Blockchain: Trouble in the Enterprise?

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Completed Research Paper

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Abstract

There has been substantial hype about the use of blockchain for supply chain and trade finance, proclaiming that it would "change the world." Although during 2016-2018 blockchain was riding high on the hype curve, in 2019 it fell into the trough of disillusionment. Along the way, some consultants have recently stopped promoting blockchain and attention appears have shifted away from enterprise blockchain systems. As a result, it probably is not surprising that recently there have been several instances where those enterprise blockchain efforts went insolvent or were shutdown. This paper investigates those blockchain systems and identifies some of the potential factors affecting the success of those systems. We also provide some potential approaches to mitigate the limitations of those applications.

Keywords: Blockchain, Enterprise, Arrow's Impossibility Theorem, Gartner's Hype Cycle, Platform Entrepreneurs, Blockchain Best Practices

Introduction

Nakamoto (2008) provided two ideas that have generated substantial discussion, research and controversy. The first idea was to use a chronologically ordered list of transactions as a ledger, using an append-only capability, in a distributed peer-to-peer computing environment. This approach was based on immutability of the transaction set and distributed peer voting on transactions to provide a measure of trust. The second idea was to use this public ledger as the basis of a market for a cyber-currency: bitcoin. The focus in this paper is on the first use, enterprise blockchains, with a particular concern for enterprise supply chain and financial trade systems.

After the introduction of blockchain, many commenters, such as Dickinson (2016), argued that the blockchain will 'revolutionize' the supply chain, and others called blockchain a 'game changer' in accounting and finance. In 2016, an interview with Don Tapscott, suggested that "blockchains could change the world." However, recently, reactions have been more tempered. In a Wall Street Journal article, motivated in part by Maersk and IBM's shuttering their joint global platform called TradeLens, Bousquette (2022) commented that "Blockchain fails to gain traction in the enterprise." Unfortunately, as noted in that article by, Francesco Bozzano, vice president of the corporate finance group at Moody's Investors Service, when talking about enterprise blockchain efforts indicated "There's not one company that has really shown, let's say, a material change (from using blockchain)."

These remarks are in stark contrasts to expectations from 2016 – 2018, when blockchain was near the peak of Gartner's technology hype cycle, was a part of Gartner's "Top Ten Strategic Technology Trends" and enterprises proposed that blockchain would revolutionize cooperative and distributed business processes. Further, although academic researchers have examined the positive side of blockchain adoption, there has been limited investigation of projects that have not done well. Accordingly, *the purpose of this paper is to examine the emerging evidence regarding blockchain use in enterprises, focusing on supply chains and financial applications that have failed, to better understand the rationales for their failure and the role that blockchain did or did not play in their failures*. As part of our analysis, we investigate some signals that indicate decreasing interest in blockchain over time and increasing concerns with enterprise blockchain. We also investigate limitations identified with those blockchain failures and opportunities to

mitigate those concerns going forward, by analyzing those bankrupt and shuttered applications.

Plan of this Paper

This paper proceeds as follows. This first section has provided an introduction and motivation to the paper, while the next section provides a review of enterprise blockchain systems, economic trade systems, notions of digitalization and digital transformation, Gartner's Hype Cycle, and some previous literature. The section following that background information, analyzes some "signals" about the emerging use of blockchain Gartner's Hype Cycle and from consulting firms. In the section after that, the paper investigates some factors potentially having a negative effect on the potential success of blockchain-based systems. Using those factors, we generate some hypotheses about what might lead to failure in those systems. In the following sections, we provide a list of blockchain efforts that have been shuttered and some blockchain issues associated with those systems. The next section drills down on four systems that this paper examines in detail and compares them back to our hypotheses. In the penultimate section, the paper examines some of the difficulties and potential solutions associated with enterprise blockchain solutions. In the last section, we conclude the paper and examine some extensions.

Background

This section briefly reviews some issues associated with blockchain and some issues associated with the systems discussed in this paper, including trade systems, digitization, digitalization and digital transformation, Gartner's Hype Cycle and previous research.

Enterprise Blockchains

Blockchains are a distributed ledger containing a sequential list of transactions. An important control is provided because transactions can only be added to the list, thus providing a permanent record of those transactions. In addition, in classic public blockchains, that ledger is distributed through the network to multiple nodes, providing a measure of trust by allowing a majority votes determination, in case of concerns over the content. In those settings, blockchains provide a shared and distributed database with no single point of failure.

Enterprise blockchains are often cloud based and so not distributed. In a public blockchain, virtually anyone can have access to the distributed node information. However, in private blockchains, there typically is an administrator, whose jobs include "permitting" participants and configuring system capabilities.

As noted by Pettey (2017) "Contrary to what many believe, blockchain is not a like-for-like replacement for traditional database technologies — it lacks the ability to create, read, update and delete information." Instead, typically, search, manipulation and analysis typically are done off-blockchain in classic databases or data warehouses. As a result, an important, but often overlooked concern with blockchain-based system is the distinction between "On Ledger" versus "Off Ledger" activities. While much of the discussion of the advantages of blockchain, focus on platform capabilities, unfortunately, many activities and workflows in enterprise blockchain-centered systems are off-ledger (e.g., Accenture 2022). For example, activities such as database search are much easier off the blockchain. In addition, certain processes occur off the blockchain whether as pre or post the placement of data on the blockchain. Information that is part of those processes or analyzes will not have the same controls as information on the blockchain.

Economic Trade Systems

Economic trade systems typically are systems that are designed to facilitate country to country trade. One of the first and best-known digital trade systems was Singapore's Tradenet (Konsynski and King 1990). As seen in that case, on the Tradenet web site (tradenet.gov.sg) and in other sources, such systems have substantial data requirements and those data requirements must meet the needs of a range of users, including government regulations, shipping company requirements, customer and shipper requirements, and others in the supply chain. As noted in that case, Singapore establishes the system requirements based on the legal, etc. needs of the country and any system designed to facilitate goods for that country would need to account for those requirements.

