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# The Role of Collaborative Governance in Blockchain-Enabled Supply Chains: A Proposed Framework

Denise McCurdy

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# THE ROLE OF COLLABORATIVE GOVERNANCE IN BLOCKCHAIN-ENABLED SUPPLY CHAINS: A PROPOSED FRAMEWORK

BY

Denise L. McCurdy

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree

Of

Doctorate in Business Administration

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## ACCEPTANCE

This dissertation was prepared under the direction of the DENISE LYNN MCCURDY Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Business Administration in the J. Mack Robinson College of Business of Georgia State University.

Richard Phillips, Dean

DISSERTATION COMMITTEE

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## DEDICATION

To my parents for two of life's greatest gifts – my faith and my family's unconditional love.

To my children who believed and inspired me just by being themselves.

And first, last, and forever, to Colin. This journey could not have happened without your unfailing love and support.

*Happiness is when what you think, what you say, and what you do are in harmony.*

*Mahatma Ghandi*

## ACKNOWLEDGMENTS

Embarking on a doctoral journey is, in the end, not a solitary trek. We pass through the significant milestones with the help of those around us. I am no exception, and I am grateful for the abundant love and support I have received. To my doctoral advisor, Dr. Karen Loch, I thank her for her unwavering commitment and belief in my abilities. I also thank my doctoral committee, Dr. Richard Baskerville and Dr. Baozhong Yang, for their support and kindness throughout my journey. I am grateful to the GSU faculty and staff; you took the high road, and you made it easy for us to join you. To my fellow cohorts, thank you for your friendship and honesty. And to my Cold Chain, DappyFish, and DappyChain teams, thank you for the shared learnings and laughter.

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# ABSTRACT

The Role of Collaborative Governance in Blockchain-Enabled Supply Chains: A Proposed Framework

by

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The blockchain age is dawning. Firms large and small are teaming up with partners and solution providers to deploy blockchain, especially in supply chains, often called the "sleeping giant" use case. But blockchain is still new, and despite early successes in simulated environments, how companies need to collaborate in a blockchain world is unclear.

To help close the blockchain collaboration research gap, this design science study explores the technological and ecosystem business decisions required to deploy an interoperable blockchain solution. The research partially builds a supply chain artifact, and the challenges experienced by the design team prompts further investigation with twenty blockchain experts.

With the discovery that effective and collaborative governance is a key mechanism to remove obstacles in blockchain deployment, the study concludes with a collaborative governance model. Inspired by public policy makers, the framework includes technological rules to assist practitioners as they collaborate in a blockchain world.

*Keywords*: Blockchain, Relational View, Collaborative Governance, Supply Chain, Design Science, Interoperability

## Chapter 1: Introduction

Supply chains. A big yawn, right? But not when they fail. More complicated than they appear and taken for granted until they break, most of our daily transactions operate with some type of underlying supply chain structure. While a relatively simple concept, supply chains can be defined as organizations involved with the up and downstream flow of products, services, finances, and information from a source to a customer (Mentzer et al., 2001). What's notably absent in this definition is a mention of a particular industry or a type of commodity. Transporting goods or services from point A to point B requires a certain level of supply chain coordination, and in some cases, a great deal.

And when supply chains fail? We've all heard the grim stories. Reference the food industry: about 48 million people in the U.S. (1 in 6) get sick, 128,000 are hospitalized, and 3,000 die each year from foodborne diseases due to supply chain failures (CDC, 2010, December 15). Pharmaceutical industries have their own unique challenges. In the U.S., Avastin, used to treat certain lung, colon, and kidney cancers, was counterfeited in Turkey in 2012. The fake Avastin made its way to the U.S., and eventually affected practices in 22 U.S. states (FDA, 2018, November 15). Low-income countries have additional burdens; substandard supply chains allow counterfeit medications in as many as 1 in 10 medical products (Pisa & McCurdy, 2019).

In each of these examples and many more, the lack of visibility and security in the supply chain compromises the quality and safety of what we use and consume. Regulators have taken note, and the U.S. has responded with new regulations to increase food and drug safety. The Food Safety Modernization Act (FDA, 2018, November 15) and the U.S. Digital Supply Chain Security Act (FDA, 2018, October 30) are both intended to increase supply chain traceability and facilitate product recalls. These new regulations affect a wide range of industries, including

manufacturers, third party logistic providers, retailers, and others throughout the ecosystem. These regulations seek to provide visibility throughout an entire supply chain, often difficult given the circuitous routes goods and services must take.

Do we have the ability to track and trace our domestic and global supply chains, as the FDA requires? Industry experts believe that an emerging technology, called blockchain, has the potential to greatly improve the integrity of existing supply chains of all types. Because blockchain increases the visibility within the entire supply chain, authenticity and quality are tracked and communicated every step of the way. However, there is limited empirical knowledge of how blockchains work, and more importantly, how firms must work together to launch a successful blockchain-based ecosystem. There are a handful of impressive proofs-of-concept projects that test the operational efficiencies of blockchain. In one such project, Frank Yiannas, the former Vice President of Food Safety for Walmart, compared a standard supply chain process with a blockchain-based process using sliced mangoes. It took over six days to find where the mangoes came from using the standard process – a long time for foodborne illnesses to take root in unsuspecting communities. Using a blockchain-based solution, it took approximately two seconds to find the exact producer (Hackett, 2017, August 22).

We are in a scenario with barge-size moving parts where efforts to serve the chain must be proactive, and deviation from the plan is, unfortunately, complex and slow. The regulatory environments will soon mandate a level of traceability that many believe blockchain technology can resolve. But blockchain technology is still new, and in spite of early successes in simulated environments, the collaborative and technical decisions required in a blockchain world remain unclear. It's an environment with unclear governance, unwritten standards, and an uneven regulatory climate. Given the role many believe blockchain can play to improve supply chains

and the regulatory pressures bearing down on supply chain ecosystems, this design science study focuses on blockchain's potential to improve supply chains for firms in a shared ecosystem.

**A Blockchain Primer**

In 2008, an anonymous individual or group that goes by the name of Satoshi Nakamoto published a technical paper titled "Bitcoin: A Peer-to-Peer Electronic Cash System." The paper outlined a novel way to solve the fraud issues associated with digital currencies in a peer-to-peer environment. Preventing double-spend in peer-to-peer networks is complicated; there isn't a centralized clearing house, such as a bank, to coordinate and monitor transactions. To prevent double-spend concerns, the paper proposed a mechanism to combine a ledger used for recordkeeping with a mechanism for reconciling the transactions in that ledger, without using a trusted, centralized bookkeeper (Security, 2017, January 10).

This mechanism is called blockchain. At its simplest, blockchain is a shared database managed by a network of computers around the world (Security, 2017, January 10). It's similar to a giant spreadsheet, representing transactions of any type of data one wishes to capture (e.g., a title to an automobile, a training certificate, or an intangible asset). These transactions are recorded as blocks of information in a chronological chain. Each chain is copied and kept synchronized across multiple nodes or computers, making the system highly resilient to attacks or data loss. The system uses complex mathematical functions to arrive at a definitive record of who owns what, and when. Data can be added to a blockchain but cannot be retroactively modified or deleted without alerting users. Though blockchain's first use case was with bitcoin, the benefits of having a trustworthy record for any type of asset became quickly apparent.

Smart contracts are a critical component of some blockchain networks. Developed by Nick Szabo (1994), smart contracts are lines of embedded computer code that self-execute once

certain triggers are met, such as a purchase order received, or a delivery made to a warehouse. Some consider smart contracts as "one of the most successful applications of blockchain technology. Using smart contracts in place of traditional ones can reduce the transaction costs significantly" (Pratap, 2018, p. 2).

Blockchain networks can be categorized as either permissioned or public, and this categorization determines who can publish blocks. In a permissioned blockchain, only certain users can publish blocks. The National Institute of Standards and Technology (Yaga, Mell, Roby, & Scarfone, 2019) describes a permissioned blockchain network as something similar to a controlled corporate intranet, while a permissionless (public) blockchain network is more closely related to the public internet, open to anyone who desires to participate. Permissioned blockchain networks are often used for businesses and organizations, while public blockchains are typically used for Bitcoin and other cryptocurrencies. Table 1 provides a description of blockchain network types. Though the study of blockchain technology can be quite extensive, this basic understanding of blockchain technology is adequate for the purposes of this research.

*Table 1. Blockchain Network Types*

| **Blockchain Type** | **Properties** |
|---|---|
| Permissionless public blockchain | Anyone can join the network, read, write, and verify transactions through Proof of Work or Proof of Stake. |
| Permissioned public blockchain | Only trusted and validated peer nodes may join the network. Consensus is determined between participating organizations. |
| Permissioned private blockchain | Only trusted and validated peer nodes may join the network. Consensus is determined within an organization through an agreed algorithm. |

(Adapted from Pedersen, Risius, & Beck, 2019)

## The Research Gap

Blockchain is a foundational technology that some are hailing as the new internet (Cretin, 2018; Swan, 2015). Used first in 2009 with bitcoin (Nakamoto, 2008), blockchain technology is one of the top five strategic priorities for global businesses – and growing (Insights, 2019). Projected to represent 10% of global gross domestic product by 2025 (FreightWaves, 2017; Lima, 2018), blockchain has multiple use cases, with supply chain as the dominant use case (Rauchs, Blandin, Bear, & McKeon, 2019). Yet there is limited empirical knowledge in how blockchain technology works in a supply chain ecosystem. This lack of research is especially true for permissioned (private) blockchains. This empirical gap is critical, as 45% of supply chain-related blockchain deployments fall into the permissioned category (Insights, 2019).

This study, situated in the supply chain ecosystem, closes the research gap by exploring permissioned blockchains and the role of interfirm collaboration. Though collaborative decision-making is not unique to supply chains, blockchain, or even to technology in general, blockchain's unique properties require firms to interoperate more closely on a technical and an organizational level.

## Study Motivation

The lead researcher has a background in strategy in the information and communications technology industry and follows emerging technologies. Blockchain was especially interesting, especially for supply chain tracking, and in 2017, it was beginning to figure prominently in trade publications. Blockchain requires firms to work closely together, much more so than traditional technologies. This level of company collaboration in blockchain implementation was intriguing to the researcher, given her previous work in managing joint alliance activity. She had "been to this party" before. Opening the kimono is difficult, at best, for firms who are more used to

guarding their resources carefully. Would the interfirm collaboration, required for successful blockchain deployment, fare differently?

**Organization of the Study**

This is a design science study with significant field engagement. Preparation for the research began in November 2018. The data intake lasted approximately eighteen months, and the research concluded in March 2020. The original research question, "How can organizations renew their business models to successfully deploy blockchain into a shared supply chain?" underpinned the work.

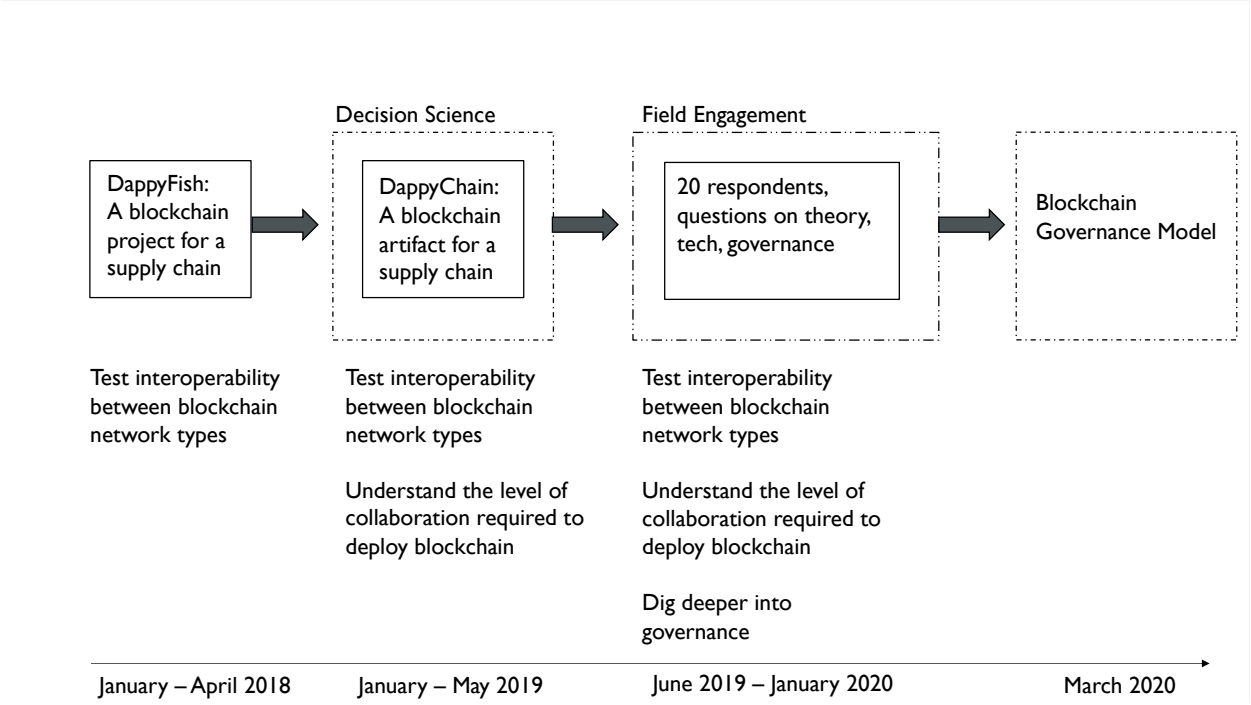
Using the Design Science research paradigm (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007), the research team created a blockchain-enabled supply chain artifact in the Georgia State University blockchain lab. The artifact simulated a supply chain use case for track and trace purposes. Calling ourselves the DappyChain team (as a play on words for distributed application or DApp) we had two goals with the artifact:

1. To test the interoperability between public and permissioned blockchain networks.
2. To capture the collaborative decisions required by firms to successfully deploy blockchain.

Our artifact was only partially successful. This failure to launch required further research to understand the barriers to success and what challenges prevented us from completing our work. We acknowledged our blockchain knowledge inadequacies, but we also uncovered governance concerns related to our decision making processes. To better explore these barriers, we used the findings from our design science learnings to develop an interview protocol to engage with blockchain subject matter experts. We refined our research question to "What is the role of governance in blockchain-enabled supply chains?" Armed with interview questions

crafted to explore our artifact more fully, we uncovered core themes from our interviewees. Clearly hearing the need for blockchain governance, we revisited the literature for governance models, ultimately adapting a governance model for blockchain. The adapted model includes technological rules that can be designed by practitioners for their specific situation (Aken, 2004). Our findings are summarized in the discussion section, providing our response to the research question: **What is the role of collaborative governance in blockchain-enabled supply chains?** Figure 1 provides a graphical representation of our approach to this study:

*Figure 1. Study Overview*



## Chapter 2: Theoretical Background

Supply chains have existed for millennia; the Silk Road through Central Asia and the Spice Route over the Indian Ocean were mostly linear chains that took a finished product to its ultimate destination (Sanyal, 2012). Throughout their development, there have been many challenges to the effectiveness and efficiency of trading transactions. Most certainly, like their modern counterparts, these early supply chains required a certain level of cooperative behavior between trading entities.

Cooperative behavior has roots in social exchange theory (Thibaut & Kelley, 1959) which states that parties enter into and maintain exchange relationships with others with the expectation that doing so will be rewarding (Blau, 1964; Gouldner, 1960; Homans, 1961; J. A. Miles, 2012). Trust, repaying obligations, and cost-benefit analyses are major premises of social exchange theory. While the social exchange helps explain motivations amongst trading partners, the industry structure view (Porter, 1980) takes a business perspective and widens the aperture to include customers, suppliers, potential entrants, and substitute products. Porter believes that successful supplier relationships occur because the firm (itself) is a capable, attractive partner with whom to transact. These successful supplier relationships can translate into a competitive advantage, especially if a firm defends its turf respective to these relationships. In the Resource-Based View, Barney (1991) takes a similar "within" firm perspective. However, he focuses on an organization's internal resources, stating that "sources of sustained competitive advantage are firm resources that are valuable, rare, imperfectly imitable, and non-substitutable" (p. 116).

### Relational View

Dyer and Singh (1998) extend Barney's Resource-Base View to include interfirm capabilities and suggest that firms who work effectively with other firms sustain a competitive

advantage. However, departing from the Resource-Base View, which focuses on internal resources, the authors state that "a firm's critical resources may span firm boundaries and may be embedded in interfirm resources and routines" (p. 660).

Dyer and Singh continue to discuss four determinants that, if performed well by firms, contribute to interorganizational competitive advantage and relational rents[1]. These determinants include relation-specific assets, knowledge-sharing routines, complementary resources and capabilities, and key to this research, effective governance (see Figure 2). Dyer and Singh's refocus on unit-of-analysis – from within to across firms – is not trivial. According to the authors, firms in (relative) isolation cannot enjoy the supernormal rents/outsize profits that are jointly generated and owned by partnering firms. In short, carefully guarding resources is detrimental. Instead, it's the *sharing* of knowledge, information, and resources that improve profits.

