and International Trade in the Digital Era"	United Nations UNCITRAL	Online
25	21.06-25.06.2021.	Conference participation	IAPH World Ports Conference 2021	International Association of Ports and Harbors	Online
26	28.06-02.07.2021.	Conference participation	Global Trade Virtual Week	The Economist	Online
27	30.06.2021.	Webinar	2nd Maritime Trade Digitalisation Webinar – Electronic Bills of Lading (eBLs)	Maritime and Port Authority of Singapore	Online
28	16.08.2021.	Webinar	Webinar on Blockchain Technology for Cross-Border Trade	UN Economic and Social Commission for Asia and the Pacific	Online
29	13.09.2021.	Hybrid in-person Conference and Webinar	Reforming English Law to Enable Electronic Bills of Lading: The Law Commission's Electronic Trade Documents Project	Quadrant Chambers - Pre-eminent international organization for shipping and aviation law	Online
30	15.09-24.09.2021.	Conference participation	OECD Global Blockchain Policy Forum 2021	Organization for Economic Co-operation and Development (OECD)	Online
31	18.10-22.10-2021.	Conference participation	ICC International Trade & Prosperity Week	International Chamber of Commerce (ICC)	Online
32	18.11.2021.	Webinar	ICC Digital Trade Webinar 'Building a modern digital trade ecosystem - Scaling Legal Reforms'	International Chamber of Commerce (ICC)	Online
33	13.01.2022.	Webinar	Logistics Technology: Figuring Out the Elusive Standardization Problem in Global Logistics	Journal of Commerce and IHS Markit	Online

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