A key requirement is that such systems can use electronic documents rather than paper documents and this requirement generally requires legal change in the countries where it is applicable. Perhaps surprisingly, digital and paper documents are not broadly considered equivalent by law. For example, as noted by S & P Global (2022), recently the U.K. "… introduced an Electronic Trade Documents Bill into Parliament, part of a G-7 commitment to reform trade documents …. to put digital trade documents on the same legal footing as their paper-based equivalents."

Digitization, Digitalization and Digital Transformation

It is generally accepted that digitization is concerned with getting data and information into a digital format, while digitalization is concerned with changing workflows and the business model to be digital, rather than manual, to provide new cost reductions, revenue enhancements and value creation. Digital transformation is seen as digitizing products and services through digital efficiencies, innovations and inventions. Building a blockchain capability inevitably requires at least digitization, but likely also digitalization and digital transformation. A key concern are interfaces with other systems, both gathering digital inputs and generating digital outputs to facilitate blockchain use.

Gartner's Hype Cycle

Researchers have suggested that an important tool in the analysis of technology diffusion is Gartner's Hype Cycle (Linden and Fenn 2003, O'Leary 2008), seen in Figure 1. The hype cycle contains five basic steps and provides a life cycle model of technology diffusion. The first step is the "technology trigger," typically is an event generating attention and publicity for an emerging technology. At that point in time there are not likely to be working prototypes but most analysis is still in the lab. The second step is the "peak of inflated expectations," where there are a number of startup companies or technology companies beginning to offer products, using the specific technology. At this point, those companies start providing information to help generate interest in those products, and the press begins to pursue interest in the technologies. Some firms also begin to experiment with the technology and build systems to see how well the technology will meet their needs. The third step is the "trough of disillusionment," that begins to capture some of the difficulties that firms have implementing the new technology as they build systems using the technology. Unfortunately, it is unlikely that the technology will be able to live up to all of the hype given it, and firms begin to find that out. In some cases, this can mean the end of the specific technology, if the costs to make the technology work exceed the benefits. However, as firms and vendors build experience, they may be able to begin to mitigate the problems found in the trough of disillusionment. This is a critical step in the continued life of a technology. If it is successful, then more firms will be able to adopt the technology and make it work in their organizations. The final step is the "plateau of productivity, where the technology finds mainstream adoption. The hype cycle can be related to other technology life cycles, such as the adoption curve and the performance curve.

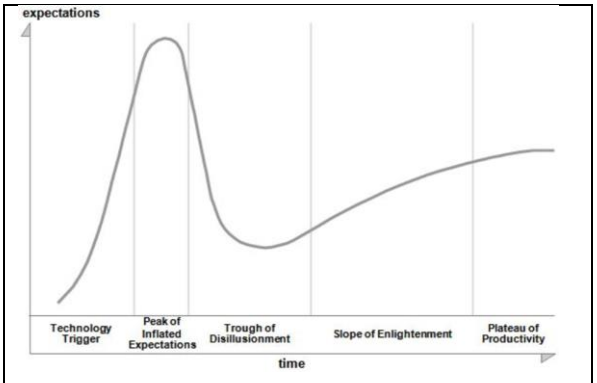

Figure 1. Gartner's Hype Cycle

Selected Previous Research

This section provides a brief review of some of the previous research using blockchain technology in

business. Much of the research to this time, generally was prior to when these enterprise blockchains began to experience difficulties. O'Leary (2017) reviews some issues of concern with blockchain, and some applications of blockchains in supply chains. Lacity (2018) addresses some challenges of introducing blockchains into enterprises, while O'Leary (2019) analyzes blockchains in virtual organizations. Petersen et al. (2019) layout a decision approach for when to use blockchain. Gozman et al. (2020) review development of a prototype system built for regulation, noting the importance of blockchain fit. Lacity and Van Hoek (2021) investigate how Walmart Canada used blockchain to reimagine freight invoice processing. Lacity and Lupien (2022) provide a comprehensive state of the art and state of the use of blockchain technology, providing further detail about blockchain and some of the key firms' projects.

Signals About Blockchains in Enterprises

Although blockchain has been seen as a "game changer," there have been some signals over time that suggest that there may be difficulties with introducing blockchain systems into enterprises.

Blockchain Fatigue

The notion of blockchain fatigue was first noted by Gartner (2019), which predicted that 90% of blockchain projects would suffer blockchain fatigue by 2023. Blockchain fatigue has been defined as a disillusionment with blockchains as a solution for problems such as supply chain (Clarke-Potter 2019). Blockchain fatigue also was seen as limiting the development of blockchain use cases, fatigue in using it or even fatigue in proposing it for use. It is likely that fatigue would result in fewer new uses of blockchain to solve problems. It is also likely that such fatigue could result in decreasing patience with blockchain projects and increasing potential failure, resulting in fewer resources devoted to using blockchain as a solution.

From the Peak of Inflated Expectations to the Trough of Disillusionment

We can trace the hype of blockchain from its introduction into enterprises to the current situation. In 2015, blockchain had not yet been added to Gartner's hype cycle. By 2016, blockchain had risen to near the peak of expectations, but by 2017 blockchain had already started downward off of the peak of expectations and was headed into the trough of disillusionment and its location was the roughly the same during 2018. By 2019 and 2020, blockchain had fallen into the trough of disillusionment. Some may argue that its residence in the trough of disillusionment may signal its death or need for a new generation of blockchain tools. A summary of the location of blockchain in Gartner's hype cycle is given in Figure 2.