"Sharing" can take multiple forms. Bromiley and Rau (2014) conclude that shared resources between firms (a dyadic relationship) can lead to superior firm performance for both partners. Carter, Kosmol, and Kaufmann (2017) extend the shared resource concept to firms in a larger supply chain ecosystem, finding that all firms in the ecosystem sustain a performance advantage. Other research points to the importance of shared trust and cooperation amongst supply chain partners in building resilient supply chains (Dubey et al., 2019) and better performing supply chains (Panayides & Lun, 2009). Effective knowledge-sharing and investing in relation-specific assets are also known to increase short-term rent generation (Weber, Bauke, & Raibulet, 2016). From a healthcare perspective, studies have demonstrated the importance of

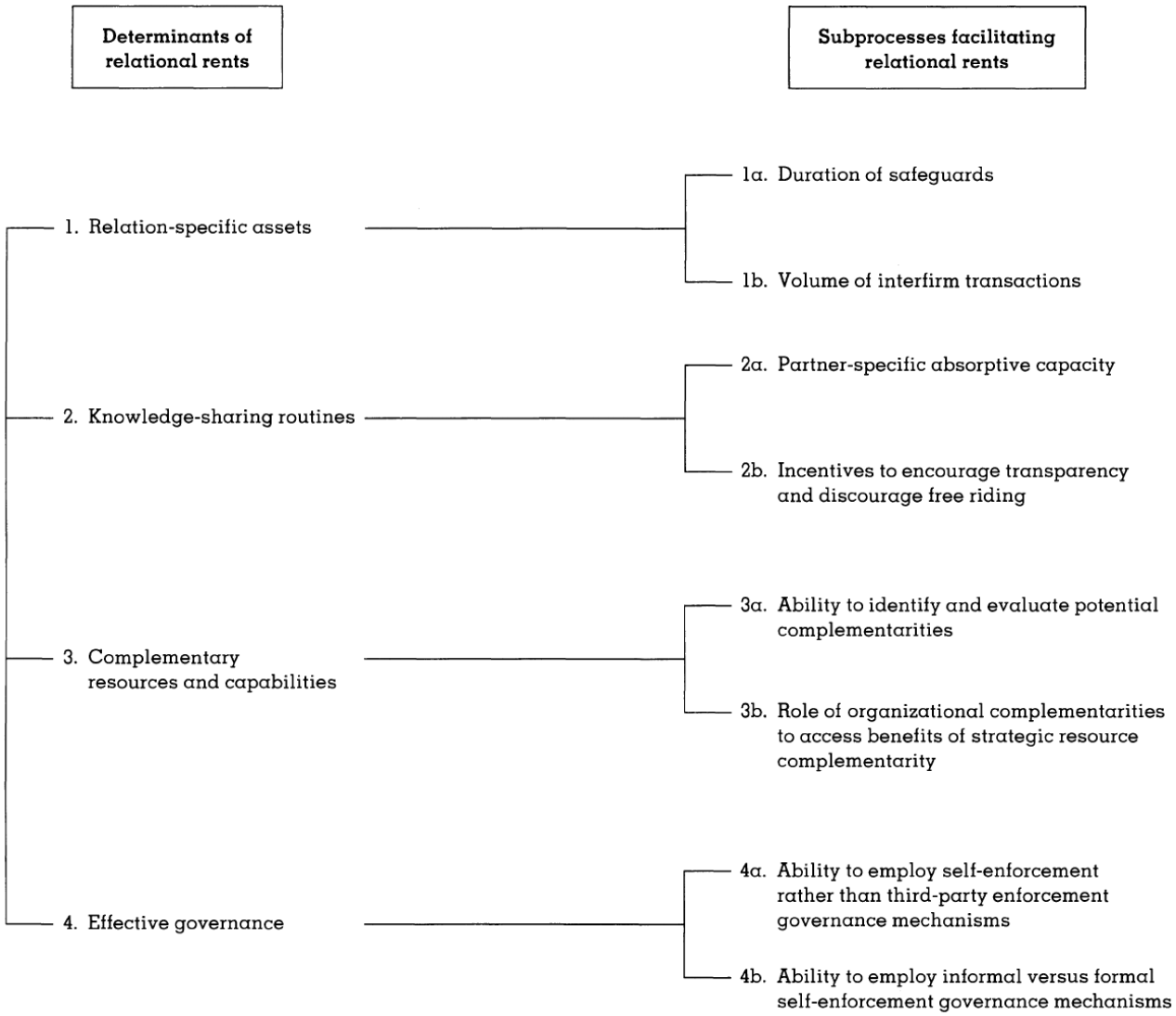
[1] Dyers and Singh define relational rent as "a supernormal profit jointly generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners" (p. 662).

shared innovation for physician partnering activities (Dobrzykowski, Callaway, & Vonderembse, 2015) and shared knowledge for improved hospital supply chain performance (Chen, Preston, & Xia, 2013).

If one believes that interfirm sharing is a source of competitive advantage, is blockchain, as a structured mechanism for sharing, worth pursuing? Can blockchain improve a firm's operational performance, thus leading to a competitive advantage? Due to the newness of blockchain, it's difficult to say. Aside from the Wal-Mart example referenced earlier in the paper, Pan, Pan, Song, Ai, and Ming (2019) quantitatively analyzed fifty Chinese firms on the ability of blockchain to improve operations, as measured by asset turnover and reduced sales expense rates. The authors found that blockchain does improve asset turnover rates and reduces sales expenses, resulting in improved operational capabilities (Pan et al., 2019). Another study reported that even in less transformational applications, firms are still likely to see more process automation, enabling human resources to focus on value-added activities (Morkunas, Paschen, & Boon, 2019, p. 300). These few published studies cannot yet support the promise of operational improvements, with a favorable effect on competitiveness. Blockchain's impact on competitive advantage will likely become clearer as blockchain becomes embedded into more firms' operations and results are shared.

Keeping the Relational View as our theoretical lens, we revisit firms who plan to deploy blockchain technology. We are interested in exploring how the determinants of relational rents, as described by Dyer & Singh, are shaped by blockchain technology. We are especially interested in the governance determinant, given the level of sharing required to deploy blockchain. Thus, we turn our sights to governance research in Information Technology, and specifically blockchain, for guidance.

*Figure 2. Determinants of Interorganizational Competitive Advantage*




*(Dyer & Singh, 1998)*

**IT and Blockchain Governance**

As discussed in the theoretical background, governance, as it relates to relational rent, is a key tenet of the Dyer & Singh model. If we turn to other research, we find that governance has been explored from an information technology perspective as well. Defining governance as "specifying the framework for decision rights and accountabilities to encourage desirable behavior in the use of IT" (Weill, 2004, p. 6), Weill (2004) argues that good IT governance leads to superior returns on IT investments. Weill goes on to develop a framework for six different governance types and suggests superior IT governance can be accomplished by aligning a firm's business goals (asset utilization, profit, or growth) to a potential governance model. Key findings from Weill's work include the importance of incentives to endorse desirable behaviors, and eight critical factors that contribute to effective IT governance.

Research in *blockchain* governance, the focus of this study, is more elusive, in large part due to blockchain's relatively recent entrée into the IT space. There is interest in the topic; as of February 10, 2020, there were approximately forty-two million hits for the term "blockchain governance." Yet the academic research, given the cycles required for peer-reviewed research, lags behind, as we see in the search term review table (see Table 2).

*Table 2. Search Term Review*

| Search Vehicle | "Blockchain Governance" |
|---|---|
| Google | 41,800,000 |
| Google Scholar | 20,400 |
| ABI/Inform | 503 |
| Web of Science | 162 |
| JSTOR | 24 |
| EBSCO/host | 12 |

There are a few examples of academic research on governance. Beck, Müller-Bloch, and King (2018) applied Weill's IT governance research to blockchain technology. Using a case

study approach, Beck et al. (2018) explored the three dimensions of IT governance for a peer-to-peer blockchain commerce platform. Comparing the differences for decision rights, accountability, and incentives, the authors believe that governance in the blockchain economy is qualitatively different from time-honored forms of governance (Beck et al., 2018). In the blockchain economy, using Weill's Extended IT Governance Framework (Weill, 2004), decision rights are more decentralized, the blockchain network itself acts as a mechanism to provide accountability, and incentives are aligned structurally with the blockchain network (Beck et al., 2018). Much of Beck's paper focuses on blockchain networks from a *public*, permissionless perspective, in that consensus mechanisms are codified in the blockchain type and incentives are transactional and "built into" smart contract completion.

Authors Schmeiss, Hoelzle, and Tech (2019) further this work by discussing the challenges of balancing the openness of blockchain with the need for creating value for all participants in a platform ecosystem. Using three case studies, Schmeiss and colleagues (2019) explore how governance mechanisms can be encoded into the blockchain technical architecture, addressing three key considerations to value creation: access, control, and incentives. Again, the authors focus on public blockchain platforms as opposed to permissioned platforms, stating that "While private BCTs [blockchain technologies] have their purpose for a number of important use cases, here we focus on public BCTs to determine how BCT can support central governance issues of openness in platform ecosystems" (Schmeiss et al., 2019, p. 125).

Notably, most firms are more likely to use permissioned blockchains, which requires less codified governance and more cooperative behavior. Lacity (2018) explores governance for permissioned blockchains, and finds that blockchain adoption may be impeded by overwhelming managerial challenges, especially in areas such as standards, regulations, and shared governance

models. (M. C. Lacity, 2018). In later research, M. Lacity, Steelman, Zach, Cronan, Paul (2019) turn their focus on larger enterprises in a White Paper called "Blockchain Governance Models: Insights for Enterprises." The authors define seven blockchain governance models that have different degrees of centralization. From benevolent dictator to democracy, the authors discuss the decision and voting rights typically found in each blockchain model type, addressing the relative advantages and disadvantages of each model (M. Lacity, Steelman, Zach, Cronan, Paul, 2019). While the authors provide a good overview of blockchain governance models, they do not specifically discuss collaborative models. Table 3 summarizes this current scholarly research and highlights a gap in the research for collaborative governance models specific to blockchain.

*Table 3. Summary of Literature Review Findings*

| **Source** | **Finding 1** | **Finding 2** | **Finding 3** | **Area of Overlap/Gap** |
|---|---|---|---|---|
| Don't Just Lead, Govern: How Top-Performing Firms Govern IT (Weill, 2004) | Good IT governance contributes to overall firm performance. | Identified six IT governance archetypes for five key IT decision types. | Firms choose IT archetypes based on their core objectives (asset utilization, profit, growth). | IT governance/not blockchain governance |
| Governance in the Blockchain Economy: A Framework and Research Agenda (Beck, Muller-Bloch, & King, 2018) | Blockchain will manifest into a new organizational design. | The governance rules will be specified in the blockchain. | IT governance rules no longer apply in the blockchain economy (compared to digital economy). | Public blockchain governance/not permissioned |
| Designing Governance Mechanisms in Platform Ecosystems (Schmeiss, Hoelzle, & Tech, 2019) | Blockchain technology can address the tensions between openness and value creation. | Governance routines can be embedded into the technical architecture of some blockchain technologies. | These routines specify the access, control, and incentives for actors in a platform ecosystem. | Public governance/not permissioned |
| Blockchain Governance Models: Insights for Enterprises (Lacity, Steelman, Cronan, 2019) | Identifies emerging models and practices for shared governance over blockchains. | Defines seven governance models used. | Believes firms need to plan for more decentralized models in the future. | Permissioned blockchain governance/move to public blockchains |
| Addressing Key Challenges to Making Enterprise Blockchain Application a Reality (Lacity, 2018) | Described standards, regulations, shared governance models, and viable ecosystems as key managerial challenges. | Focuses on different challenges between small start-ups and established corporations. | Identifies five questions for firms when considering blockchain technology. | Permissioned blockchain governance for start-ups and traditional enterprise/uses theory of disruptive innovation |

**Practitioner Perspective**

Given the scant published research from the academic community, we turn to practitioners. We know that many firms plan to join with other organizations to adopt blockchain. A survey conducted by Deloitte found that "the vast majority of respondents (N=1,053) either participate or will likely join a blockchain consortium [with other firms]" (Deloitte, 2018, p. 25). Yet the difficulties in working with other firms in an ecosystem is one of the biggest barriers to blockchain adoption (PwC, 2018). In another study, the World Economic Forum and the United Arab Emirates (Al Olama, 2020) found that the top three challenges to blockchain implementation for corporations and service providers are unclear regulatory implications, difficulty bringing together the required stakeholders, and educating and awareness of the involved stakeholders.

Gartner provides some insight into the challenges of blockchain consortiums, believing that collaboration is essential for creating rules including membership rules, processes, rule enforcement, economic and pricing models, access rights, data standards, and data sharing protocols, at a minimum (Gartner, 2019). McKinsey cites similar concerns. In their opinion, "There must be a governance agreement covering participation, ownership, maintenance, compliance, and data standards" (McKinsey, 2019, p. 46). GS1, a global standards organization, also believes that the most pressing issue for blockchain adoption is governance, and that it is more complex than the technology. GS1 describes a number of collaborative decisions firms must make, including (among other things) rules of participation and how to finance (GS1, 2018). Radcliffe (2019) discusses the differences between permissioned and public blockchains, finding that cooperative governance agreements for permissioned blockchains require daily attention to maintain high levels of trust and cooperative behavior between the parties.

As the literature review suggests, there is consensus amongst scholars and practitioners about the need for governance in a blockchain environment. Blockchain ecosystems are, by their very nature, a shared resource for firms, but how trading partners collaborate to successfully adopt blockchain is an emerging study. These can be complicated relationships to navigate because of overlapping roles; one can simultaneously be a competitor, a supplier, or a customer. The ability to understand how to respect boundaries in a shared environment is difficult for firms used to guarding their resources protectively (Johnson, McCurdy, Schechter, & Loch, 2020). This work seeks to elucidate the governance issues at play in blockchain implementation so as to provide guidance for firms as they navigate the challenges of sharing resources with trading partners. Thus, the first phase of our Design Science research set out to simulate a blockchain use case that required firms to work together to jointly deploy blockchain, and to document all the hard decisions that entailed. An overview of the research approach can be found in Table 4.

**An Overview of the Research Approach**

*Table 4. Research Approach*

| Engaged Scholarship Component | Research Component |
|---|---|
| Area of concern (A) | Permissioned blockchain for firms in a supply chain ecosystem. |
| Problem setting (P) | Firms lack collaborative governance models to deploy blockchain |
| Theoretical framing (F) | |
| 1. $F_I$: Theory independent of area of concern | Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage (Dyer & Singh, 1998) |
| 2. $F_A$: Theory draws on area of concern | Collaborative Governance in Theory and Practice (Ansell & Gash, 2007) |
| Research methods (M) | Design Science and field engagement (interviews) |
| Contributions (C) | |
| 1. To theory ($C_F$) | $C_F$: Supports Relational View that blockchain technology, which requires close interfirm collaboration, may improve a firm's competitive advantage. |
| 2. To Area of concern ($C_A$) | $C_A$: Furthers the Collaborative Governance theory and extends it to blockchain technology. |
| 3. To practice ($C_P$) | $C_P$: Proposes a governance model specific for blockchain and provides a smart contract artifact and code for a simple supply chain purchase order. |
| Research Question (RQ) | What is the role of collaborative governance in blockchain-enabled supply chains? |

*Adapted from Mathiassen (2017)*

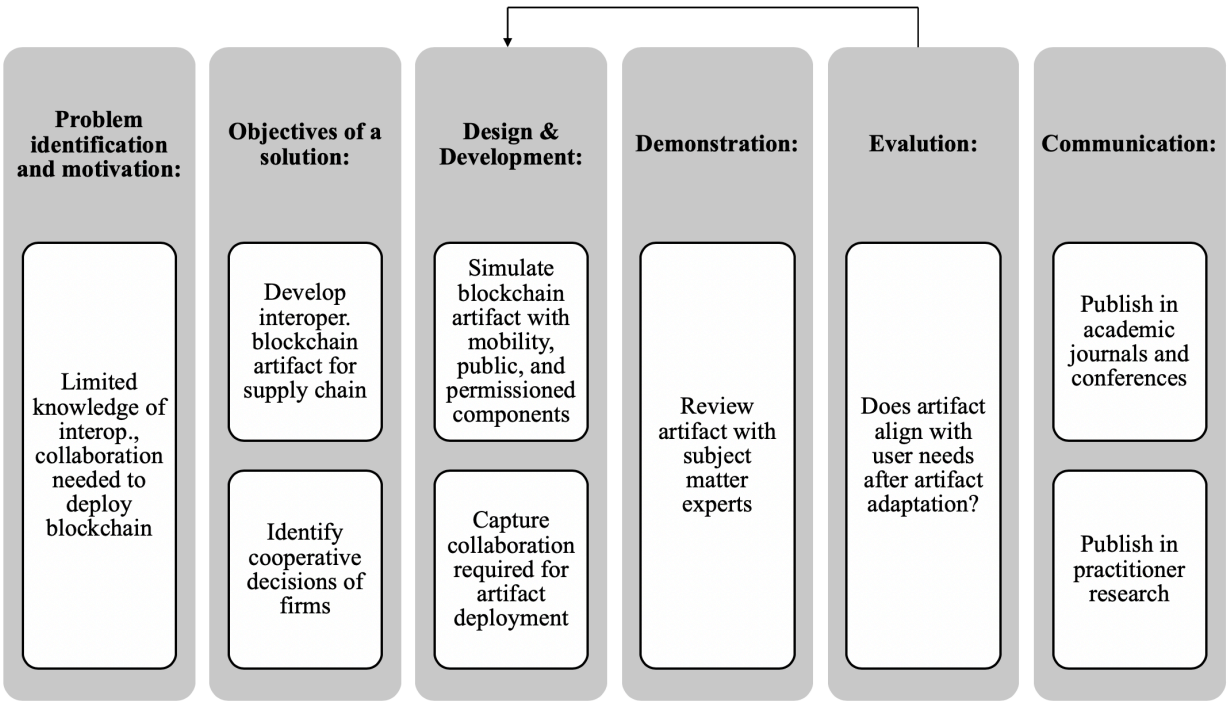
# Chapter 3: Design Science

## Selected Design Science Framework

Design Science as a research paradigm (Baskerville, 2008; Iivari, 2007) is still relatively new. Originally credited to Herbert Simon with his seminal work *The Science of Design: Creating the Artificial* (Simon, 1988), Design Science is well suited for information systems research as it endorses a "build then explain" approach. Specifically, the researcher "creates and evaluates IT artifacts intended to solve identified organizational problems" (Hevner, March, Park, & Ram, 2004, p. 77). An artifact can be several things, including a modeling tool, a change intervention, governance strategies, computer code, or another type of knowledge-containing phenomenon (Gregor & Hevner, 2013). Or an artifact can be "constructs, models, methods, and instantiations" (March & Smith, 1995, p. 256). Said another way, an artifact can be considered an experiment with scientific rigor.

In this study, we developed a blockchain-based artifact for supply chains following the design science framework of Peffers et al. (2007), and informed by the exemplar journal articles (Baskerville, 2008; Baskerville, Baiyere, Gregor, Hevner, & Rossi, 2018). The design science methods are fairly prescriptive, and we adhered to each step: Identify the problem, define the objective of the artifact, design and develop the artifact, and demonstrate the artifact (in this case, as a final term project for the GSU Fintech class.) We chose this particular design science framework as it allows for an objective-centered entry point for an industry need, specifically the use of interoperable blockchain technology in supply chains (Peffers et al., 2007). Figure 3 represents our planned artifact using the selected design science framework. At this point in our design experiment, all boxes are white, denoting planned but not tested or deployed artifact activities.

*Figure 3. Planned Artifact using the Design Science Research Framework*




*(following Peffers et al., 2007)*

Before moving forward with constructing the artifact, we secured the approvals of the IRB (Institutional Review Board) and the lead researcher's doctoral committee. After receiving approval, we moved to the next step: technically designing the artifact.

**Designing a Blockchain Artifact – DappyChain emerges**

The DappyChain team formed in January 2019 at Georgia State University as part of a blockchain class. The final class project required a functional blockchain artifact. The lead researcher of this study, as part of her doctoral studies, presented a potential blockchain project to the class. Four classmates agreed to join the project, and Team DappyChain was born.

Comprised of five students, the multidisciplinary DappyChain team had approximately fourteen weeks to complete their project (or the Design Science artifact). One team member was an undergraduate in the computer science department. Two team members were doctoral

students in the computer information science department. Another team member was a graduate student in the actuarial science department. As stated, the lead researcher was a doctoral candidate in the business school.

Given the study emphasis of the lead researcher, we started our design science experiment with two goals, a primary technical goal, and an ancillary organizational goal. For the technical goal, we wanted to design and test an artifact that allowed for the blockchain network types to interoperate, or "talk" to each other, as we anticipated that such interoperability amongst blockchain networks would be a future requirement. Blockchain interoperability allows different blockchains to exchange data seamlessly enabling users to trust data across platforms (Hewett, Lehmacher, & Wang, 2019; Larsen, 2018; O'Neal, 2019). Hence, the artifact was composed of a permissioned blockchain, a public blockchain, and a mobile application. The team planned to use an Oracle program resident in the permissioned blockchain to watch for Ethereum transactions, in this case a purchase order event, and encode the purchase order on a smart contract for the permissioned network (Thevenard, 2019).

Our second organizational goal was to capture the collaborative decisions we needed to make (as separate entities) to jointly deploy a blockchain network. In order to do this, we simulated a generic supply chain ecosystem with manufacturer, retailer, shipper, and consumer roles. This multidisciplinary approach permitted the team to exploit the individual technical expertise needed for each assumed role, but to also use our business skills to complete the artifact. We used the design decision critieria (see Appendix A) to explore the variety of decisions we needed to consider for our artifact.

The purchase order was a critical data element, as it was the first entrée into the blockchain network. We used a generic purchase order with preexisting smart contract coding

(Appendix B) to simulate this supply chain ecosystem. The interoperable artifact we designed was intentionally challenging and included technical elements still in development. During this process, the DappyChain team made a number of design decisions (Table 5). The originally designed artifact, complete with process flows, can be found in Appendix C.

*Table 5. Artifact Decision Matrix*

| **Date** | **Design Discussion/Decision** | **Issues/Rationale** |
|---|---|---|
| 1-19-2019 | Team of 5 forms. Discussed strengths of each team member. | Discovered a wide range of skill sets. Uneven programming knowledge. |
| 1-29-2019 | Agreed on collaboration tools | Slack, Trello. These were new tools for some team members. |
| | Discussed motorcycle as best use case | Potential to use photo image. |
| | Discussed security and privacy concerns of consumer data in use case. | Requires a permissioned blockchain type, though team concerns about this. |
| 2-6-2019 | Agreed to use Ethereum for public blockchain | Widely used, smart contract functionality, robust tools and support online. |
| | Discussed Hyperledger Quilt or Hyperledger Fabric | Both created for enterprise; Quilt probably better, but still new, lack of online support. |
| | Discussed standards to use | Reverted to using blockchain stack, lack of published standards. |
| 2-11-2019 | Agreed on Hyperledger Fabric | To address privacy concerns, has channels for encryption. Also has online training materials available. |
| | Agreement to use pBFT (practical byzantine fault tolerance) for consensus protocol | Follows Fabric stack. Easy decision. |
| | Agreed on Solidity for smart contract programming | Follows Ethereum and Fabric stack. Easy decision. |
| 2-19-2019 | One member leaves team | Discussion on picking up work, concern over lost programming skills. The team is busy with other work, difficult to distribute additional work. |
| | Attempted Truffle, returned to Mist | Technical issues with Truffle, and lack of skills (and time) to learn. |
| 2-26-2019 | Interoperability issues between permissioned and public blockchains. | Public to permissioned with cost ether; consulted with GSU computer programming professor for assistance. |
| 3-5-2019 | Changed use case to generic package | Some disagreement to change use case but ultimately team agreed to keep it simple. |
| 3-19-2019 | Stood up test HLF network with 4 nodes using GO, java, JavaScript. | |
| 4-10-2019 | Agreement to use Mist-based smart contract app rather than Medium. | Challenges with Solidity version control! Required one team member to translate. |
| 4-25-2019 | Class presentation! | |

Once we completed the basic artifact design, and as part of the design process, we shared our artifact with blockchain experts in the business and academic community (see Table 6). The feedback we received was supportive, and after making adjustments to the artifact, we proceeded with the next steps – testing and evaluating the artifact.

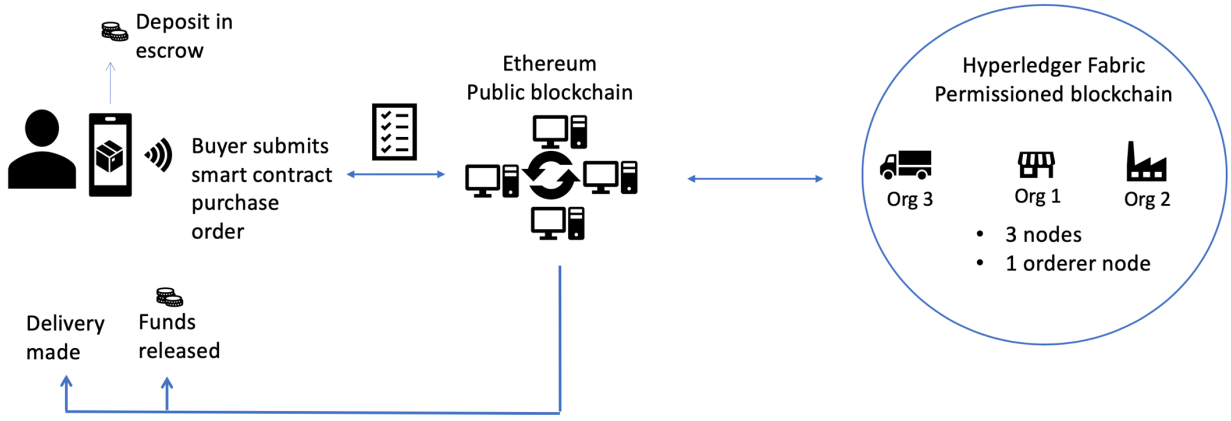
*Table 6. Artifact Design Feedback*

| **Industry of reviewee** | **Feedback** |
|---|---|
| Large firm, consumer products | Interested in the mobility aspect of the artifact. Considers change management across firms critical. |
| Academic, research lab | Reading from or writing to a blockchain, and executing smart contracts, may require that each party be able to demonstrate compliance with specific policy criteria that are applicable to the blockchain. Need to include basic security policy rules, privacy policy, data interoperability rules, and domain-specific business rules related to the use of the data. |
| Large firm, ground transportation | There are multiple standard organizations competing for "market share." Overall supports the artifact but feels the legal issues are big, including "who's in charge." What happens when something goes wrong? Who is legally liable? EDI isn't standardized, because different customers require different EDI arrangements. What do we (as firms) get for being part of a particular blockchain ecosystem? |
| Small firm, blockchain start-up, identity | Contact believes topic is relevant, especially as it relates to governance, but "I don't have good answers…answers vary by context and stakeholder." |
| Large firm, ground transportation | Believes blockchain will deliver, but privacy is a concern; wouldn't want other shippers to see each other's data. Concerns regarding how to negotiate privacy with other firms. |
| Small firm, blockchain start-up, supply chain tracking | Firm is "blockchain startup that uses Internet of Things (IoT) to record journey of the products across the supply chain from manufacturer to customer to create an extra layer of visibility, transparency, and authenticity." Contact believes true interoperability is some time away, but the mobility aspect can be easily coded. |
| Large firm, retail, home improvement | Contact uses barcodes on pallets, using WIFI mesh tech. Believes blockchain will improve vendor relations, as they can pay vendors faster (know when the correct shipments arrived). Not certain a public/permissioned blockchain network would be relevant; they are big enough to mandate compliance from other suppliers. |
| Large firm, logistics | Sees benefit of artifact but recommends using a purchase order as the asset identifier, because if a purchase order number gets entered incorrectly at the front end, it can create havoc throughout the supply chain process. |
| Academic, blockchain lab | Still need someone who is allowed to publish the purchase order, some type of central authority. Agrees that if you can share data between firms, you can operate better. But firms need to agree on rules of what takes place and when. These complexities do not go away with blockchain. |

**Testing the Blockchain Artifact**

We had our work cut out for us to test our artifact. We were stretching the limits of our knowledge. Using class time and additional hours outside class, the team investigated how to code the public, permissioned, and mobile elements. Technical interoperability between blockchain networks remained a key goal, and to test this, we designed the artifact using Ethereum (Buterin, 2013) for the public blockchain, and Hyperledger Fabric (Androulaki et al., 2018; Cachin, 2016) for the permissioned blockchain (see Figure 4).

*Figure 4. Planned Blockchain Artifact*




Our second goal was to capture the collaborative decisions required by multiple entities to deploy blockchain – human interoperability, if you will. Permissioned blockchains were an important element of the artifact design, as these types of blockchain networks require firms to work together to agree on a number of blockchain design decisions. To achieve the permissioned blockchain, we designed a two node Hyperledger Fabric network. We were inspired, as discussed, by a generic purchase order for our smart contract, defining roles for manufacturer, retailer, shipper, and consumer. The roles allowed us to explore the decisions we needed to make

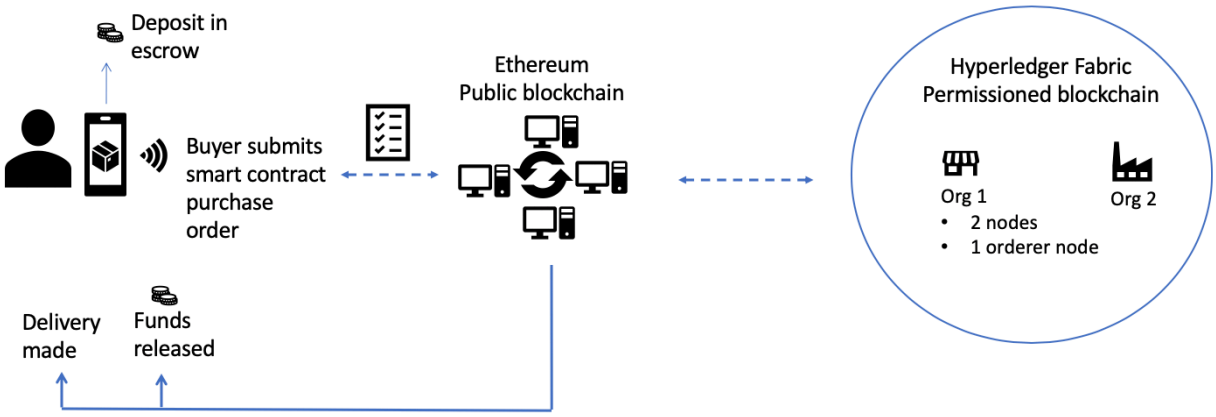
regarding blockchain network types, protocols, security concerns, and use cases.

We used Solidity for the Etherum, a smart contract programming language, and Geth and Mist programs for the Ethereum tools. Geth allows users to mine Ether, the type of token on the Ethereum network. It also acts as a node for the Ethereum blockchain network. (Bruno, 2018). Mist connects to Geth in the background, and also serves as an interface for the wallet. Mist essentially provides an easier human interface to communicate with Geth. We deployed two smart contracts to order and track a generic product. We were successful in running our smart contracts in Ethereum (see Appendix D for our smart contract programming code).

We purchased an Android phone for the mobile application, and attempted to use Android Studio (Zapata, 2013) to connect our mobility solution to the Ethereum blockchain. We had technical scaling issues with our approach, as the size of running a full node on a mobile phone was prohibitive. The current size of the Ethereum blockchain is around 180GB, more than half of the space on most recent iPhones. Because of these challenges, we suggest using a solution similar to Metamask that allows a user to connect to the blockchain without running a full node (Bahga & Madisetti, 2017).

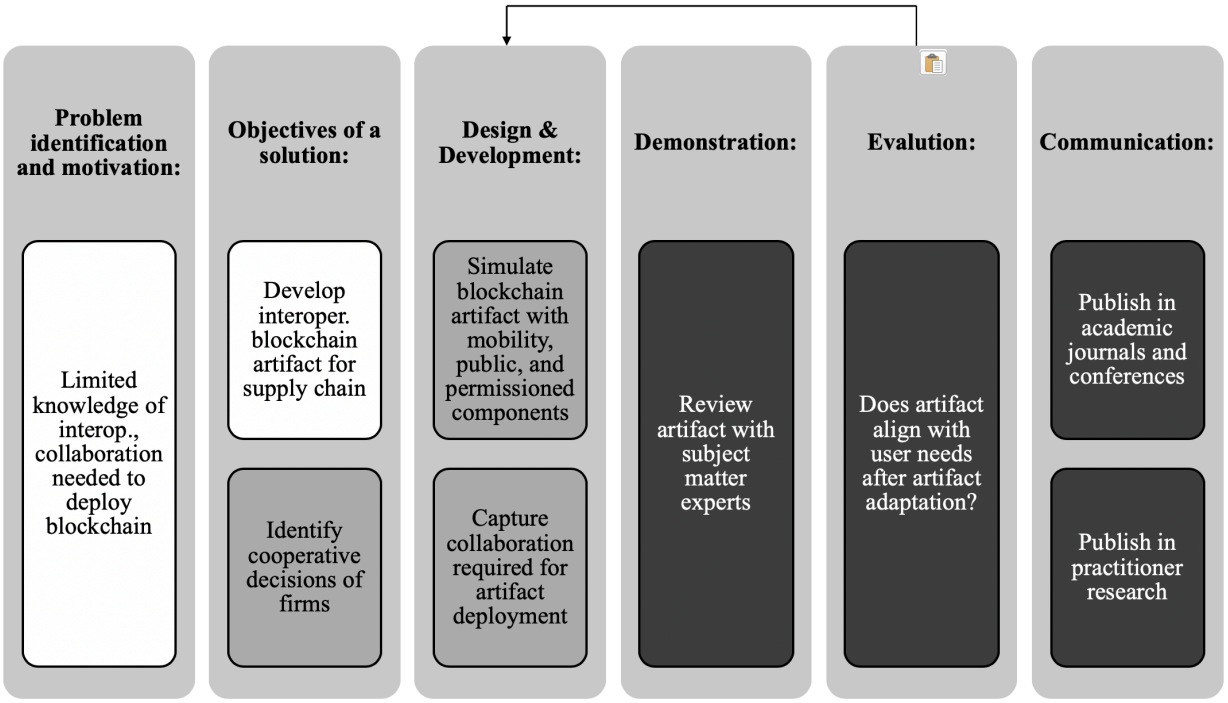
We successfully deployed the Hyperledger Fabric network, with two nodes and one orderer node (Figure 5). We were not successful connecting our permissioned to our public blockchain networks, nor our public blockchain to our mobile application. Had we succeeded with demonstrating technical interoperability, the dotted lines would have been solid.

*Figure 5. Deployed Blockchain Artifact*



The updated design science framework in Figure 6 provides a visual of the deployed artifact. As discussed, we could not fully deploy the artifact. The white boxes depict full deployment, the gray boxes partial deployment, and the black boxes represent activities we could not fulfill.

*Figure 6. Deployed Artifact using the Design Science Research Framework*




*(following Peffers et al., 2007)*

Note: White boxes denote full deployment, light gray boxes represent partial deployment, dark gray represents undeployed.