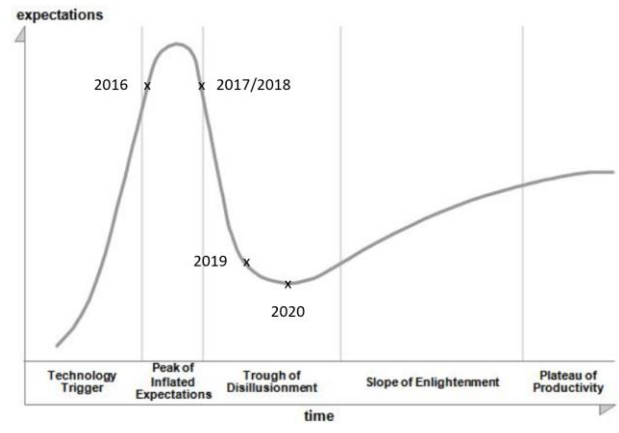

Figure 2. Gartner Hype Curve for Blockchain (2016 – 2020)

After 2020, there was no individual assessment of blockchain on the hype cycle. However, in 2020 and 2021, Gartner generated hype cycles specifically for "blockchain technologies," as a standalone, indicating that blockchain was seen as an important set of technologies by Gartner. However, in July 2022, blockchain was aggregated in Gartner's "Hype Cycle for Blockchain and Web 3.0." Vermaak (2022) suggests that "Web 3.0 is a decentralized internet built on an open blockchain network that is not owned and controlled by

large entities." If this is the evolution of blockchain, then it will be interesting to see the role of enterprises using blockchain and Web 3.0 in the future. Gartner (2019) also noted that "… most blockchain technologies are still 5 to 10 yeas away from transformational impact." Further at that time, Gartner noted that "Blockchain technologies have not lived up to the hype and most enterprise blockchain projects are stuck in experimentation." Finally, as noted by Litan (2021) "… successful permissioned enterprise blockchain projects are scarce."

IBM's Annual Report Disclosures on Blockchain Decrease to Zero

There have been signals that some consulting firms seem to be deemphasizing blockchain projects. For example, an analysis of IBM annual reports for the use of "blockchain" and "AI" or "Artificial Intelligence" are summarized in Table 1. The numbers of uses of blockchain are at the maximum in 2018, and goes to zero in 2021 and 2022, while the comparative use of artificial intelligence / AI has generally increased over time. As a result, this table suggests a peak in 2016-2018, similar to the results in Figure 2 for the peak hype cycle information. Further, this also suggests a limited role or interest in blockchain in the near future.

Year	Blockchain	AI/Artificial Intelligence
2015	0	1
2016	21	13
2017	28	56
2018	33	60
2019	11	54
2020	6	86
2021	0	58
2022	0	64

Table 1. Number of Uses of Technology Words in IBM Annual Reports

Factors Affecting Likelihood of Enterprise Blockchain System Success

The purpose of this section is to elicit some potential factors affecting the likelihood of Enterprise Blockchain success, beyond the general ideas and concerns of blockchain systems. In so doing we use a number of established and new theories. Although we list several different factors affecting the potential success of these blockchain trade and financial systems, there can be others. We chose these factors because they are likely to be *questions* of any practitioner before adopting a new technology such as blockchain. There is a summary of our hypotheses and questions given in Table 2.

Group Decision Making/Arrow's Dictator

Arrow (1970) investigates the situation where groups need to make a decision that all need to abide by. Arrow finds that if a group of decision makers has two or more members, with three choices to choose between, then it is impossible to create a social welfare function that will satisfy all three requirements associated with a rationale decision that is optimal for all participants. In the case of a system, representing many different perspectives and participants, it is impossible to generate a configuration that is optimal for all. As a result, in those settings, power struggles likely lead to a dominant group or individual, or the equivalent to Arrow's "dictator" making the decisions. Thus, there are at least two implications for blockchain.

In trade systems, disparate groups may band together. However, the needs of disparate companies and countries in economic trade systems are unlikely to be the same. As noted by Bousquette (2022) such projects rely on companies "… often with different sets of priorities." *Thus, for hypothesis #1, multiple nonhomogeneous groups will negatively affect the potential success of enterprise blockchain systems.*

In addition, in blockchain consortiums, the dictator might be the administrator or lead consultant or

dominant configuration voice. Thus, with Arrow's theorem, it is apparent that there would likely be concerns from other participants in the development of some proposed blockchain projects. Further, part of the payoff to digital transformation is the development of new information by the system for the developing firm. Although distributed blockchain systems often are touted for making information visible throughout the network of users, it is likely that other shippers and participants would recognize that the "owner" (Arrow's "dictator") likely would have numerous potential informational advantages. For example, if a competitive shipper, were to join the system owned by another shipper, it is possible that many information asymmetries would be eliminated for the system owner. As a result, our exploratory *hypothesis # 2 is that competitors will not want to join a blockchain consortium created by a competitor, with the potential to be an Arrow dictator, or to provide others with value creating information asymmetries*.

Technology Complexity of Blockchain

According to Bousquette (2022) experts have indicated that although the blockchain approach "… can provide a level of trust that other shared databases don't, but the technology is complex, requires more computing power and is more expensive to run than existing databases…." Thus, in order to fully adapt and employ the technology, organizations must employ and adapt to additional complexity and cost, which of course can limit ability of organizations to adapt to the new technologies. This results in the *hypothesis #3 that the additional complexity of blockchain will be a negative effect on the success of blockchain supply chain and trade systems*.

Technology Limitations of Blockchain

It is important to know the limitations of any implemented technology. An important issue affecting the potential success of enterprise blockchain is how well blockchain technology can accommodate enterprise requirements. As noted by Petersen, Risius and Beck (2019, p. 99) "… the drawbacks of blockchain databases (e.g., scalability, capacity, latency, privacy) mean that the technology is not always appropriate." For example, Accenture (2022) identified some limitations of blockchain when set in an enterprise environment, including issues of latency and concurrency. There is higher latency in distributed systems. The typical blockchain architecture increases that latency because of the "round-trip" flow of data going from the ledger, and then distributing the data out to partner nodes and related applications. A blockchain architecture can support concurrency, which is needed for increasing scale. However, concurrency can cause contention when multiple transactions target the same alternate data set.

Similarly, as noted above, blockchain is not a replacement for classic database capabilities, thus, to the extent that databases are needed they will need to be integrated into these blockchain applications. Further, although blockchain provides the strong feature of append only, because decision makers will need to analyze and use the data, that capability will need to be included in these systems, increasing the technological requirements beyond those of a non-blockchain system. Finally, developers will need to assess do these enterprise applications actually need a blockchain consensus layer as part of the application? As a result, this suggests the hypothesis #4 that *blockchain technology limitations will have a negative effect on the success of blockchain trade and financial systems*.