**Artifact Evaluation**

Upon completion of the project, each team member was interviewed for their observations regarding the technical and the collaborative decisions required to build the artifact. Though many of the decisions we made focused on the technology, we encountered challenges that would hint to later collaboration concerns. We found that we had different ideas for the use case. Who gets to decide? We disagreed at times on the tools to use. Should we go with the software and code that was better supported with online help, or with the tools we believed to be technically superior? Our differing levels of knowledge came into play. Did we all need to have the same level of coding experience, or could we specialize in certain tasks (i.e., a mobile application developer, a coder for one particular language, a coder for another language, and an overall project leader)?

The debrief also revealed some important information about project staffing and management. Early in the artifact design stage, a programmer member left the team. Who should pick up his work? Key technical knowledge had walked out the door, stretching the resources of the existing team members. Though we didn't know it at the time, the challenges we encountered could later be described as knowledge asymmetry; human capital concerns (resource constraints, re-training); offboarding; and the concept of an anchor tenant. Though we were not able to deploy a working end to end artifact, we captured a number of key learnings:

**Permission to public interoperability** – We struggled with our interoperable solution. As discussed, we could launch the Hyperledger Fabric and Ethereum blockchain networks, but we could not connect the two. We learned that instead of having a public Ethereum network as part of the design, incorporating an Ethereum Virtual Machine (EVM) node on Hyperledger Fabric was an option we could have explored. If that failed to work, we also had the option of

using Hyperledger Sawtooth. This new design would have allowed for a web portal for mobile connectivity. Additionally, we could have installed Hyperledger Fabric or Sawtooth as a master node, then connected to the Ethereum network. This design would have been the preferable arrangement, but due to time constraints, we did not design or test this. Our blockchain network interoperability goal was ambitious; in spite of the solid technical skills of the team, blockchain interoperability continues to develop, and remains unresolved at the time of this writing.

**Evolving standards** - Standards are evolving across industry groups; there is no one standards body; hence blockchain development is fragmented and uneven. Yet standards are a recognized and critical component for the networked technological economy, and they encourage broader adoption (Lerner, Tabakovic, & Tirole, 2016; Lerner & Tirole, 2014).

Public blockchains naturally include a certain amount of governance. For example, in choosing public Ethereum, the blocks of information are resident on every node (computer), which improves redundancy but affects latency and introduces privacy concerns; all the onchain data is visible to all. It's important to know that when choosing a type of blockchain network, it's necessary to either accept this integrated governance OR spend considerably more time on managing governance concerns. As we had incorporated public and permissioned blockchain types, we needed to have some knowledge of both.

**Multiple blockchain choices** - There are different blockchain variations for public and permissioned versions, and the programming and development tools vary per blockchain network type. Consensus protocols, how blocks are ordered and executed, and other technology concerns vary across blockchain type. A smart contract code written for one type of blockchain network will not translate to another (nor are they called smart contracts across the board; Ethereum uses smart contracts and Hyperledger Fabric uses chain code). It was an intense

learning curve for the team to adequately understand the variety of technical components that blockchain employs.

**Robust knowledge sharing/time constraints** – The team came into the project with different skill sets. To even partially deploy the artifact, a minimum level of knowledge was required. This baseline knowledge sharing required significant time to understand the technical tools and the underlying business process. We underestimated the amount of time needed for this skill uplift.

**Scarce skills** – We found it difficult to find people who could provide the necessary expertise to deploy our artifact. Subject matter experts tended to be knowledgeable in either public or permissioned blockchain network types, rarely both. Finding expertise in blockchain interoperability was, as predicted, very difficult, as this is an emerging area. Firms who require interconnectivity will be on the bleeding edge of technology though the artifact subject matter experts, by and large, agreed that blockchain interoperability is inevitable.

**Reliance on third parties** – We relied on multiple software and consortium providers to develop our artifact. It became clear that relying on blockchain providers for their expertise helped with the technical heavy lifting but required faith that "it will work." This reliance can contribute to vendor lock-in. Firms should weigh the pros and cons of a blockchain build or buy. If a firm invests in blockchain expertise in-house, prepare for a sizeable investment in training.

**Need for well-documented use cases with deep underlying process knowledge –** Picking the correct use case was critical. We discovered that it was critical to know the detailed underlying business process for the selected use case, as this helped inform the technical solution, including the correct blockchain "flavor," consensus protocols, and development tools. Many tools found online were immature, underdeveloped, and were updated frequently,

necessitating rework for the team.

**Need for an overall blockchain roadmap** – At the completion of our studies, we observed that a number of our challenges with deploying a complicated blockchain ecosystem could have been attenuated with some kind of a roadmap. Not a project or implementation plan per se; that is more about sequencing. Instead, we would have benefited from a big picture view from the very start that may have, at a minimum, provided the team the right questions to consider and a clue to our knowledge gaps.

**Challenges with the Artifact and the Move to Field Engagement**

At this point, the research took a different turn. Instead of demonstrating an interoperable blockchain artifact, complete with requisite design decisions, we needed to investigate why the artifact test failed to deploy successfully. What were the problems? Were the issues strictly technical, (i.e. the interoperable technology for the artifact wasn't ready for primetime)? Or did the problems lie more with the nature of collaboration? Or perhaps it was a combination of the two. In other words, did technical or organizational design problems prevent full deployment?

Replete with the artifact evaluation, and still curious about the importance of interoperability and how firms can effectively collaborate to deploy blockchain, we moved to field engagement. We were interested in what others, especially industry blockchain practitioners, thought of blockchain deployment challenges. Is interoperability as important as we suspected? Are facets of technology prohibiting success? What type of governance model or mechanism is needed to manage the collaborative decision-making process? From the view of experts in small firms and large, blockchain service providers and blockchain consumers, are our experiences typical for firms in the "real world" and not just in a simulated environment? How many of our challenges were similar to those felt by others?

The lead researcher, now solo, analyzed and consolidated the collective learnings into general themes. These themes formed the basis of the interview questions for the field engagement research (see Table 7). For example, evolving standards was an observation from the artifact design work that transitioned into questions for the field. This additional research – the field engagement - required new approvals from the IRB and the researcher's doctoral committee. After securing these, the researcher, armed with a theme-inspired interview protocol, moved to the field (for the full interview protocol, see Appendix E). The researcher was curious to learn if the themes resonated with the blockchain subject matter experts; hence, she asked respondents for their views to help verify/confirm/disconfirm the design science learnings.

*Table 7. Design Science Learnings Mapped to Interview Questions*

| **Design experiment learnings…** | **…led to these interview questions…** |
|---|---|
| **Artifact permission to public interoperability:** We were not able to develop a working interoperable blockchain artifact (public and permissioned). We believed it was important, however, per our industry contacts and the literature. | Q. 31: Have you or do you plan to connect to other blockchain networks? What are the major reasons to do so? What are the biggest challenges you foresee? How ready is your company (or industry) to do this interconnect?<br><br>Q. 33: Do you plan to have a shared set of tools (MIS) across the ecosystem?<br><br>Q. 35: Do you have a need for blockchain globally? |
| **Competitive advantages of blockchain:** Not explored in design experiment. | Q. 8: Do you believe that deploying blockchain will give your company a competitive advantage? If so, why is that? If not, why?<br><br>Q. 12.2: Do you feel that being a blockchain ecosystem could lead to future revenue opportunities for your firm? |
| **Evolving standards:** Standards are evolving across industry groups; development is fragmented and uneven. Public blockchains include a certain amount of governance baked in; knowledge of this prerequisite is important. | Q. 18: What standards did you use, or do you plan to use? Why did you choose these standards? Did you consider others? If so, what are these? What is the importance of blockchain standards to you/your firm? |
| **Multiple blockchain choices:** There are different blockchain variations for public and permissioned versions, and the programming and development tools vary per blockchain network type. Consensus protocols, how blocks are ordered and executed, and other technological concerns vary across blockchain type. A smart contract code written for one type of blockchain network will not translate to another. | Q. 14: What were the largest technical challenges you encountered in your firm's blockchain implementation (or do you anticipate)? How did you resolve those? What issues were unresolvable and why?<br><br>Q. 15: What blockchain type did you use (or are considering), Ethereum, Corda, HLF, Quorum, Bitcoin, etc. What decision criteria did you use?<br><br>Q. 16: What type of consensus protocol did you use/planning to use? PoW, PoS, PBFT, etc. What influenced this decision? |
| **Robust knowledge sharing required amongst members:** The team entered this project with different skill sets. In order to even partially deploy the artifact, a minimum level of knowledge was required. This issue translated into technical tool knowledge-sharing, but also a deep understanding by all team members of the underlying business process. We underestimated the amount of time needed for this skill uplift. | Q. 9: Do you believe that blockchain will require more or less interdependence with firms in your blockchain ecosystem (network)? What are the implications of your answer?<br><br>Q. 11: Do you believe that blockchain will require your firm to conduct more or less knowledge sharing with the firms in your blockchain ecosystem? If yes, to what extent? |

| | |
|---|---|
| **Scarce skills/resources and time constraints:** We found it difficult to find people who had the necessary expertise to deploy our artifact. Subject matter experts tended to be knowledgeable in either public or permissioned blockchain network types. Finding expertise in blockchain interoperability was, as predicted, very difficult. Firms who require interconnectivity will be on the bleeding edge of technology. | Q. 12: Do you believe deploying blockchain will lend itself to more or less sharing in the future?<br><br>Q. 25: To what extent did blockchain require large organizational changes within your company (or did you anticipate these?). Can you describe these changes? *(i.e. org changes, retraining, downsizing, culture, etc.)* |
| **Need for well-documented use cases with deep underlying process knowledge:** Picking the correct use case is important, as is knowing the underlying business process you hope to displace/disrupt/improve with blockchain. | Q. 23: How much disruption is blockchain likely to cause to your existing business operations? What type of disruptions are these (anticipated?) How did you handle these (or plan to handle?)<br><br>Q. 27: Can you describe any process changes you encountered (or anticipate) because of your blockchain implementation? Can you elaborate on any unresolved process changes? |
| **Need for overall blockchain roadmap:** We needed to make a number of decisions collaboratively as part of the initial discussions. Though the artifact was a simulation with assumed "roles," firms who adopt blockchain will have a large number of decisions to make collaboratively, depending on the type of governance model. | Q. 21.2: What are the ideal qualities you look for in blockchain partners? *(in your ecosystem)*<br><br>Q. 22: What were the largest non-technical challenges you encountered in your firm's blockchain implementation (or do you anticipate)? How did you resolve those? What issues were unresolvable?<br><br>Q. 24: How will you introduce blockchain in your firm? Across your ecosystem? How did you gain agreements with your ecosystem?<br><br>Q. 30: Describe for me how you onboard members for your ecosystem (or plan to do so). What lessons did you learn? What would you do differently/same?<br><br>Q. 30.1: Do you feel you can unwind your blockchain ecosystem easily or with some difficulty?*)*<br><br>Q. 32: Once blockchain is launched in the ecosystem, how do you (plan to) manage change within your firm? How will you manage change across the ecosystem (interfirm)? |

# Chapter 4: Field Engagement

## Interview Selection Criteria

The researcher is a member of several industry groups engaged in blockchain development activities. Because of these professional connections, she had access to a range of blockchain subject matter experts, important due to the exploratory nature of this study. To that end, interviewees were selected from small and large firms, different industries, and from a pool of blockchain service *providers* and business *buyers* of blockchain services. This broad range of voices has its advantages for probing a variety of views but makes generalizations for a particular group more difficult. However, the research question is intended to uncover empirical knowledge about interoperability and collaborative governance from a number of viewpoints. The selected interviewees represented this needed diversity, and they represented academia, transportation, pharmaceutical, financial technology, and standard-setting organizations. To ensure confidentiality, group names are not shared, but the industries they represent are noted. Finally, in order to meet scientific rigor, the research followed exemplar practices for qualitative research (Charmaz, 2014; M. B. Miles, Huberman, & Saldana, 2013). After receiving additional Institutional Review Board (IRB) approval to conduct in-depth interviews, the researcher proceeded with the interview requests.

## Firm Demographics

As discussed, the firms represented a mixture of blockchain service providers, and those who will likely use blockchain technology. They ranged in size from single-person entities to major corporations. The firm size is represented by the number of employees, as opposed to annual revenue, and for simplicity uses general guidelines established by the United States Small Business Administration (https://www.sba.gov). Eleven firms fall into the blockchain service

provider category; eight are small or start-up organizations. Additionally, three large firms provide blockchain solution(s) in addition to their core business.

Nine firms do not provide a blockchain service but will likely use blockchain technology. Of the nine, two are start-ups, and seven are large enterprise firms. All respondents have a pivotable role in blockchain development for their respective firms or industries, and this was a criterion for their participation. Table 8 provides an overview of the firm demographics. This mixture of respondents from small and large firms, blockchain service providers and likely buyers of blockchain, and multiple industry types formed the basis for the research question: What is the role of collaborative governance in blockchain-enabled supply chains?

*Table 8. Firm Demographics*

| Title/Interviewee code | Industry | BC Service Provider or Non-Provider | Firm Size | Number of employees |
|---|---|---|---|---|
| Founder/S3 | BC consulting/SME | Provider | small | 1 - 10 |
| CGO/S4 | BC service provider/Governance | Provider | small | 1 - 10 |
| CEO/S7 | BC service provider/Health | Provider | small | 11 - 50 |
| CEO/S8 | BC service provider/Fintech | Provider | small | 1 - 10 |
| Sr VP/S9 | BC service provider/Credentials | Provider | small | 11 - 50 |
| Head of Growth/S10 | BC svc provider/Interoperability | Provider | small | 11 - 50 |
| CTO/S1 | BC consulting/Enterprise | Provider | small | 51 - 100 |
| CEO/S6 | BC service provider/Health | Provider | small | 51 - 100 |
| CRO (Revenue)/L8 | BC service provider/IT | Provider | large | 10,000+ |
| Director/L9 | BC service provider/Software | Provider | large | 10,000+ |
| Director/L10 | BC service provider/Finance | Provider | large | 10,000+ |
| | | | | |
| Founder/S2 | IT consulting/SME | Non-Provider | small | 1 - 10 |
| COO/S5 | eCommerce/SME | Non-Provider | small | 11 - 50 |
| Professor/L1 | Academic/IT | Non-Provider | large | 10,000+ |
| Manager/L2 | Ground transportation | Non-Provider | large | 10,000+ |
| Manager/L3 | eCommerce | Non-Provider | large | 10,000+ |
| Manager/L4 | Air transportation | Non-Provider | large | 10,000+ |
| Founder/L5 | Nonprofit pharma | Non-Provider | large | 10,000+ |
| Manager/L6 | Ocean carrier | Non-Provider | large | 1001-5000 |
| Manager/L7 | Rail transportation | Non-Provider | large | 5001-10000 |

Note: * For simplicity, small firms are fewer than 500 employees and large firms are over 1000 employees.

**Interviewee Profile**

The interview protocol contained several questions that queried respondents on demographic data, their personal familiarity with blockchain, and their perception of their firm's readiness to adopt blockchain. As the descriptive demographics in Table 9 and Table 10 illustrate, the blockchain service provider respondents were generally younger, with two baby boomers, seven Gen Xers, and one millennial. In contrast, the non-blockchain service providers were split evenly: Five baby boomers and five Gen X ages. These differences carried over to time in role and industry, as the blockchain service providers had less time in their respective roles and industries (2.9 and 16.3 average years, respectively), not surprising given their generally younger ages. In contrast, the non-blockchain providers had significantly more time in their roles and in their industries (8.8 and 28.6 average years, respectively).

*Table 9. Descriptive Statistics of Interviewees*

| Descriptive Statistics of Interviewees (n=20 ) | | |
|---|---|---|
| **Entire Group** | | |
| **Gender** | | |
| | Number | % |
| Male | 16 | 80 |
| Female | 4 | 20 |
| **Generation (Age)** | | |
| | Number | % |
| Baby Boomer | 7 | 35 |
| GenX | 12 | 60 |
| Millennial | 1 | 5 |
| **Blockchain Provider Status** | | |
| | Number | % |
| Provider | 11 | 55 |
| Non-Provider | 9 | 45 |
| **Years in the Industry** | | |
| Range | 2 - 46 years | |
| Mean | 21.8 years | |
| **Years in Role** | | |
| Range | 1 - 26 years | |
| Mean | 5.525 years | |

*Table 10. Descriptive Statistics by Provider Status*

Descriptive Statistics By Provider Status (n=20 )

| Gender | | | | |
|---|---|---|---|---|
| | Provider (n= 11) | | Non-Provider (n = 9) | |
| | Number | % | Number | % |
| Male | 9 | 82 | 7 | 77 |
| Female | 2 | 18 | 2 | 23 |
| **Generation (Age)** | | | | |
| | Provider (n= 11) | | Non-Provider (n = 9) | |
| | Number | % | Number | % |
| Baby Boomer | 3 | 27 | 4 | 44 |
| GenX | 7 | 64 | 5 | 56 |
| Millennial | 1 | 9 | 0 | 0 |
| **Years in the Industry** | | | | |
| | Provider (n= 11) | | Non-Provider (n = 9) | |
| Range | 2-35 years | | 16 - 46 years | |
| Mean | 16.3 | | 28.6 | |
| Median | 15 | | 30 | |
| **Years in Role** | | | | |
| | Provider (n= 11) | | Non-Provider (n = 9) | |
| Range | 1 - 6 years | | 1 -26 years | |
| Mean | 2.9 | | 8.8 | |
| Median | 3 | | 7 | |

From a perspective of blockchain familiarity, as Table 11 illustrates, the blockchain providers, whether large or small, generally are more familiar with blockchain (average 4.5 on a 5.0 scale). Blockchain providers also have higher levels of adoption within their firms and feel ready to implement blockchain for themselves and others (average 4.9 on a 5.0 scale). Again, this is not surprising given the nature of their businesses; the blockchain providers need to know their solutions well enough to sell to potential buyers.

The firms who are consumers of blockchain solutions are less familiar with and less ready to adopt blockchain (3.7 and 3.4 on a 5.0 scale, respectively). Interviewee L5 is an exception, as this respondent is also an active member of a blockchain standards consortium. One data point is not a sample size, but it does indicate that engaging in blockchain consortiums may have knowledge-acquiring merit.

*Table 11. Familiarity with Blockchain*

| Interviewee code* | BC Service Provider or Non-Provider | Familiarity with blockchain** | Readiness of firm to implement BC ** |
|---|---|---|---|
| S3 | Provider | 5 | 5 |
| S4 | Provider | 4 | 5 |
| S7 | Provider | 5 | 5 |
| S8 | Provider | 5 | 5 |
| S9 | Provider | Abstained | 5 |
| S10 | Provider | 4.8 | 5 |
| S1 | Provider | 4.5 | 5 |
| S6 | Provider | 5 | 5 |
| L8 | Provider | 4 | 5 |
| L9 | Provider | 5 | 5 |
| L10 | Provider | 2.5 | 4 |
| **Ave** | | **4.5** | **4.9** |
| | | | |
| S2 | Non-Provider | 3.5 | 3.5 |
| S5 | Non-Provider | 5 | 5 |
| L1 | Non-Provider | 4 | 2.7 |
| L2 | Non-Provider | 3.5 | 2 |
| L3 | Non-Provider | 4.5 | 2 |
| L4 | Non-Provider | 4 | 3 |
| L5 | Non-Provider | 4 | 2 |
| L6 | Non-Provider | 3 | 2.5 |
| L7 | Non-Provider | 2 | 2.5 |
| **Ave** | | **3.7** | **3.4** |

Note: ** Familiarity and Readiness columns represent a 5-point scale, with 1 "low" or "not at all" and 5 "high" or "very ready," respectively. For the entire text, see questions 3 and 39 of the interview protocol.

The interview protocol also queried respondents for their general views of blockchain, the technical challenges and non-technical challenges, and their views on blockchain governance, as informed by our earlier challenges in the design experiment. The complete interview protocol can be found in Appendix E.

**Data Collection and Analysis**

The interviews took place between June 2019 and January 2020. The interviews were semi-structured in nature, informed by M. B. Miles et al. (2013). Before starting, the researcher conducted a structured informed consent briefing with each subject and obtained their consent to

participate (see Appendix F for the informed consent form). After consent was received, the interviews were audio recorded and transcribed. The interviews were approximately sixty to ninety minutes long. Over 350 pages of interview data were recorded. Initial first cycle coding was conducted using NVivo 12 Plus for Windows. After the initial coding, a three by three inter-rater reliability was performed, achieving a 0.75 overall unweighted Kappa value. Per NVivo, fair to good inter-rater reliability ranges are from 0.40 to 0.75, with values over 0.75 considered excellent inter-rater reliability. At 0.75, the study met the reliability guidelines, and the analysis continued.

The interviews were analyzed as informed by Charmaz (2014), as we studied and interpreted the data to find analytic categories. At this point, the data was transferred to Excel to provide a better cross view and to explore emerging themes. The data was organized as a matrix in which the columns were labeled as interviewee code, with each row representing a summarized response to each interview question. A second cycle coding was completed which included analytic memos and jottings, also known as "analytic sticky notes" (M. B. Miles et al., 2013). Finally, a third analysis was performed using a qualitative data analysis program, NVivo, comparing the themes from Excel with those in NVivo. After cycling between the data and the themes uncovered in NVivo and Excel, fourteen themes and ninety-one subthemes emerged. After further analysis, the themes were consolidated into higher-level concepts, resulting in the six themes and twenty-three subthemes, as seen in Table 12.

**Findings from Interviews**

The interviews yielded rich data regarding participants views of blockchain technology in general, its ability to confer a competitive advantage, technical considerations, and key to this research, the challenges of governance. As discussed, six themes and twenty-three subthemes

emerged. These themes are explored in more detail, with key observations noted, and possible explanations for the differences among the respondents.

*Table 12. Themes and Subthemes.*

| Themes/subthemes |
|---|
| 1. The adoption of blockchain technology is inevitable:<br>a. Similar to the internet, a foundational technology<br>b. Interoperability an essential requirement for domestic blockchain networks…<br>c. …And as it relates to global blockchains |
| 2. Blockchain is likely to provide a competitive advantage:<br>a. Improves efficiencies and reduces costs<br>b. Opportunity to capture new revenue<br>c. Increased trust in previously unknown entities and existing partners<br>d. First mover advantage – or the fear of missing out?<br>e. Participating in an ecosystem IS a form of competitive advantage |
| 3. Importance of standards for blockchain adoption:<br>a. Lack of standards may impede adoption<br>b. Need for robust proof-of-concepts |
| 4. Technology concerns:<br>a. Challenges with blockchain technology aren't a deal breaker<br>b. Integration with existing systems<br>c. As part of a firm's digital transformation |
| 5. Impact of blockchain technology on human capital concerns:<br>a. Anticipated organizational change<br>b. Lack of skilled resources<br>c. A major socio-technological disconnect<br>d. Implications of increased knowledge sharing |
| 6. Blockchain requires new and intense forms of collaboration:<br>a. Change of focus from within to across firms<br>b. Potential disruptive nature of blockchain<br>c. Supplier disintermediation changes landscape<br>d. Legal, regulatory, and intellectual property co-commitments<br>e. Importance of use case selection<br>f. Need for new governance models |

1. ***The adoption of blockchain technology is inevitable***

Generally speaking, most respondents believe that the benefits of blockchain will drive overall adoption and will become **inevitable**, with some stating that it will become as pervasive and foundational as the internet:

> "So that's the answer, blockchain is the new Internet. It's the Internet of value."
> *( founder, small firm, blockchain consulting, S3)*

> "…it's like the Internet, like a company that's not on the Internet would just be strange. Right? Like it would be hard to imagine how they're doing business. So I view eventually that's how pervasive participation in a blockchain network and the data sharing that will be enabled by it will be."
> *(CEO, small firm, blockchain service provider, health, S6)*

> "I think the blockchain is going to be five to 10 years from now where e-commerce is today. We're not even going to think about it. It's just going to be running in the background."
> *(CRO, large firm, L8 )*

This thinking extends to the need for blockchain networks to "talk" or **interoperate** seamlessly. There was virtually no disagreement on this; every respondent agreed that interoperability is necessary for blockchain to be a viable technology. This insight supported our design science research, in that the need for blockchain interoperability is crucial (per the respondents) for widespread adoption:

> "This has gotta be some way for the technologies, you know, because not everybody's going to buy multiple technologies. There's gotta be some way for those blockchains to interoperate."
> *(manager, large firm, ground transportation, L2)*

> "So I think there's going to be public blockchains that the organization may need to take part in. I think that there will be private ones. And then being able to interoperate between both of them. I think it's going to be...I think blockchain isn't going to turn out like we think, I think we need to expect it."
> *(manager, large firm, air transportation, L4)*

The requirement for interoperability was also observed for blockchains that extend beyond sovereign borders. This need for interoperability across blockchain ecosystems and country borders was again noted by 90% of the participants:

> "You know, in all our supply chain projects, supply chain manufacturing happens in China, Asia, and the big companies, the large companies out here, shipping happens across country boundaries, right? We consider that [global] from day one."
> *(CTO, small firm, blockchain consulting, S1)*

> "I don't think [non global business] exists anymore and at least in my mind because when I started thinking global, I'm thinking then what is local? There's far few things left that are just local."
> *(founder, small firm, IT consulting, S2)*

> "…as long as there is an actual business between me or my company and some company somewhere else, Vietnam or India or Australia, then it should be borderless, blockchain will be applicable."
> *(CEO, small firm, blockchain service provider, fintech, S8)*

> "Oh, yes. No doubt about it. It would be sad if these are only closed ecosystems."
> *(IT Professor, large academic institution, L1)*

The requirement for **global interoperability** has interesting cultural and operating model implications. Some firms commented on blockchains' perceived abilities to improve global

business processes:

> "Oh, I think blockchain globally is one of the key benefits of blockchain. And the thing that's really global about blockchain is cross border transactions."
> *(COO, small firm, eCommerce, S5)*

> "It may improve things internationally more than it would domestically…because a lot of customs agencies around the world are not as technically adept as say, US customs or Europe."
> *(manager, large firm, ground transportation, L2)*

> "We deal with 30 some odd countries. So the more this technology is global, the better it will be for all of us."
> *(manager, large firm, ocean carrier, L6)*

> But challenges were also noted from a legal perspective:
> "…things like GDPR…we've stayed away from any private personal data…we'll have to see how to deal with it."
> *(CEO, small firm, blockchain service provider, health, S6)*

> "We do have a need for it globally. And you know, there's certainly the legal ramifications of what does it mean and where does the data reside? We deal with that now with a lot of the government agencies…"
> *(Manager, large firm, eCommerce, L3)*

While others commented on the implications of global blockchains, given the amount of collaboration required across different cultures:

> "I'll tell you one that stands out for me as probably underappreciated…the extent to which a lot of people will not welcome a shared source of truth, because they may live in cultures…where admitting a mistake is a loss of face. You're supposed to know everything in advance…you're not supposed to ever have any problems."

*(CGO, small firm, blockchain service provider, governance, S4)*

> "I think the co-development will be interesting globally because people from different countries process logic differently. And actually it might be beneficial, you know, having these different kinds of minds looking at the same code set."
> *(founder, large firm, nonprofit pharma, L5)*

The overriding theme, the need for blockchain interoperability, was clear throughout all the interviews. Equally clear is the need for further research into the legal and regulatory concerns, but also, intriguingly, the cultural considerations. If blockchain requires much closer collaboration than previous technologies, such as the internet, how might the deployment of blockchain upend how we interact with global partners?

### *2. Blockchain is likely to provide a competitive advantage*

To more closely probe the Relational View, we asked respondents if they believed that blockchain could give their firm a competitive advantage. Many believed this to be the case, primarily because of the process improvements and more standard ways of working, which lead to **operational efficiencies** *across* industry ecosystems. The friction experienced in existing cross-business practices is seen as an inhibitor to effectiveness, which in turn drags on competitiveness. The promise of blockchain's ability to standardize how firms work together resonated with many interviewees:

> "I'm biased but I think it will transform the way they do business with each other… I believe that the potential is there to completely simplify the way these companies do business with each other."
> *(CEO, small firm, blockchain service provider, health, S6)*

"It makes it easier to work with multiple suppliers so that your data exchanges, your contracts and things like that with them, are all similar as opposed to all different. So the interaction with them is a lot easier."
*(manager, large firm, eCommerce, L3)*

"We believe that there was going to be some efficiencies and reduction in the communication that goes on with throughout the supply chain."
*(manager, large firm, ocean carrier, L6)*

"And the more transparency and visibility we have, the more efficient we are. That's the goal."
*(director, large firm, blockchain service provider, software, L9)*

In addition to more standardized ways of working, many respondents believe that blockchain can positively affect the bottom line by **reducing operational costs**:

"I think overall it should reduce it [costs] because a lot of the duplication that happens should come down."
*(founder, small firm, IT consulting, S2)*

"When a blockchain solution is developed, costs should be lower than the current state..."
*(founder, small firm, blockchain service provider, consultant, S3)*

Not all respondents agreed with this:

"I think if anybody's looking for cost reduction in blockchain, they're sorely mistaken. They're going to have scalability problems and efficiency operation problems. That's not the value pursuit in my view."
*(IT Professor, large academic institution, L1)*

"So in the sense that we were expecting some sort of return on investment, some improvement in the process, speeding up the process, or getting paid faster, none of those

goals and objectives were met…and so it didn't result in a clear ROI. And so the project was stopped."
*(manager, large firm, ground transportation, L2)*

Some respondents believe that this reduction in costs can unlock capital that can be used for more profitable purposes, including the ability to tap into **new revenue opportunities by** monetizing something that was previously unmonetized, or reaching new customers. This response was heard, predictably, by blockchain service providers regardless of size:

"…And if you save money, you either have better profits or you can use that saved money to position yourself better somewhere else, place it where it needs to be, where it can have a bigger impact, which gives you a competitive advantage."
*(CEO, small firm, blockchain service provider, fintech, S8)*

"And on the more strategic end, they can look at what products can they create, what different business models can they bring into the market. It'll be new and unique and we'll have the competitive positioning create a sustainable competitive advantage going forward."
*(founder, small firm, blockchain service provider, consulting, S3)*

"And also it can also provide the ability for things that previously couldn't be bought and sold to be bought and sold…So it provides liquidity to something that before you couldn't get liquidity except by taking it to an auction."
*(Head of Growth, small firm, blockchain service provider, interoperability, S10)*

**Improved trust,** through confidence in the data and the ability to trust unknown entities involved in the chain, is another important perception of the value blockchain technology can bring. The implications of increased trust has other potential effects, including reduced costs for intermediaries, which currently provide the trust mechanism, and for resolving disputes.

Respondents shared these thoughts regarding the importance of trust:

> "When used properly, it creates a shared source of truth between people who would otherwise struggle to communicate, coordinate and trust one another…So people who succeed in deploying will succeed in capturing significant economic gains, very rapidly, particularly at the expense of their competitors who haven't."
> *(CGO, small firm, blockchain service provider, governance, S4)*

> "Key drivers for blockchain are going to be transparency and immutability and trust against non-trusted parties."
> *(COO, small firm, eCommerce, S5)*

> "There are some things kind of unique to blockchain that help reduce fraud or help reduce trust issues either between counter parties or between untrusted participants in some commerce exchange."
> *(director, large firm, blockchain service provider, finance, L10)*

> "So being able to…connect to entities that you don't normally do business with, but be able to authorize or rather authenticate and authorize them."
> *(founder, large firm, nonprofit pharma, L5)*

Interestingly, one respondent mentioned trust from the context of helping firms meet corporate and social responsibility goals:

> "People will be asking to see, not just the report, but the data behind it. And you will be able, as a company, you'll be able to provide [from] that data trust with your customers. And with trust loyalty comes."
> *(director, large firm, blockchain service provider, software, L9)*

A number of respondents believe that engaging in blockchain activities, whether as blockchain solution provider or a user, will confer a competitive advantage from a **first mover**

**perspective:**

"So one thing I noticed in the industry is the best place to cash in on a technology is when it is in the upward phase, where many companies are sitting and watching it. So you want to commercialize the technology, become a practitioner when it is in the beginning stages before anybody else gets it. And so that's what we did."
*(CTO, small firm, blockchain service provider, consulting, S1)*

"Because we're a startup who decided before we started that we wanted to provide blockchain solutions to a consortia and industry, and so forth. So we've made that decision as part of existing."
*(CGO, small firm, blockchain service provider, governance, S4)*

"We believe the capabilities of blockchain are still early, this is not something companies can self-manage yet today. And so by facilitating the industry, we believe we can drive the protocol that could really have rapid and broad adoption in the industry."
*(CEO, small firm, blockchain service provider, health, S6)*

"The competitors that we have in our environment are not engaging in this. And so we believe that that we can have a leg up, particularly for some of our large accounts that we have that are interested in this technology…we think we can have a competitive edge if we adopt this blockchain technology and leverage it with some of our very large accounts that are also adopting blockchain programs."
*(manager, large firm, ocean carrier, L6)*

Though other respondents see themselves on the tail end of the whip, and for these firms, it is more of a fear of missing out:
"So you have startups who are unencumbered by old processes building a solution on a new technology that you wake up one day and you realize is everywhere. So that was another…disruption issue that was driving us as well. There is a concern that someone's going to disrupt us, right?"
*(manager, large firm, ground transportation, L2)*

Some firms also believe **the ecosystem** *itself* may confer a competitive advantage, and that the importance of "picking the right horse" is critical. This requirement to pick the right type of blockchain applies not just to the technology, but to the right blockchain ecosystem:

> "I noticed that when a number of companies are contemplating blockchain and they start to invest in developed PoCs [proof-of-concepts] and things like that, they start to formulate ideas around what would be, I would call, consortium building. And so that could be considered a shared asset, the consortium itself."
> *(founder, large firm, nonprofit pharma, L5)*

There are interesting implications to the notion that particular consortiums in and of themselves may confer a competitive advantage, as a sort of super firm. It is a concept which warrants further exploration. How firms explore, choose, and change ecosystems may be driven by competitive concerns, or the technological superiority of the other participants. It's possible that firms join ecosystem "pods" easily or with some difficulty, given the amount of collaboration required for each ecosystem "pod."