Digitalization and Digital Transformation

Digitization, digitalization and digital transformation require that the domain allow breaking away from manual processes and paper documents. Yet, as noted above, even the relatively sophisticated economies of the G7 apparently are still (slowly) transitioning to digital processes and documents. As an example, it was recently estimated that the bills of lading rate of digitization in international shipping is between 1.5% to 2% (Ledger Insights 2022). Further, that does not even recognize that using a blockchain approach will require integration with other off-blockchain activities, processes and documents. Since organizational change is seldom simple, or done without causing concerns, it is not surprising that in a recent assessment of digital transformation (Block 2022) noted that "In 2016, Forbes assessed the risk of failure in digital transformation to be 84%." As a result, this leads to *hypothesis #5, since a high percent of digitalization or digital transformation projects fail, there is a very high likelihood of failure of enterprise blockchain projects*. Digitalization and digital transformation is an omitted correlated variable.

Management and Project Management

When we read that "blockchain will change the world," the dialogues are focused on the technology, as if the there are no concerns of project management or even management buy-in. In order to see if this observation was prevalent, using Google, we did four quoted searches: "blockchain is a game changer" and "blockchain will change the world", both alone and with the second term "management." For game changer we found 142,000, without management and 60,400 with management (43%), and for changing the world, we found 89,500 without management and 58,300 (65%) with management. Thus, we explore *hypothesis #6, that the existence and the quality of management and project management will affect the likelihood of the project success*.

Network Effects

Blockchain typically brings multiple organizations together. As a result, a key capability is the development of network effects. Katz and Shapiro (1994) note that "Because the value of membership to one user is positively affected when another user joins and enlarges the network, such markets are said to exhibit "network effects," Blockchain and other technologies depend on their developers generating the attention of those network participants. Enterprise blockchain applications in finance and supply chains depend on broad deployment and adoption. As a result, this leads us to *hypothesis #7 that successful enterprise blockchain applications depend on the development of network effects*.

Hypothesis 1 - Projects that require multiple nonhomogeneous groups will negatively affect the success of enterprise blockchain systems. *(What role can my firm play in configuration?)*
Hypothesis 2 - Competitors are not likely to be interested in joining a blockchain consortium created by a competitor to provide others with value creating information asymmetries. *(Will competitors be able to create information asymmetries if my firm joins a blockchain consortium?)*
Hypothesis 3 - The additional complexity of blockchain can have a negative effect on the success of blockchain supply chain and trade systems. *(Will blockchain complexity have a negative impact?)*
Hypothesis 4 - Blockchain technology limitations will have a negative effect on the success of blockchain trade and financial systems. *(Will blockchain technology negatively affect success?)*
Hypothesis 5 - Since a high percent of digitalization or digital transformation projects fail, there is a very high likelihood of failure of enterprise blockchain projects. *(How will this help our firm's move to digitization, digitalization and digital transformation?)*
Hypothesis 6 – The existence and the quality of management and project management will affect the likelihood of the blockchain project success. *(Can the technology alone work?)*
Hypothesis 7 – Successful enterprise blockchain applications depend on the development of network effects. *(How can we create value using an enterprise blockchain?)*
Hypothesis 8 - Failure among blockchain related firms, such as cryptocurrency firms, will negatively affect the success of enterprise blockchains. *(Will other firms use affect the success of our use?)*
Table 2. Summary of Hypotheses

Crypto Winter and Collateral Damage / Spillover Effects

Recently, there has been concern about so-called "crypto winters," where a crypto winter has been described as meaning that (Duggan 2023) "… an extended period of trouble may be settling over the crypto market." In this paper we take a broader point of view than just firms in the "crypto market." Thus, an alternative view might be that there can be "collateral" damage (spillover effects) among firms broadly related by their use of blockchain for enterprise activities. From this perspective, if blockchain does not work in one setting, then that can have a negative impact on other firms' uses of the technology. This leads to the exploratory

hypothesis #8 that failure among blockchain related firms, such as cryptocurrency firms will affect the success of enterprise blockchains. This perspective also is consistent with the notion that blockchain fatigue can affect many different enterprise applications.

Systems Investigated and Some Characteristics

As part of our analysis, we performed a search for bankrupt, failed or shuttered firms based on enterprise applications of blockchain in supply chain and market finance. Despite the claim that blockchain projects have a 90% failure rate (Swim 2023 and others), we found only four documented enterprise blockchain "failures" and "shuttered" systems in supply chain and finance. However, this lack of firms also is consistent with Gartner's (Litan 2021) finding that "successful permissioned enterprise blockchain projects are scarce," since there appear to be a limited number of firms in these areas to begin with. Our resulting list of firms that we found and analyzed is in table 3.

As part of our search, we did an extensive Google search for "blockchain," "supply chain," "financial," "shuttered," "bankrupt," and other related terms. We excluded crypto firms, such as FTX, from our search. As we found failed firms or sources of information about such firms, we searched those materials for additional evidence of other firms that would fit our search.

Our search did not include non-blockchain based firms such as Trade Information Network. In addition, we did not include Symbiont, because, although it had been entered into Chapter 11, it was rescued later by a white knight, within roughly one month. SETL was not included because they have reinvented themselves after insolvency and are on-going. We also did not include companies such as Komgo and MonetaGo, which apparently have dropped blockchain in favor of other technology approaches. We also did not investigate B3i (Lacity and Lupien 2022), because it was an insurance blockchain consortium effort. We did not include Everledger, which reportedly entered into insolvency proceedings in May 2023, because it is a system aimed at tracking provenance of diamonds. We consider "provenance" systems as outside of our scope.