Not all firms were bullish about the ability of blockchain to provide a competitive advantage. A few firms were more mixed; though they acknowledged potential efficiencies, they were more cautious about the unknown aspects of blockchain. In their view, blockchain may be a defensive requirement or necessary table stakes, especially if driven by customer demand (or regulatory requirements). Only the large, non-blockchain service providers responded this way:

> "The key was the customers were coming to us and asking us…I think the issue is not a competitive advantage as much as it's a competitive defense."
> *(manager, large firm, ground transportation, L2)*

> "Yeah, I guess, at that point we are, we are not sure yet. We think it may be necessary…it probably will be necessary. Exactly how we can gain a competitive advantage out of it, I think we're still…the jury is still out on that."
> *(manager, large firm, eCommerce, L3)*

> "But as far as our day-to-day, we're struggling seeing how the blockchain will benefit us or give us that edge that our technology doesn't already provide us."
> *(manager, large firm, rail transportation, L7)*

One firm, who represents both a large firm and is a blockchain service provider, seems more nuanced:

> "I'm in this space cause I very, very strongly believe that. I think the caveat I would put is that you've got to be selective both in terms of the applications of blockchain and then also in terms of what you publish on the blockchain…if you prudently design your system. And you know, that's true of any system you put in place."
> *(CRO, large firm, blockchain service provider, IT, L8)*

Taken as a holistic theme, 18 of the 20 participants believe that blockchain may improve a firm's competitive advantage, albeit the larger firms had reservations due to the complexity of their business models. This positive perception ensures that blockchain technology will at least be explored by established firms, due to its [perceived] efficiencies, and by start-up firms, who wish to capitalize on new business opportunities. This theme – coupled with the belief that blockchain is inevitable – requires a deeper look into the collaboration required to deploy blockchain.

### *3. Importance of standards for blockchain adoption*

Many respondents discussed the need for blockchain standards, and how the **lack of**

**standards** may impede adoption. This shortfall was mentioned by both providers and non-service providers, and seemed to be a universal concern:

> "That is a clamor for standards. It's a discussion that happens. Now enterprise companies being risk-averse, they will find reasons not to get it. That's how I look at it. Oh, it's not stable enough. It's not proven enough."
> *(founder, small firm, blockchain service provider, consulting, S3)*

> "It's very immature in that space. And right now some of that's intentional because there's a lot of horse races going on and you know, competing options to be standards and it'll take some time, you know, for those to emerge…"
> *(director, large firm, blockchain service provider, finance, L10)*

With some believing that industry won't wait for the traditional standards bodies; there is the perception that industry groups are creating standards:

> "In the blockchain space, it's all over the place. There is no standard that anybody has adopted yet…the discussion always ends up being, oh, we must have standards. We must have common terminology. We must have a common procedure and protocols. And then it goes to, well, you don't, so what do we do now? You know, either wait for it to happen, go ahead and do what you gotta do."
> *(founder, small firm, blockchain service provider, consulting, S3)*

> "And it's kind of interesting, because the large ones, Ethereum and Hyperledger, they're literally creating their own standards as they go along. And so I don't know whether you consider them to be, you know, quasi standards bodies. I don't think they consider themselves to be standards bodies, but they are creating a standard, in a way."
> *(founder, large firm, nonprofit pharma, L5)*

> "You get organizations like CTIA and IEEE, and all of these guys, there's a long list of them. Who will try and create certain standards that everybody can adhere to. But that's

kind of like a slow train. I think there's a second tranche, which is the leaders, you know, people who step onto the blockchain early will effectively end up driving the rules for the application of blockchain."
*(CRO, large firm, blockchain service provider, IT, L8)*

There is a concern that multiple organizations creating differing sets of standards, whether they acting as standards bodies or industry groups, can lead to fragmentation:

"And so it concerns me…80% of the world's trade have their own group that is working on standards. And so you know, having BiTA going on its path and DCSA going on its path and God knows how many others…they're all out there doing some form of their own standards. And it frankly makes me a little nervous about what that means."
*(manager, large firm, ocean carrier, L6)*

And this fragmentation can lead to possible vendor lock-in:

"There are a lot of vendors in the blockchain space that are trying to basically create their own proprietary vendor-owned blockchain networks and force people to use those networks. They think that they can create a customer lock-in around these proprietary networks."
*(Sr VP, small firm, blockchain service provider, credentials, S9)*

There was also an expressed need for **more robust proof-of-concepts** (PoCs) that tackle the thornier challenges, such as the legalities of smart contracts, and how blockchains may work in production. Per the respondents, existing PoCs are just testing the waters, and won't be truly tested and vetted until these robust PoCs take place:

"It's all very well doing a proof of concept where you demonstrate that you have a hash that demonstrates that something's been published. But when you start getting into the guts of high performance, high throughput transactions and things of that kind of nature, then we've seen clients struggle with that."
*(Head of Growth, small firm, blockchain service provider, interoperability, S10)*

> "So yeah, we've done a few proof of concepts, but if you ask for my personal opinion, I don't think this is enough, I don't believe that the proof of concept with one or two companies is enough. I think it needs to be broader to a supply chain, a proof of concept or proof of value."
> *(director, large firm, blockchain service provider, software, L9)*

There are cost and governance implications to proof-of-concepts which will need upfront legal agreements and collaborative management, as this respondent furthers with:

> "I think, you know, as these proof-of-concepts get larger and they start to become production, then we'll see more shared investment in consortia to run the blockchain and to administer them."
> *(manager, large firm, eCommerce, L3)*

### *4. Technical Challenges in Blockchain Adoption*

We asked respondents to discuss their thoughts on the **technical challenges** they encountered in deploying blockchain, either in proof-of-concepts for their own firms, production blockchain, or what they observed for their clients. Some challenges surfaced, but the overarching concept was that the technical issues are not "deal breakers" as it relates to blockchain adoption:

> "I would say there haven't been a lot of technical problems yet that we've encountered with blockchain. Although we haven't done anything at huge scale at this point."
> *(manager, large firm, eCommerce, L3)*

> "So far, we've not had any that we couldn't overcome. There's obviously some learning of the technology and the use of APIs for us now, which is relatively new."
> *(manager, large firm, ocean carrier, L6)*

"So on our side, the technical was very little…so probably the most difficult is making sure the data was correctly formatted and complete for discussion and met what the scenarios that we were testing."
*(manager, large firm, rail transportation, L7)*

"So technically now I really don't think there are huge challenges in terms of the ability to design a system to deliver what you wanted to deliver. I think the biggest challenge is a mindset issue. How do you get people to think differently and apply it differently?"
*(CRO, large firm, blockchain service provider, IT, L8)*

The technical issue mentioned most often, however, was scalability:

"We build a solution today, but it has to scale for something that'll happen five years from now, right? So designing it for scalability is that key technical challenge…"
*(CTO, small firm, blockchain service provide, consulting, S1)*

"First I'd say would be scalability…it's not unresolvable. It's just careful planning."
*(IT professor, large academic institution, L1)*

"You know, that's another thing that the blockchain has problems with scalability. I heard someone talking about yesterday that you know, that can be fixed, but it's a big lift to fix the scalability problem with blockchain."
*(manager, large firm, ground transportation, L2)*

While other participants mentioned performance and latency:
"You know, blockchains are not very good at writing data, they tend to affect performance. So you've got to be very selective about what data you want to publish onto the blockchain."
*(CRO, large firm, blockchain service provider, IT, L8)*

> "Well, technical challenges that I heard and I didn't experience them, but technical challenges were around the first one that we heard was about around latency."
> *(director, large firm, blockchain service provider, software, L9)*

When asked about how to **integrate** blockchain technology with a firm's existing equipment, many believe that blockchain will likely need to work with legacy systems:

> "Integration is our other second big challenge because blockchain solutions don't work in isolation. They have to be integrated into oracles, into the business participants' supply chain systems, in the third-party systems that do not have anything to do with our blockchain."
> *(CTO, small firm, blockchain service provide, consulting, S1)*

> "Wholly replacing is rather fanciful. But neither is replacing underneath. It's not just a new data protocol on the back end and it's not just an interface protocol on the front end of it."
> *(IT professor, large academic institution, L1)*

> "You know, the biggest challenges that we find are integrating with existing systems and in particular, working with a number of internal systems both in our company and in other companies and you know, working with legacy interface..."
> *(manager, large firm, eCommerce, L3)*

Though the start-ups didn't seem to feel the same pain as the larger firms:

> "So the movement into blockchain is not that complicated because they don't have to transition from old systems. They just need to start new systems."
> *(CEO, small firm, blockchain service provider, Fintech, S8)*

There are governance implications to uneven systems integrations as firms move to blockchain-enabled system stacks. These include the ramifications if one firm in an ecosystem integrates and another does not; will the blockchain network still work? At a minimum, a

conversation is required that assesses the impact to the ecosystem in the event of system changes required for the successful running of a blockchain ecosystem.

Some firms mentioned the importance of blockchain needs to take its place as part of a firm's **holistic digital transformation**, not as a project:

> "I think to me it should be a part of a digital transformation initiative that's ongoing and that of the evolution of the firm and the evolution of the market. If it's taken as a project, it's going to be very disruptive. If it's taken as a part of that evolution, it can blend in with the evolutionary practice."
> *(IT professor, large academic institution, L1)*

> "I don't think blockchain will be the last disruptive technology that happens. So I think it'd be advantageous for us to look at the change management process, not from a particularly part of blockchain change but how does the organization inject for a technical change… holistic transformation of which blockchain is one element."
> *(manager, large firm, air transportation, L4)*

> "So a lot of companies look at this as a combination. Blockchain is not the highest, the most interested technology that these companies are looking at. It's one of the top five…so a lot of companies have had to move on that journey of digital transformation. This is just another step in that direction."
> *(founder, small firm, blockchain service provider, consulting, S3)*

A company's holistic change implies heavy use of trained resources, and again the potential requirement to transform more in lockstep with ecosystem partners. It's possible that firms agree to a minimum level of technology across their ecosystems; this may, in turn, provide an opportunity for uplift across the ecosystem.

### *5. Impact of blockchain technology on human capital concerns*

The amount of disruption and **organizational change** to deploy blockchain is likely to be significant, per the participants, and these concerns were expressed by large and small, blockchain provider or buyer: most notably, disruption includes significant uncertainty and concern regarding the amount of changes within a firm's organizational structure:

> "People flipping hate change. It makes them extremely uncomfortable. It's more work, it slows them down. And the kind of work we're talking about is taking core processes for fulfilling supply chain and customer needs and changing them and eventually changing all of them."
> *(CGO, small firm, blockchain service provider, governance, S4)*

> "And I think that large organizational change will be in the accounting and auditing side of the business. So because now blockchain has this built in transparency and immutability and settlement, right?"
> *(COO, small firm, eCommerce, S5)*

> "There's so many different types of industries that are just going to, those jobs are gone."
> *(CEO, small firm, blockchain service provider, fintech, S8)*

> "I think there'd be a massive [organizational] change with blockchain."
> *(manager, large firm, air transportation, L4)*

Many firms believe that there will be a **lack of human resources**, and that the requirement for retraining and redeployment is likely to be significant. They reference the steep learning curve and trained resources needed:

> "It's a learning curve for the technicians, not just the bits and the bytes, but this idea of an ecosystem and sharing the data, all things we've been taught not to do really for security

reasons or other rules. So it was hard for the technicians…they were not that enthusiastic."
*(manager, large firm, ground transportation, L2)*

"You have to invest people and their time and many companies, including mine, don't just necessarily segment some people off and say, okay, this is your project and this is the only thing you're gonna work on."
*(manager, large firm, ocean carrier, L6)*

And potential large-scale redeployment and internal shifts, as firms shed the functions that are no longer required due to blockchain's immutability:

"Even within an organization, you have people in their roles that are doing the middleman job and then there are people who are more at the edges, the ones that in the middleman, yes, those rules are gonna shrink and then they would have to be retrained and redeployed."
*(founder, small firm, IT consulting, S2)*

"Redeployed. Right. Anytime you have a lot of people doing something because there's confusion and there's a mess, there's an opportunity to clean that up."
*(founder, large firm, nonprofit pharma, L5)*

Some express the benefits of this human capital redeployment, as it may result in an ability to get closer to the customer:
"I believe that there will be resources that can be redirected that are today being used for inefficient operations. So that can mean we can place people where we can get greater value than where they are placed today…to handle fundamental paperwork and process documents. We believe that there is an opportunity to take those resources and put them to better use and of greater value to the organization."
*(manager, large firm, ocean carrier, L6)*

Though some participants, large and small, providers or buyers, weren't convinced:
"I dunno, I think that one is still to be seen. I haven't given as much thought to sort of that broader reorganization requirement."
*(CEO, small firm, blockchain service provider, S6)*

Respondents believe there will be an increase in **knowledge sharing** between parties in the supply chain, with some discussing the difference between knowledge sharing in a blockchain environment versus electronic data interchange, or EDI:

"Yes, [quite a bit more knowledge sharing with firms and customers in an ecosystem as opposed to say EDI or another technology] because EDI is a data format essentially."
*(CTO, small firm, blockchain service provide, consulting, S1)*

While others note the challenges of knowledge asymmetry that is likely to happen:
"What I found is that usually when companies come together to co-develop a blockchain solution for themselves, there's usually an imbalance of knowledge in the group. And so there's a tremendous amount of knowledge sharing both technical and business."
*(founder, large firm, nonprofit pharma, L5)*

The ability to keep the playing field level is an important implication to successful blockchain ecosystems. The partnership may implode if firms believe that inequitable knowledge sharing is taking place due to more technologically advanced (or better resourced) partners. Finally, some respondents observed the benefits of increased knowledge sharing:

"I think it [increased knowledge sharing] will open up people's eyes to see that by cooperating with their trading partners and competitors, they can actually drive huge efficiencies. So I think that people have praised it as coopetition. I think it will grow as people see demonstrated examples of how it works."
*(CEO, small firm, blockchain service provider, health, S6)*

### *6. Blockchain requires new and intense forms of collaboration*

A number of respondents expressed concern regarding to new forms of collaboration that blockchain requires. Respondents believe that blockchain, if adopted, is likely to require a **change of focus** (and maybe business models) from *within* to *across* firms:

> "The key question often in interorganizational systems, is where does my company and in your company begin? And whether I know how you operate, am I a link to accommodate that?"
> *(IT professor, large academic institution, L1)*

> "Because you've got to have an entire ecosystem to align. It's not about just one person stepping in and redesigning the entire process value chain. It's really about people on all steps of the value chain, basically getting in on the act. And that takes time because it's not just about technology, it's about culture, it's about mental readiness, you know, a bunch of different things."
> *(CRO, large firm, blockchain service provider, IT, L8)*

This intense collaborative behavior manifests in a number of areas and includes exposing operating models and potentially competitive good practices. Large firms will be more cautious until trust is established:

> "I have to have some visibility on your operational practice and you on mine or we have to reconcile and accede to both accommodating a central standard or a protocol. And therefore, that reveals an operating practice. So you know how I work and, and I know how you work or collectively we have decided to work according to this operating standard. So by nature it reveals operational practices on the parties."
> *(IT professor, large academic institution, L1)*

> And accommodating process and business rules cross-ecosystems:

> "But the nuance of the business rule enforcement probably, at least in today's technology, will not be easy to port from one network to another. And we're going to have to start figuring out how that might be possible."
> *(CEO, small firm, blockchain service provider, health, S6)*

Blockchain is also perceived to be disruptive, and this **disruption** can be viewed from a number of directions, from process changes required to adopt blockchain, to lockstep change management to keep a blockchain ecosystem running smoothly, to positive and negative relationships changes with existing suppliers. The feedback paints a nuanced picture, with some firms believing in significant change:

> "So any process that is there, whether it is an EDI [electronic data interchange] process or whether it is an ETL process, over time should get eliminated completely. There won't even to be a need for it."
> *(founder, small firm, IT consulting, S2)*

> "Just like there are process changes with digitization, there are going to be process changes for anchoring data to a blockchain. I mean depending on the software solution that you're using, those process changes could be anywhere from very simple to extraordinarily complex."
> *(Sr VP, small firm, blockchain service provider, credentials, S9)*

> "Absolutely. I mean. from just the documents sharing side of the technology it's going to change the way we process hazardous documents. It's going to change the way we process bookings, distribute bills of lading. Absolutely."
> *(manager, large firm, ocean carrier, L6)*

> "But the processes are completely going to change because a lot of processes that are manual today will be automated. A lot of processes that exist today, compensating people or whatever. All of those will change I think."

*(CRO, large firm, blockchain service provider, IT, L8)*

Others were either uncertain, believing blockchain is more likely to be kept "under the hood" or will function as internal plumbing, with minimal required change:

> "I don't think that we should go about it any different or we wouldn't go about any different than we do any change process. So we're always changing business rules and processes."
> *(manager, large firm, air transportation, L4)*

> "I don't think so, from a process standpoint, whether it's blockchain or a database, it shouldn't matter. But you know, I think blockchain in certain cases allows you to do things that you can't do with the current technology and so they may find that they're able to do something, but I don't think just because of the technology that they would have to change a business process."
> *(founder, large firm nonprofit pharma, L5)*

> "I really would like to dig more into blockchain, but right now everything that I have been exposed to, I see it as, yeah, the same thing, just a prettier package."
> *(manager, large firm, rail transportation, L7)*

A number of respondents believe that firms not in the blockchain ecosystem may become **disintermediated** over time, and this is likely to disrupt the supplier landscape:

> "We talked to a company who worked on paying bills, paying freight bills and they were worried that they were, they were gonna they were going to have to change their organizational structure to meet the needs of blockchain. They had some very interesting out of the box thinking."
> *(manager, large firm, ground transportation, L2)*

> "I think especially in the identity area and I'm kind of hitting hard on this only because...there can be large swatches of what businesses do today that they're paying for cost wise that they don't need to do anymore."
> *(founder, large firm, nonprofit pharma, L5)*

> "But I think the issue if we take our lessons from the internet days, is that many companies will disappear…And I think that's a great lesson for anybody who kind of drags their feet. I think caution is advisable, but there's a difference between caution and dragging your feet, I think."
> *(CRO, large firm, blockchain service provider, IT, L8)*

> "I think you're also going to see the decline of many organizations…so a lot of these things will go the way of the rotary telephone, to some extent. I think we will see huge organizational upheavals where you have intermediaries who realize that they're going to get forced out eventually."
> *(Head of Growth, blockchain service provider, interoperability, S10)*

This rapid disintermediation implies more fluid supplier relationships, i.e. if a supplier exits a downstream ecosystem that affects *your* firm's ecosystem. Will operating models be able to keep up with this pace of change?