Closing Date	Consultant	Company	System	Time in Process
June 2022	IBM	Consortium of 12 Banks and IBM	We.trade	Live since 1/2019 (1/2017 – 6/2022)
November, 2022	Digital Asset	ASX-Australian Sock Exchange	Chess-Replacement: Clearing and Settlement System	7 Years 2016 – 11/2022
December 2022	IBM	Maersk - IBM	TradeLens	4.5 Years 8/2018 – 12/2022
March 2023	R3 and Corda	Commerzbank, LBBW, İşbank and other banks	Marco Polo / TradeIX	5.5 Years 9/2017 – 3/2023

Table 3. Some Enterprise Blockchain Systems Reported Shuttered

In addition, our analysis does not say that blockchain-based systems are failing across the board. There is another more recent non-profit system, the GSBN trade system, a Chinese system with key partners including COSCO, OOCL (Hong Kong) and Bank of China, indicating the potential opportunity for successful use of blockchain technologies in finance and supply chain settings (Haldane 2023).

Digitization, Digitalization and Digital Transformation in Sample

Since moving to blockchain appears to be a part of enterprise efforts to either digitize, digitalize or digitally transform firms, we investigated the extent to which enterprise efforts were identified as part of those efforts, as seen in Table 4. To the extent that these corporate efforts could be linked to such efforts, could provide potential difficulties. In the analysis of our four systems, we find that all of them have been frequently associated with notions of all three concerns of digitization, digitalization and digital transformation. Accordingly, not only do these firms and their partners face the basic move to blockchain, but in addition, they all face the process of moving all of their participants to digital processes and documents, further complicating their efforts.

Firm	Digitization	Digitalization	Digital Transformation
TradeLens	6,040	8,470	8,130
We.trade	6,310	8,040	54,400
ASX Blockchain	112	10	628
Marco Polo Network	4,620	1,270	5,580
Table 4. Joint Appearance of Quoted Search of Firm and Term in Google (5/2023)			

"Role of Blockchain"

Although we are examining systems that are said to employ blockchain, it is not clear what the role of blockchain is in these four systems or if the role is the same in each. In order to determine how people "perceive" and "communicate" about the role of blockchain in these systems, we did a Google search, and the results are summarized in Table 5.

Quoted Search Term	We. Trade[1]	ASX-Blockchain	TradeLens	Marco Polo Network	Total - Google
Replacing with Blockchain	0	0	0	0	4
Blockchain Fit	63	2	85	1	4,380
Blockchain Centric	38	3	45	6	41,900
Underpinned by Blockchain	444	1	1160	6	61,900
Enterprise Blockchain	6,230	643	3620	3,060	310,000
Blockchain Based	8,390	782	12,200	1,330	6,210,000
Total by Project Name	3,390,000	3,420	118,000	14,000	
Table 5 – Google Results by Blockchain System Descriptors and Project					

In some settings, such as the ASX system, there were references (e.g., Bousquette 2022) to "replacing … with blockchain." Of course, "replacement" has a number of implications. "Replacing" suggests "duplication," while "blockchain" suggests using a single technology, rather than multiple technologies. Long ago, Hammer (1990) examined the need to not just replicate existing processes but to reengineer the process and account for technology capability changes. Further, although blockchain may play a critical role in the development of these systems, they clearly are not the only technologies involved in solving the overall problem. As a result, this suggests that users will need to accommodate additional technologies, requiring increasingly complex additional integrated technologies, and process changes.

Analysis of Individual Systems and Hypotheses

In this section we drill down on the individual systems reviewing some of their capabilities and some of the rationales for why they were shuttered or why they became insolvent.

TradeLens

Maersk and IBM built TradeLens as a neutral and open supply chain, underpinned by blockchain that was designed to digitize the global supply chain.[2] The goal of TradeLens was to provide a platform for collaboration and information sharing across supply chains, to reduce trade friction and promote global trade. As a result, Maersk and IBM joined forces in 2018 to create a system designed to facilitate trade between different locations, countries and partners, though the shipment of goods. Since its development,

[1] These results may not be for "we.trade," because Google seems to drop the "." as part of the search.

[2] https://www.TradeLens.com/about

TradeLens has been called (Cecere 2022) "the only successful deployment of Enterprise Blockchain in a public supply chain network." Thus, it is not surprising that while previous researchers have investigated the positive potential of TradeLens, there has been a limited focus on the issues associated with its shuttering.

Although TradeLens had a number of clients, and the business was on-going, at the end of 2022, they announced that "… TradeLens has not reached the level of commercial viability necessary to continue work and meet the financial expectations as an independent business."[3] Across the industry there apparently was substantial surprise at the move. However, Bartlett (2023) questioned whether a lack of profit was the primary concern, noting that a number of businesses, such as Facebook, took several years to generate a profit.

TradeLens was designed as a for-profit and standalone business venture, and Maersk and IBM touted TradeLens as neutral and open. According to Ledger Insights (2022) "While Maersk managed to sign up multiple other shipping lines, at the end of the day, it was viewed as a Maersk offering. It was a big ambitious project for which Maersk was footing the bill alone, even if there was a longer-term vision to get other stakeholders to contribute."

The potential use of TradeLen's data has been suggested as a strategy to help Maersk attain vertical integration. As noted in Bartlett (2022) "Maersk has been proven to follow its vision aggressively, with integration into the maritime supply chain. One may have the assumption that it used TradeLens to its advantage to achieve vertical integration. There is no neutrality and, for a tool like this, neutrality is essential." Instead, it was suggested that data was a potential issue: "In a sector with over-generous exemptions from competition rules, what assurances do shippers have that their data is not a common commodity, to be shared freely between nominally competing shipping lines?" As part of that concern some have wondered what will happen to TradeLen's data now that TradeLens is no longer functioning?

Although our discussion above suggests some potential concerns associated with the blockchain technology, as noted by one commenter, Warburton (2022) there has been "no specific mention of whether the underlying technology was to blame" for the shuttering of TradeLens. Instead, most of the dialogue around the shuttering has examined other concerns.

In her discussion of TradeLens, Bousquette (2022) noted a major concern was that "… TradeLens could only work with the collaboration of a host of companies and nations—which never fell into place." For example, Valeur (2019) noted that not long after the foundation of TradeLens, that COSCO, the large Chinese shipping firm, choose not to join TradeLens. However, in 2021, COSCO was a founding partner in an emerging competitor to TradeLens, GSBN. This may have been the result of concerns that could have been traced to Arrow's impossibility theorem. For example, GSBN's founders appear to have a more homogeneous group of participants and requirements, because of the focus on China.

Other commentators, such as Ledger Insights (2022) suggest that the current rate of 1.2% of digital bill of ladings, makes trade digitization impossible, which was an important concern to TradeLens. Although that rate is expected to climb, full digitization of information and complete digital transformation is impossible with such a low rate. As a result of this concern, there have been new blockchain-based efforts aimed at this single issue (Wave BL).

Finally, as a result of TradeLens shuttering their platform, Mearian (2022) suggested that "Maersk's TradeLens demise likely a death knell for blockchain consortiums," suggesting a concern for collateral damage (spillover effects) among other blockchain firms.

We.trade

We.trade was designed to help buyers and sellers with cross-border trading, by facilitating trust and "streamlining" trade. What does we.trade do? As noted by IBM (No Date),

> Without financial guarantees, trading with new partners creates huge counterparty risks. Would-

[3] https://www.maersk.com/news/articles/2022/11/29/maersk-and-ibm-to-discontinue-TradeLens#:~:text=Unfortunately%2C%20while%20we%20successfully%20developed,expectations%20as%20an%20independent%20business.

> be traders may be short of capital. Price negotiations and other manual processes, such as logistics and insurance, are slow and error prone. And cross-border traders have to deal with geopolitical crises, trade wars, regulatory compliance and currency conversions.
>
> Banks that facilitate trades through letters of credit and financing also face difficulties. Generally lacking digital trade services, they instead rely on slow and costly manual processes. This hinders trading for customers and prevents banks from making the most of international commerce. For insurers and logistics organizations, we.trade is a key opportunity to further integrate their service offerings into the trade eco-system, and acts as a welcome new channel to market.

Ciaran McGowan, former General Manager of we.trade, indicated that the system was designed to simplify international trade, removing asymmetries of information by using a platform where all parties are connected "… the buyer, the seller, the buyer's bank and the seller's bank … shippers and credit insurers and transport insurers, they all be on the same platform. Everybody will be seeing the same picture. There is cost efficiency for all of the parties." According to Hyperledger Foundation (2022), one of the key contributions of the we.trade platform was its ability to issue events payments based on smart contracts on the blockchain.

We.trade started with 7 shareholder banks, but by April 14, 2020, there were 5 additional shareholder banks, where each of those banks had an equity stake and each of them were also customers. IBM was the development partner, and they took an open-source strategy, using products such as Linux, Hyperledger, Open shift. Further, we.trade appears to have had business model challenges. Lacity and Lupien (2022) suggested that it would be difficult for we.trade to scale because both the buyer and the exporter had to be customers of the same bank, not just part of the we.trade network. Further Lacity and Lupien (2022) noted that we.trade's CEO left soon after the launch, leading Ledger Insights (2022) to indicate that they did not have a CEO, suggesting potential organization and project management issues.

In mid-2022, we.trade began insolvency procedures. As noted by S & P (2022) unfortunately, "Month-on-month growth rate in transactions confirmed the value of the platform but was not quick enough to ensure the network effect needed to ensure the sustainability of the company." We.trade's failure seemed surprising. The system had been implemented and used. Gooding (2022) reported that some smaller banks and Spain's CaixaBank and Finland's Nordea, had fully deployed the system. Caixa adopted we.trade as part of their digital transformation strategy and became one of the highest-rated banks in the world based on the quality of its digital products and services.[4] Nordea was named as the 'World's Best Trade Finance Providers 2022' for Denmark, Finland and Norway.[5] Since the system was actually in use by small and medium sized banks, it is clear that the technology worked, was not too complex and not too costly. In addition, because the banks were in different countries, apparently, the multiple sets of regulations did not inhibit deployment, but they did not appear to generate sufficient network effects. Unfortunately, as noted at the time, they were unable to obtain further investment to continue as a going concern.

Marco Polo Networks (Formerly Known As Trade IX)

Marco Polo / Trade IX was designed to connect trading partners and participating banks using a decentralized network platform that would allow users to exchange and automatically match trade data. Using the blockchain would provide an irrevocable payment commitment from the buyer's bank to the supplier. This approach would also allow financial institutions, companies and other participants to exchange and share trade data in real-time. Besides improving efficiency and transparency, this would allow the ability to track and manage trade transactions from beginning to end. As noted by Koll (2022) the "… entire operation excludes the use of paper documents and makes the process of digitalization far more accessible across all parties."

Marco Polo was initiated in September 2017, with more than 30 banks as members of the consortium. As part of system development there were some missed deadlines in building the production systems, but they went live with a version including receivables, discounting and payment commitments in the fourth quarter

[4] https://www.caixabank.com/comunicacion/noticia/caixabank-launches-the-blockchain-platform-we-trade-to-execute-and-finance-its-corporate-customers-foreign-trade-transactions_en.html?id=42117#

[5] https://www.nordea.com/en/news/wins-for-nordea-trade-solutions-at-the-global-finance-awards-2022

of 2020 (Wragg 2023). However, a review of the current web site suggests a full featured capability, including links to enterprise resource planning systems. Unfortunately, they were unable to build a large enough client base according to their insolvency filing (S&P Global 2022). An analysis of their web site in May 2023 found that the last mention of "blockchain" was in 2021, suggesting that they had deemphasized the technology going forward, since that time.

As noted by Wragg (2023), prior to their insolvency, Marco Polo had been in discussions with Bank of America over a potential strategic partnership. However, after the FTX and other blockchain collapses (including we.trade and TradeLens), the bank pulled out of talks and they indicated that they would not proceed with the collaboration as exemplified by a headline in the Irish Examiner that read "Liquidators appointed to Cork firm following FTX crypto collapse." When FTX and other firms went bankrupt, apparently it cast a concern about other blockchain-centric firms and systems.