Many firms discussed that blockchain is well beyond the existing **legal** frameworks to support it, and these issues loomed large, especially for the established enterprise firms:

> "So outsiders, startups, come in and say, you guys in the supply chain should be driving more efficiencies by doing this on a blockchain? Well, I had to brief the chief legal counsel who got it after several briefings, not just by me, by others. He was very concerned about sharing data where we have, you know, GDPR, HIPPA privacy laws. He goes, wah, you know, looks like a quagmire."
> *(manager, large firm, ground transportation, L2)*

"And I said [to the FDA lawyers], there's these things called smart contracts that are coming up and you're going to have to at least interface or talk to technical folks to approve these contracts and they're going to be written in code, not in English. And they looked at me like I had two heads…"
*(founder, large firm, nonprofit pharma, L5)*

"We all have more to lose or we can get sued."
*(manager, large firm, air transportation, L4)*

But the start-ups are aware of these challenges that large firms face:
"And yeah, a lot of things can go wrong, period. So when you're dealing with data and data transfer not just for small-sized companies like mine, but with large companies that have a lot to lose, then you're really putting everything on black, so to speak."
*(CEO, small firm, blockchain service provider, Fintech, S8)*

Some firms believe that a certain amount of **regulatory oversight** is required because of potential collusion concerns:

"They're at the edge of regulation, they're at the edge of what's being currently done or what's what we know of other companies already doing."
*(CGO, small firm, blockchain service provider, governance, S4)*

"The startups said why don't you just all pull the data together? Well, it's not like we didn't think of this right? But there are rules, one, there are rules, government rules, regulations."
*(manager, large firm, ground transportation, L2)*

While others (both providers and non-providers) prefer a light touch per the respondents, believing that heavy regulation can stifle innovation:

"I would think that most industries would like to keep the regulators as far away as possible…"
*(CEO, small firm, blockchain service provider, health, S7)*

"I also appreciate the fact that they are at least to date not choosing a solution, that could prove to stifle innovation."
*(CEO, small, blockchain service provider, health, S6)*

"It's gonna be very interesting…I would not get congress involved early on because of the ignorance and the bad limiting policy that would be the result of that…and all too often laws in the beginning prevent things from innovating."
*(IT professor, large academic institution, L1)*

"I, I like good guidance but I don't like meddling. How's that? I don't like the heavy hand approach. I think more of a framework more than anything else."
*(manager, large firm, ocean carrier, L6)*

There were also multiple concerns regarding the potential loss of **intellectual property,** which can inhibit sharing:

"So when other participants came along and were asked to participate and to provide their time and energy, they said, okay, but you know, who owns all of the fruits of all of this? And IBM and Maersk said 'well we do.' And so everyone said, well, we're not going to join that because all we're going to do is be a disadvantage and show the position, and you'll own all the intellectual property. You are effectively an intermediary that we can't really buy into… if I just put this into the market, then others who did not necessarily contribute to this could get an advantage, it's that a free rider problem."
*(Head of Growth, small firm, blockchain service provider, interoperability, S10)*

> "I think sharing with the customers is somewhat feasible now. Sharing across the industry is much more difficult. And then sharing with the customer, it's really sharing with an industry of customers. So if you begin all this sharing, you gotta be careful."
> *(manager, large firm, ground transportation, L2)*

There is an interesting counterpoint to this thinking. For all the concerns about loss of intellectual property, oversharing, and potential collusion concerns, firms in highly regulated environments often have high levels of sharing and interdependence today. For these firms, blockchain may need to reach higher ROI hurdles:

> "We're very interdependent on each other. So that's where I'm struggling to see the benefit of using blockchain versus what we use today…we're so integrated with each other."
> *(manager, large firm, rail transportation, L7)*

The implications are clear. Firms need knowledgeable legal support, well versed in blockchain technology, that can assist with the nuances and unknowns. These skills are currently in short supply. At a minimum, firms that participate in a blockchain ecosystem need to understand the legal and regulatory requirements are of their ecosystem partners. These can include anti-compete rules, privacy laws such as HIPPA and GDPR, and other fiduciary requirements, such as Sarbanes-Oxley Act. This legal advice is critical in gaining ecosystem partners, and an effective governance model should assess and account for how to include your partners' requirements in the ecosystem, at least until the legal frameworks are sorted out.

The importance of choosing the right **use case** was a concept that frequently occurred. Finding the proper use is critical and harder than it sounds:

> "Be clear of the problems that you're trying to solve and focus on those, and the value that people are deriving from the solution of those problems."
> *(manager, large firm, eCommerce, L3)*

> "The most problematic problem I believe was finding the right use case…You get disappointed because it doesn't do what you think it should do."
> *(manager, large firm, ground transportation, L2)*

This same interviewee explains that when the use case includes requirements from all the ecosystem participants, it can underwhelm expectations:

> "So then you start to constrain the use case with these permission blockchains which is okay, but as you begin to water it down, you lose the benefit. So we couldn't find the right balance."
> *(manager, large firm, ground transportation, L2)*

Conversely, deploying the right use case is worth the effort, as it is superior to existing technology:

> "[Finding the right use case] doesn't cook you breakfast, it's not going to solve all of the world's problems, but it is technologically advanced compared to traditional systems."
> *(CEO, small firm, blockchain service provider, Fintech, S8)*

This implies that, given the downstream ramifications of good or poor use case selection, it's important to have a good understanding, and agreement, from the ecosystem partners as part of the initial governance. Included in the use case selection is the importance of having incentives baked in for *all* ecosystem partners.

Ultimately, many firms believe that these new ways of working can be managed with good **governance**. However, implementing even fairly simple proof-of-concepts has been problematic to date:

> "Yeah. It just killed me with the governance thing set up wrong before. I've had so bad an experience with that."

*(Head of Growth, small firm, blockchain service provider, interoperability, S10)*

"How you get the business relationships in place and the governance around blockchain is where we've seen real, real issues even in setting up proof of concepts. We've tried to work with some government agencies on it and it's been a real struggle in how we would set that up."
*(manager, large firm, eCommerce, L3)*

Though some (the large firms) observe that they have long-standing, complex supplier agreements in place, which they plan tap into; blockchain is doing "more of the same:"

"We already had an existing relationship with this carrier, and we kind of leveraged the existing APIs and things that we had."
*(manager, large firm, eCommerce, L3)*

"I think the governance model is the same for blockchain ecosystem as any kind of any other kind of shared ecosystems. In other words, the industry needs to come up with the rules for access to things. And I don't see that as any different between a blockchain environment and an API environment for example."
*(founder, large firm, nonprofit pharma, L5)*

"But you know, maybe I'm getting a bit long in the tooth, but I don't really see the dynamics between supplier and vendors changing that dramatically except that all the transactions now are immutable and there's less opportunity for fraud, which is all good."
*(CRO, large firm, blockchain service provider, IT, L8)*

Yet governance is recognized as critical to successful adoption, and this was observed by small and large firms, regardless of blockchain provider or consumer:

"I asked him, so is governance important? And he said, oh my God, it's so important. Which makes me wonder why wasn't it in his presentation? And he went on to say that

governance challenges were the number one thing that prevent proofs of concept from scaling up to production."
*(CGO, small firm, blockchain service provider, governance, S4)*

"You still have, in my mind at least, a lot of the same governance challenges in either model, whether the companies themselves are standing it up or whether you're asking some other service provider to say, Hey, we don't want to build the plumbing, you build the plumbing and we'll just operate on top of this network that you provided. That to me it's probably going to be a similar set of challenges."
*(director, large firm, blockchain service provider, finance, L10)*

Some respondents expressed a need for multiple blockchain **governance frameworks**.

"I don't think there is one a governance model. I think there's going to be a handful of governance model depending on what type of consortium it is."
*(founder, small firm, IT consulting, S2)*

"It would be good to have more explicit examples of governance...I'm curious whether there could be a template for governance, you know, that you can install. I mean, an example of that is how people develop code on like GitHub. They choose a license. They, you know, ABCD. There seems to be a process there that I think is going to look a lot like the kind of governance that we need in business."
*(founder, large firm, nonprofit pharma, L5)*

When asked what a good partner looks like, the respondents believe that good partner traits include leadership support, openness, and committed resources:
"So I think there, there needs to be a sense of curiosity, the ability to operate in a research mode for a period of time. In order to discover what the technology may be able to do, how the thing that we're trying to do together might be different in a blockchain world."
*(founder, large firm, nonprofit pharma, L5)*

"Well, I think somebody who can devote the time and the effort to putting it together."

*(manager, large firm, ocean carrier, L6)*

"I don't want to be playing poker. In order for it to be a seamless process, you have to be willing to show the good, the bad, and the ugly…you know, you both are sharing everything that you have and not only does it just build the relationship better, but then you can also help each other through your tough times."
*(manager, large firm, rail transportation, L7)*

And the desire (and culture) for open sharing:
"People who have a corporate culture of problem solving and honesty and transparency. Um, not a problem hiding culture, but a problem facing culture."
*(CGO, small firm, blockchain service provider, governance, S4*

The smaller firms believed that it will be more difficult for like-sized companies to navigate the challenges in blockchain governance, and that there is a need for a large "anchor tenant" to set the direction for the rest of the ecosystem partners:

"If you're dealing with like-sized companies, that's really hard to do. If you've got a Walmart or a Maersk that's the leader in the industry, then it's easier because they're the bigger player in that ecosystem and they can force it…and I'd say generally speaking, that's why, with blockchain, it is harder for a medium sized company to have integration with other medium sized companies."
*(CEO, small firm, blockchain service provider, Fintech, S8)*

"So it's kind of like a strong leadership rather than mandate. I was going to say dictator, but that sounded too harsh…Well, good luck to them [group of like-sized firms]. They'd probably fall apart before they managed to build anything."
*(CEO, small firm, blockchain service provider, health, S7)*

The role of incentives in shared value, or a response to the "what's in it for me" was also considered important, and should be part of a blockchain governance model:

“Whether there's an incentive or not, the governance process has to be more, I would say, uh, merit-based, more fair, and people need to have trust in that.”
*(founder, small firm, IT consulting, S2)*

“I think one of the big one is to figure out how to involve people and provide benefit to all. I mean, one of the problems with one of our early proof of concepts is that, in the reconciliation one, there was cost savings to the carrier. Just in terms of savings and how they interacted with us. But we received much more benefit from it.”
*(manager, large firm, eCommerce, L3)*

Because without the correct incentives, it may be difficult to achieve a critical mass with a blockchain ecosystem:
“So one of the most important problems I would say is companies failing to see what the incentive, investment, and financial model is…without an incentive model there will not be many participants joining the network.”
*(CTO, small firm, blockchain service provide, consulting, S1)*

Even though the six themes represent broad agreement across the interviewees, differences appeared in the subthemes. The data in Table 13 provides an overview of the sub thematic differences that the interviewees placed on blockchain technology. Not all interviewee subgroups had sub thematic differences, and these are noted by cells without text.

*Table 13. Sub-thematic Differences Between Interviewees*

| Themes | SIZE | | ROLE in INDUSTRY | |
|---|---|---|---|---|
| | SM | LARGE | Solution Providers of BC | Non-Providers (Users of BC) |
| 1. Adoption of blockchain technology is inevitable | Inadequate preparation | Regulators driving adoption | Requirement for interoperable blockchain networks | -- |
| 2. Blockchain is likely to provide a competitive advantage | Worth the investment due to efficiencies | Unsure of benefits; many unknowns | Lead to new revenue opportunities, monetize stranded assets | Improve process efficiencies, standard ways of working |
| 3. Importance of standards for blockchain adoption | Standards driven by industry groups | Standards may drive ecosystem selection | Reliance on large firms for standard adoption | More reuse of existing standards |
| 4. Technology concerns | Unknown tech issues, code stability | Latency, scalability | Blockchain key management | Integration with legacy systems |
| 5. Impact of blockchain on human capital | Part of digital transformation journey | Steep learning curve; lack of resources | -- | Disruptive to existing operations |
| 6. Blockchain requires new and intense forms of collaboration | Will greatly change or eliminate industries | May be able to reuse existing relationship agreements | Governance a core capability; start early | Depends on extent of industry monopolization |

For the final question, the respondents ranked seven key concepts in order of importance for blockchain adoption (Table 14). Listed alphabetically, the concepts (costs, governance, human resources, interoperability, legal, security, technical) were communicated via a Zoom chat session (for most of the interviews). This method of interview allowed the respondents some reflection time. Respondent rankings ranged from one to five, with one the highest ranked, or most important concept, as it relates to blockchain adoption, and five the lowest. We then analyzed, via word clouds, the number of times concepts surfaced in the language that the respondents used. We were curious to understand if the ranked concepts mapped to the language used throughout the interviews.

We found that for blockchain providers from mostly but not exclusively small firms, the most important consideration in adoption was cost, followed by technical concerns. The importance of cost and technical concerns wasn't surprising due to the nature of blockchain service providers; first, small firms tend not to have deep financial reserves, and second, they are selling complex, technical solutions to enterprise-savvy clients, who have a long history in supplier management. Perhaps the thornier issues of governance and legal considerations are not as apparent because blockchain providers are on the outside looking in. In the end, if implementation doesn't go well, blockchain providers can walk away with their firm intact.

For non-blockchain service providers, more skewed to large firms, governance ranked as the top concern for blockchain adoption. A close secondary concern included security and legal issues. Again, it is not a particularly surprising finding given that the non-providers represented established firms with more regulatory oversight (recall L4: "We all have more to lose or we can get sued"). Large firms also tend to have more established, complex supply chains and have data security concerns for their customers.

*Table 14. Ranked Concerns for Blockchain Adoption, Providers vs. Non-Providers*

| Category | Blockchain Service Providers<br># firms: 11 total<br>8 small, 3 large | Non-Providers<br># firms: 9 total<br>2 small, 7 large |
|---|---|---|
| Costs | 1 | 4 |
| Governance | 5 | 1 |
| Human Resources | 7 | 6 |
| Interoperability | 4 | 4 |
| Legal | 6 | 3 |
| Security | 3 | 2 |
| Technical | 2 | 5 |

Note: A rank of 1 is high, a rank of 7 is low.

If we re-analyze the data from a firm size perspective, the rankings change slightly for the small firms but are still in broad alignment. This finding is likely because the data buckets remained mostly the same; for the most part, blockchain service providers are small firms, with 3 large firm exceptions (Table 15). Conversely, most of the non-service providers are large firms, with two small firm exceptions.

*Table 15. Ranked Concerns for Blockchain Adoption, Small vs. Large Firms*

| Category | Small firms<br># firms: 10 total<br>2 providers, 8 non-providers | Large firms<br># firms: 10 total<br>3 providers, 7 non-providers |
|---|---|---|
| Costs | 1 | 4 |
| Governance | 3 | 1 |
| Human Resources | 6 | 6 |
| Interoperability | 4 | 3 |
| Legal | 5 | 2 |
| Security | 1 | 2 |
| Technical | 2 | 5 |

Note: A rank of 1 is high, a rank of 7 is low.

In Table 16, we combine the two views for easier comparative reading:

*Table 16. Ranked Concerns for Blockchain Adoption, All*

| | # of firms | Costs | Gover. | HR | Interop. | Legal | Security | Technical |
|---|---|---|---|---|---|---|---|---|
| Small | 10 | 1 | 3 | 6 | 4 | 5 | 1 | 2 |
| Large | 10 | 4 | 1 | 6 | 3 | 2 | 2 | 5 |
| | | | | | | | | |
| Provider | 11 | 1 | 5 | 7 | 4 | 6 | 3 | 2 |
| NP | 9 | 4 | 1 | 6 | 4 | 3 | 2 | 5 |

Note: A rank of 1 is high, a rank of 7 is low.