ASX Blockchain

The Australian Stock Exchange (ASX) blockchain project was initiated as an upgrade to the existing CHESS system (Clearing House Electronic Subregister System). The system was designed to speed settlement times and reduce the costs for the exchange, and the plan was for the system to go live two years later. Unfortunately, over the life of the engagement, there were a number of problems resulting in two reports, one by Deloitte and one by Accenture. As noted by Boyd (2019), early in the project life, Deloitte was called in to assess the engagement. At the most basic level, Deloitte criticized the lack of a business case and they suggested that there were no "principles" established to describe or share created value from the project. However, shortly after, Deloitte also was criticized for being " … incapable of producing an independent report." Later in the project, Accenture conducted another independent review and ASX did their own review. At the conclusion of those two reviews, ASX's chairman apologized for the $165 million write off (Castillo and Paz 2022),

Of all of the systems investigated in this paper, the ASX Blockchain project appears to have been the largest, and seems to be the only one that was the subject of multiple external reports on concerns associated with the project. Accenture (2022) found difficulties between the workflows and the interaction with the blockchain ledger. They also found that system requirements and workflows were not established to leverage and account for blockchain's distributed environment. Accenture was also concerned with the design rigor and discipline and the ability of the resulting artifacts model to user behavior. In addition, to other concerns, they also found that there was a long turnaround to evaluate and remediate system issues, and that operations and maintenance were complex. Interestingly, Accenture (2022) noted that "Greater consideration is required regarding the purpose of the consensus layer given ASX's position as the central market operator for the CHESS use case." Accordingly, this concern basically questioned the rationale associated with using a blockchain approach to trust in this market setting, establishing issues of fit.

Accenture's (2022) report on ASX Blockchain solution to replace the existing settlement system identified some underlying technical "drivers" causing other challenges in the system design. First, "latency" was identified as a concern, beyond the normal latency associated with distributed blockchain systems. Second, they generated questions about concurrency uses in the system, because concurrency can cause contention over resources, forcing serial processing for some workflows. As part of the potential solutions designed to mitigate the limitations of using blockchain, Accenture (2022) offered a number of potential solutions including, restructure the strategy to leverage blockchain capabilities, simplify system design and redesign the on-ledger vs. off ledger activities.

Comparison to Hypotheses

The purpose of this section is to compare our findings to our hypotheses in Table 2. The results are summarized in Figure 3.

Hypothesis 1 - Projects that require multiple nonhomogeneous groups will negatively affect the success of enterprise blockchain systems.

TradeLens potentially involved a broad range of countries and companies, suggesting a number of disparate groups. Further, the discussion on TradeLens suggested that firms were concerned with the equivalent of

an Arrow dictator, suggesting the potential power of Maersk as a concern in system development.

Hypothesis 2 - Competitors are not likely to be interested in joining a blockchain consortium created by a competitor to provide them with value creating information asymmetries.

In the case of TradeLens, we found that evidence of this hypothesis. This hypothesis becomes particularly important when we think about the potential for such systems to remove information asymmetries about the participants for the lead firm.

Hypothesis 3 - The additional complexity of blockchain can have a negative effect on the success of blockchain supply chain and trade systems.

Since three of our four sample firms ultimately had products and clients, it is clear that they were able to maneuver through the complexities of blockchain to successfully build a product. Thus, in our sample, we do not have evidence of blockchain complexity being a negative concern.

Hypothesis 4 - Blockchain technology limitations will have a negative effect on the success of blockchain trade and financial systems.

In our analysis of ASX, we found that limitations of blockchain were found to be related to system failure. Accenture (2022) laid out a number of concerns associated with blockchain in a stock exchange environment. As part of that analysis, Accenture questioned whether the system should employ the consensus capability as part of the deployment.

Hypothesis 5 - Since a high percent of digitalization or digital transformation projects fail, there is a very high likelihood of failure of enterprise blockchain projects.

Because each of the systems was a digitalization effort or a digital transformation effort, perhaps that indicates that moving away from manual processes is an important failure factor associated with blockchain centric systems. Further, external governmental digitalization issues, such as the low rate of digital bill of lading adoption, may influence the overall effectiveness of blockchain trade systems, such as TradeLens.

Hypothesis 6 – *The existence and the quality of management and project management will affect the likelihood of the blockchain project success.*

Above we noted that we.trade did not have a CEO in place, of course raising concerns about there being sufficient management in place and the ability to provide appropriate project management. In the development of ASX, as noted by Boyd (2019) there were "… concerns that the project owner has placed commitment to the replacement's design above the concerns that have been raised to the project owner and that the projects scope and plan may not be best suited to issuer and investor outcomes."

Hypothesis 7 – *Successful enterprise blockchain applications depend on the development of network effects.*

In our discussions of TradeLens, we.trade and Marco Polo, we found that systems appear to have been developed and successfully implemented, but that they were not able to generate sufficient interest among their users. We.trade was unable to attain sufficient network effects because all had to be on the network.

Hypothesis 8 - Failure among blockchain related firms, such as cryptocurrency firms, will negatively affect the success of enterprise blockchains.

We found some evidence for this hypothesis in the shuttering of the Marco Polo Networks, that occurred shortly after the bankruptcies of FTX, the solvency of we.trade and the shuttering of TradeLens. These results suggest that system failures are not completely independent, and comments in the press substantiated that finding.

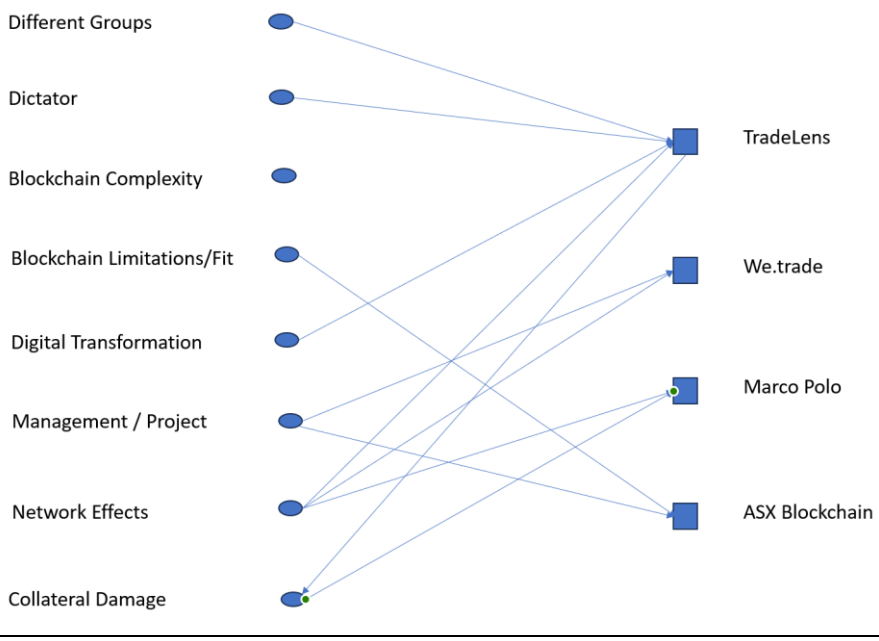

Figure 3. Hypotheses and Blockchain Project Interaction

Potential Strategies to Mitigate Limitations and Create Value

The purpose of this section is to investigate some issues and to engage some strategies that potentially could mitigate some of the limitations faced by the firms in our sample.

Consortium Characteristics

After TradeLens was shuttered, the CEO of the competitor GSBN was asked "what were some of the key success factors in the development of a blockchain consortium?" As part of that discussion two issues were established. First, he indicated that a strategy of building partnerships in the development of such systems was important. GSBN has a set of partners apparently initially focusing on the China market, consistent with hypothesis #1, on different groups. Second, he also thought that because TradeLens was associated with a particular shipping company and because it was a for-profit company, that put TradeLens at a disadvantage compared to non-profit consortiums, such as his firm, consistent with hypothesis #2.

Scope and Costs

Some commenters have noted that the nature of the projects proposed to use blockchain appears to be changing and costs of the technology are decreasing. As an example, Litan (2022) noted, that the "… good news is that the costs of enterprise blockchain projects are starting to come down and the scope of the applications are generally narrower and less ambitious." Of course, these comments suggest that in the future, there will be a greater success rate, but this also suggests that perhaps, there will be more such systems. This change in the costs, as the technology evolves suggests that our hypotheses #3 and #4 may need to change in the future.

New Tools and Developments

Perhaps we need to consider these uses of blockchain, as technology in transition, and view each of these efforts as learning experiences in how to use or not use blockchain. As noted by Hyperledger Foundation (2022) "we.trade is by no way the end station for the future development in this domain, not even the beginning of the end of the journey. This is a live state of the art solution which has moved the development considerably forward." Changes in blockchain technology would affect both hypotheses #3 and #4.

Five Years Ago, it was all about Technology ….

At the basis of this research was concern for the impact and success of blockchain systems. However, one of the key outcomes of this inquiry is the finding that perhaps the technology may not be as important as many other factors. Although we were concerned with blockchain versions of the systems, in each setting there are clearly non-blockchain systems performing the same activity. Thus, ultimately, rather than using a particular technology or not, perhaps the focus needs to be on solving business problems. In the future, rather than blockchain-based or blockchain-embedded, perhaps the blockchain aspect will be treated as just another data source, or the focus will move to simply distributed systems, rather than blockchain.

While commenting on Marco Polo Networks, Patel (2023) consistent with hypothesis #6, noted "Five years ago, it was all about technology and blockchain. We have learned that technology is an enabler through which you can offer services and connect with partners and clients, but it is not the sole driver for a successful business. Though many industry actors thought blockchain would be the holy grail of the trade finance industry, this proved not to be the case. What actually counts are well-designed and well-thought-out value propositions that solve real day-to-day corporate problems." However, unsurprisingly, many researchers and commenters likely would say the same thing about just about any technology. "It is not just about the technology, but it is about the business …." Similarly, while commenting on the failure of blockchain projects and consortiums, S & P (2022) commented that "Most of banks' blockchain projects fail either because they do not solve the problem they were intended to solve or because the problem does not exist …. or the market doesn't want it," consistent with hypothesis #7 on network effects.

Conclusion and Extensions

This paper has investigated the apparent lack of success of blockchain applications in trade finance and supply chains to better understand some of the rationales for the failures and the role of the technology and blockchain in those failures. As part of our analysis, we found in at least three of the settings, the projects worked well-enough so that the companies could generate a client base, but they were unable to maintain a profitable situation. As a result, in those settings, the issue was not whether or not the technology worked, but instead could they build a market of network effects for the product. However, we did find that it appears that the failures by blockchain-based firms such as FTX, and then other finance and supply chain systems seem to have had a spillover effect on the shuttering of the firms we investigated. Perhaps this finding was because banks were being sensitive to having relationships with failing firms, potentially increasing the probability of them failing. Unfortunately, we did find that in at least one setting there were technical difficulties associated with implementing blockchain and that in that setting workflows did not leverage the distributed environment. We also found that for ASX Blockchain a key blockchain feature (trust) did not fit well into the context of stock exchanges, and use of some of the technology capabilities were problematic. Finally, we also found that although five years ago it may have been "about the technology," now firms need to focus on the business problem.

Extensions

This paper could be extended in several directions. First, we focused on enterprise applications, including trade finance and supply chains. Future research could examine systems based on drug and food concerns or insurance systems. Second, we focused on the analysis of four specific efforts identified in the literature. As other firms fail, the sample size could be extended. Third, perhaps issues such as armchair auditors (O'Leary 2015), could be integrated into blockchain use and governance. Fourth, some of these trade finance and supply chain applications could be used to capture additional information, such as monitoring carbon or other pollutants, to facilitate ESG reporting (Environment, Social and Governance). Fifth, the information in this paper could be part of a knowledge base of best practices in blockchain (O'Leary and Selfridge 2000). Sixth, perhaps this research could become part of the entrepreneurial platform-based research, with more of a focus on the entrepreneurs and the platforms rather than the blockchain. Finally, integration of blockchain with other existing systems could be the topic of future analysis.

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