We found one striking similarity in the rankings between providers and non-providers. Amongst small and large firms, almost all respondents rank "the impact of human resources" at the lowest end of blockchain concerns. Yet, a word cloud analysis shows a different view. In the provider and non-provider word clouds (Figures 7 and 8, respectively), the term "people" appears as a top five term. We see references to human resource concerns in the language used by respondents when they spoke of significant restructuring, training, and other people impacts that blockchain adoption will likely entail. Yet when asked to rank top concerns, human resources ranked as the least important concern as it relates to blockchain adoption. This discrepancy was observed by one respondent, who ranked human resources as the least important concern, but then noted:

> "HR on the bottom because everybody forgets there's people involved trying to learn, right?"
> *(manager, large firm, ground transportation, L2)*

*Figure 7. Word Cloud, top five terms, blockchain service providers*

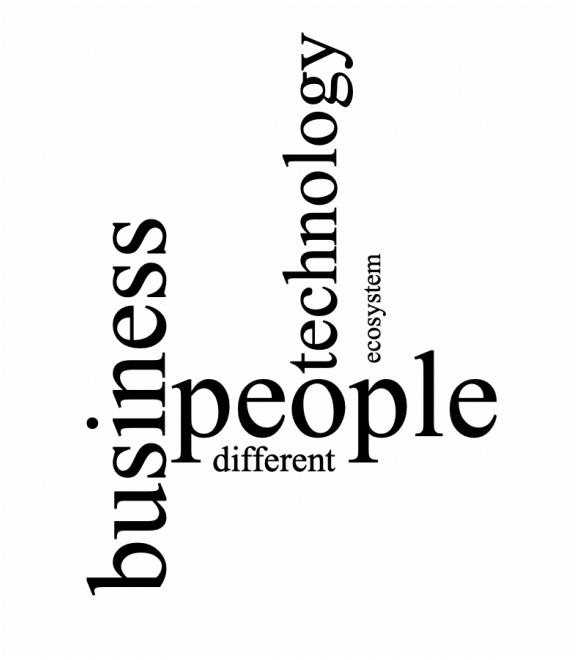
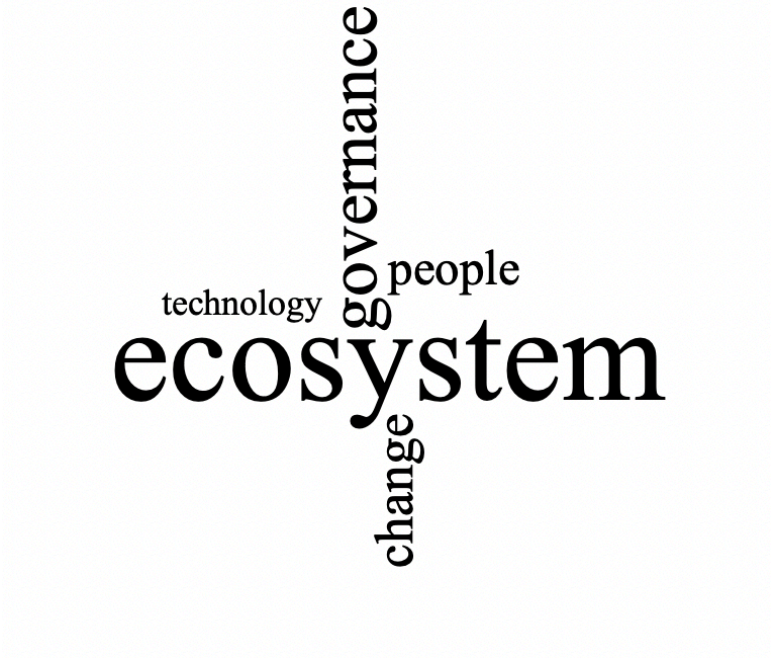



*Figure 8. Word Cloud, top five terms, non-blockchain service providers*



This **socio-technological disconnect** between the amount of change and disruption that blockchain may cause, and the (lack of) importance placed on human resources, should be an area of concern for firms wishing to adopt blockchain. Though not fully explored here, a lack of trained resources, significant process changes, and the perception that entire departments may change are issues worthy of more serious human resource considerations.

Though multiple concerns surfaced from the interview data, much of the conversation centered around the uncertainty of how to collaborate with other firms – a necessity in order to successfully implement permissioned blockchain ecosystems.

## Chapter 5: Connecting the Design Science and Field Engagement Research

We began this study with a design science experiment, which resulted in the partial deployment of a blockchain-based artifact for a supply chain use case. The artifact left the research team with unanswered questions and these questions formed part of a subsequent interview protocol. The lead researcher, turning to the field, interviewed twenty respondents representing a diverse number of industries. After analyzing the responses with qualitative data analysis software, six themes and twenty-three subthemes emerged. Table 17 provides a mapping of how the design science artifact led to the questions asked of participants, and the empirical themes that emerged from these interviews:

*Table 17. Connecting the Design Science Learnings to Field Engagement Themes*

| **Design experiment learnings…** | **…led to these interview questions…** | **…and these field engagement themes…** | **…as seen in this exemplary empirical evidence.** |
|---|---|---|---|
| **Artifact permission to public interoperability:** We were not able to develop a working interoperable blockchain artifact (public and permissioned). We believed it was important, however, per our industry contacts and the literature. | Q. 31: Have you or do you plan to connect to other blockchain networks? What are the major reasons to do so? What are the biggest challenges you foresee? How ready is your company (or industry) to do this interconnect?<br><br>Q. 33: Do you plan to have a shared set of tools (MIS) across the ecosystem?<br><br>Q. 35: Do you have a need for blockchain globally? | **Adoption of blockchain technology is inevitable:**<br>• Similar to the internet, a foundational technology<br>• Interoperability an essential requirement for domestic blockchain networks…<br>• …And as it relates to global blockchains | "So that's the answer, blockchain is the new Internet…" *(founder, small firm, blockchain start-up)*<br><br>"...There's gotta be some way for those blockchains to interoperate." *(manager, large firm, ground transportation)*<br><br>"Oh yes, yes…in all our supply chain projects…manufacturing happens in China, Asia…shipping happens across country boundaries, right? *(CTO, small firm, blockchain consulting)* |
| **Competitive advantages of blockchain:** Not explored in design experiment. | Q. 8: Do you believe that deploying blockchain will give your company a competitive advantage? If so, why is that? If not, why?<br><br>Q. 12.2: Do you feel that being a blockchain ecosystem could lead to future revenue opportunities for your firm? | **Blockchain is likely to provide a competitive advantage:**<br>• Improves efficiencies and reduces costs<br>• Opportunity to capture new revenue<br>• Increased trust in previously unknown entities and existing partners<br>• First mover advantage – or the fear of missing out?<br>• Participating in an ecosystem is a form of competitive advantage | "I'm biased but I think it will transform the way they do business with each other..." *(CEO, small firm, blockchain service provider, health)*<br><br>"And the more transparency and visibility we have, the more efficient we are. That's the goal." *(director, large firm, blockchain service provider)*<br><br>"…And so that could be considered a shared asset, the consortium itself." *(founder, large firm, pharmaceutical)* |
| **Evolving standards:** Standards are evolving across industry groups; development is fragmented and uneven. Public blockchains include a certain | Q. 18: What standards did you use, or do you plan to use? Why did you choose these standards? Did you consider others? If so, what are these? What is the importance | **Importance of standards for blockchain adoption:**<br>• Lack of standards may impede adoption | "…There is no standard that anybody has adopted yet…the discussion always ends up being, oh, we must have standards…well, you don't, so |

| | | | |
|---|---|---|---|
| amount of governance baked in; knowledge of this prerequisite is important. | of blockchain standards to you/your firm? | • Need for robust proof-of-concepts | what do we do now?" *(founder, small firm, blockchain consulting)*<br><br>"So yeah, we've done a few proof of concepts, but I don't believe [a] proof of concept with one or two companies is enough..." *(senior manager, small firm, blockchain service provider)* |
| **Multiple blockchain choices:** There are different blockchain variations for public and permissioned versions, and the programming and development tools vary per blockchain network type. Consensus protocols, how blocks are ordered and executed, and other technological concerns vary across blockchain type. A smart contract code written for one type of blockchain network will not translate to another. | Q. 14: What were the largest technical challenges you encountered in your firm's blockchain implementation (or do you anticipate)? How did you resolve those? What issues were unresolvable and why?<br><br>Q. 15: What blockchain type did you use (or are considering), Ethereum, Corda, HLF, Quorum, Bitcoin, etc. What decision criteria did you use?<br><br>Q. 16: What type of consensus protocol did you use/planning to use? PoW, PoS, PBFT, etc. What influenced this decision? | **Technology concerns:**<br>• Challenges with blockchain technology aren't a deal breaker<br>• Integration with existing systems<br>• As part of a firm's digital transformation | "So far we've not had any [technical problems] we couldn't overcome." *(director, large firm, ocean carrier)*<br><br>"The biggest challenges that we find are integrating with existing systems." *(manager, large firm, ecommerce)*<br><br>"…it's a learning curve for the technicians, not just the bits and the bytes, but this idea of an ecosystem and sharing the data, all things we've been taught not to do…" *(manager, large firm, ground transportation)* |
| **Robust knowledge sharing required amongst members:** The team entered this project with different skill sets. In order to even partially deploy the artifact, a minimum level of knowledge was required. This translated into technical tool knowledge-sharing, but also a deep understanding by all team members of the underlying business process. We | Q. 9: Do you believe that blockchain will require more or less interdependence with firms in your blockchain ecosystem (network)? What are the implications to your answer?<br><br>Q. 11: Do you believe that blockchain will require your firm to conduct more or less knowledge sharing with the firms in your | **Impact of blockchain tech on human capital:**<br>• Anticipated organizational change<br>• Lack of skilled resources<br>• A major socio-technological disconnect<br>• Implications of increased knowledge sharing | " I think [one of the biggest challenges] is having the right resources to actually create the code…" *(founder, large firm, nonprofit pharmaceutical)*<br><br>"You won't find many people who truly are experts and who truly understand, not just from a business standpoint, but also from a technical standpoint..." *(founder, small firm, blockchain consulting)* |

| | | | |
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| underestimated the amount of time needed for this skill uplift.<br><br>**Scarce skills/resources and time constraints:** We found it difficult to find people who had the necessary expertise to deploy our artifact. Subject matter experts tended to be knowledgeable in either public or permissioned blockchain network types. Finding expertise in blockchain interoperability was, as predicted, very difficult. Firms who require interconnectivity will be on the bleeding edge of technology. | blockchain ecosystem? If yes, to what extent?<br><br>Q. 12: Do you believe deploying blockchain will lend itself to more or less sharing in the future?<br><br>Q. 25: To what extent did blockchain require large organizational changes within your company (or did you anticipate these?). Can you describe these changes? *(i.e. org changes, retraining, downsizing, culture, etc.)* | | "So don't want to be playing poker. In order for it to be a seamless process, you have to be willing to show the good, the bad and the ugly." *(manager, large firm, rail carrier)*<br><br>"People flipping hate change. It makes them extremely uncomfortable." *(executive, small firm, blockchain service provider)*<br><br>"I think there'd be a massive [organizational] change with blockchain." *(manager, large firm, air transportation)* |
| **Need for well-documented use cases with deep underlying process knowledge:** Picking the correct use case is important, as is knowing the underlying business process you hope to displace/disrupt/improve with blockchain. | Q. 23: How much disruption is blockchain likely to cause to your existing business operations? What type of disruptions are these (anticipated?) How did you handle these (or plan to handle?)<br><br>Q. 27: Can you describe any process changes you encountered (or anticipate) because of your blockchain implementation? Can you elaborate on any unresolved process changes? | **Blockchain requires new and intense forms of collaboration:**<br>• Change of focus from within to across firms<br>• Potential disruptive nature of blockchain<br>• Supplier disintermediation changes landscape<br>• Legal, regulatory, and intellectual property co-commitments<br>• Importance of use case selection<br>• Need for new blockchain governance models | "We feel in certain areas it's going to be massively disruptive." *(manager, large firm, ecommerce)*<br><br>"But the processes are completely going to change because a lot of processes that are manual today will be automated…all of those will change…" *(executive, large firm, blockchain service provider)* |
| **Need for overall blockchain roadmap:** We needed to make a number of decisions collaboratively as part of the initial discussions. Though the artifact was a simulation with assumed "roles," firms who | Q. 21.2: What are the ideal qualities you look for in blockchain partners? *(in your ecosystem)*<br><br>Q. 22: What were the largest non-technical challenges you encountered in your firm's | | "The key question often in interorganizational systems, is where does my company and in your company begin?" *(academic, large university, IT)* |

| | | | |
|---|---|---|---|
| adopt blockchain will have a large number of decisions to make collaboratively, depending on the type of governance model. | blockchain implementation (or do you anticipate)? How did you resolve those? What issues were unresolvable?<br><br>Q. 24: How will you introduce blockchain in your firm? Across your ecosystem? How did you gain agreements with your ecosystem?<br><br>Q. 30: Describe for me how you onboard members for your ecosystem (or plan to do so). What lessons did you learn? What would you do differently/same?<br><br>Q. 30.1: Do you feel you can unwind your blockchain ecosystem easily or with some difficulty?*)*<br><br>Q. 32: Once blockchain is launched in the ecosystem, how do you (plan to) manage change within your firm? How will you manage change across the ecosystem (interfirm)? | | "Because you've got to have an entire ecosystem to align…" *(executive, large firm, blockchain consulting)*<br><br>"The most problematic problem I believe was the finding the right use case…You get disappointed because it doesn't do what you think it should do." *(manager, large firm, ground transportation)*<br><br>"Yeah. It just killed me with the governance thing set up wrong before. I've had so bad an experience with that." *(senior manager, small firm, blockchain service provider)*<br><br>"How you get the business relationships in place and the governance around blockchain is where we've seen real, real issues even in setting up proof of concepts…" *(manager, large firm, ecommerce)* |

Revisiting the design science and field engagement research, we synthesize the learnings from the simulation and the interview responses. First, as part of the design science work, we believed that blockchain technology was likely to be an important consideration for supply chains, and that interoperability between blockchain types was vital. Though cracking the interoperability technology was beyond our reach, most firms believe that blockchain is inevitable despite the lack of implementation standards and the significant technical challenges (Theme 1). And every respondent – all twenty – agreed that blockchain interoperability will be key to adoption. The difference is that the student team in our design experiment couldn't resource or deploy a testable solution. This concern regarding lack of workable solutions was in contrast to the interviews. Many of the interviewees believed that the technical solution to achieve interoperability will be resolved, it is just a matter of time. We were not so sanguine.

The ability of blockchain to provide a competitive advantage was not explored as part of our student simulation (Theme 2). However, as seen in the data from the field interviews, most participants believed that deploying blockchain will improve operational efficiencies. Additionally, some respondents (notably those providing blockchain solutions) believe that blockchain is an avenue to capture new revenue, especially if one is first to market. The ability to trust previously unknown entities was broadly believed as another potential competitive advantage by all, as was the intriguing opportunity to be in the "right" blockchain ecosystem.

The design science work was hampered by the lack of referential and accredited standards (Theme 3). Without these helpful guides, we could not replicate or extend existing research. Hence, in this theme, we did see parallels with the empirical research. With standards still in development, the adoption of blockchain may be deferred as firms wait for accredited standards or risk technological obsolescence. The lack of documented proof-of-concepts also

made it difficult to replicate findings in the GSU Blockchain lab. The interviewees voiced similar concerns. The early proof-of-concepts may be worthwhile for shared learnings and early education, but they did not go far enough to test the more challenging operational concerns. This lack of replicable solutions for production-grade proof-of-concepts may be equally challenging for blockchain adoption.

Technology surfaced as an area of concern in both phases of the research, experienced for different reasons (Theme 4). In the design science experiment, technological concerns took the shape of an interoperability simulation that we explored between the Ethereum and Hyperledger Fabric networks. This challenging solution required the team to make complex technological decisions, requiring a rapid skill uplift at each inflection point. Hence, as discussed, the technological solution remained out of reach for the student simulation team. The solution provider interviewees were better versed in the technology. Whereas, the non-provider interviewees largely left those decisions to the experts – the solution providers. From a technological perspective, the larger concerns for the participants were the potential issues integrating with their operational legacy systems, and/or the challenges of blockchain as yet one more step in a difficult digital journey. Though the student simulation experienced integration concerns, it was from the perspective of connecting two different blockchain network types, not from connecting new (blockchain) with existing (legacy).

From a human capital perspective (Theme 5), the student simulation experienced three of the four subthemes voiced by the interviewees. First, we discovered that the learning curve to deploy a blockchain ecosystem is quite steep. Despite the general technical strength of our team, we struggled with the development of the skills needed to deliver a working artifact. This experience and competency issue is not likely to be unique to a classroom setting, as some of our

interviewees had similar concerns (Theme 5).

Recall one respondent:

> "You have to invest in people and their time and many companies…don't just necessarily segment some people off and say, okay, this is your project…"
> *(manager, large firm, ocean carrier, L6)*

These human resources choices are an important consideration for firms wishing to deploy blockchain. Keeping the skills in-house may be the better answer, but firms must know what it means for their organizations. Outsourcing to third parties, including partners in your ecosystem, may solve some resource and skill constraints, but with that comes potential skill leakage. Second, from a knowledge sharing perspective, the design team needed to invest time to ensure we had a baseline knowledge in all parts of the technical solution and the supply chain business processes. We found that even though we adopted roles for manufacturer, retailer, shipper, and consumer, we needed a foundational level of knowledge to craft our artifact. Knowledge sharing concerns also surfaced during the interviews, though these concerns were expressed more in terms of resolving information assymetries. Third, the student team mildly experienced organization change when one member prematurely left the team. This departure represented a hole in our skills resources that firms experience routinely.

Finally, as it relates to collaboration, the student team experienced two of the six themes that surfaced from the interviews. First, we did not have an overarching blockchain governance model to assist in the artifact design and decision making, nor did we have robust use cases to use as guides (Theme 6). These two requirements also emerged from the interview data. Other considerations from the empirical research included the potentially disruptive nature of blockchain to operations, business relationships, and the unknown cross-firm legal and

regulatory co-commitments. Hence, how to effectively collaborate amongst trading partners emerged as a key inhibitor to blockchain adoption. This cross-firm collaboration centered around governance concerns, and a lack of governance models as a missing but necessary link for blockchain deployment. These models are crucial to firms who must intensely collaborate in a way that blockchain requires. Though firms have had supply chain relationships for many years, and have electronically bonded with these suppliers over time, blockchain takes the amount of collaboration to an entirely new level. The meshed ecosystem that is blockchain means working in a many to many relationship (as opposed to a binary one), in novel ways. Thus, the lack of governance frameworks to assist necessary collaborative behavior the core issue that emerged from the interview data:

> "I asked him, so is governance important? And he said, oh my God, it's so important. Which makes me wonder why wasn't it in his presentation?" *(CGO, small firm, blockchain service provide, governance, S4)*

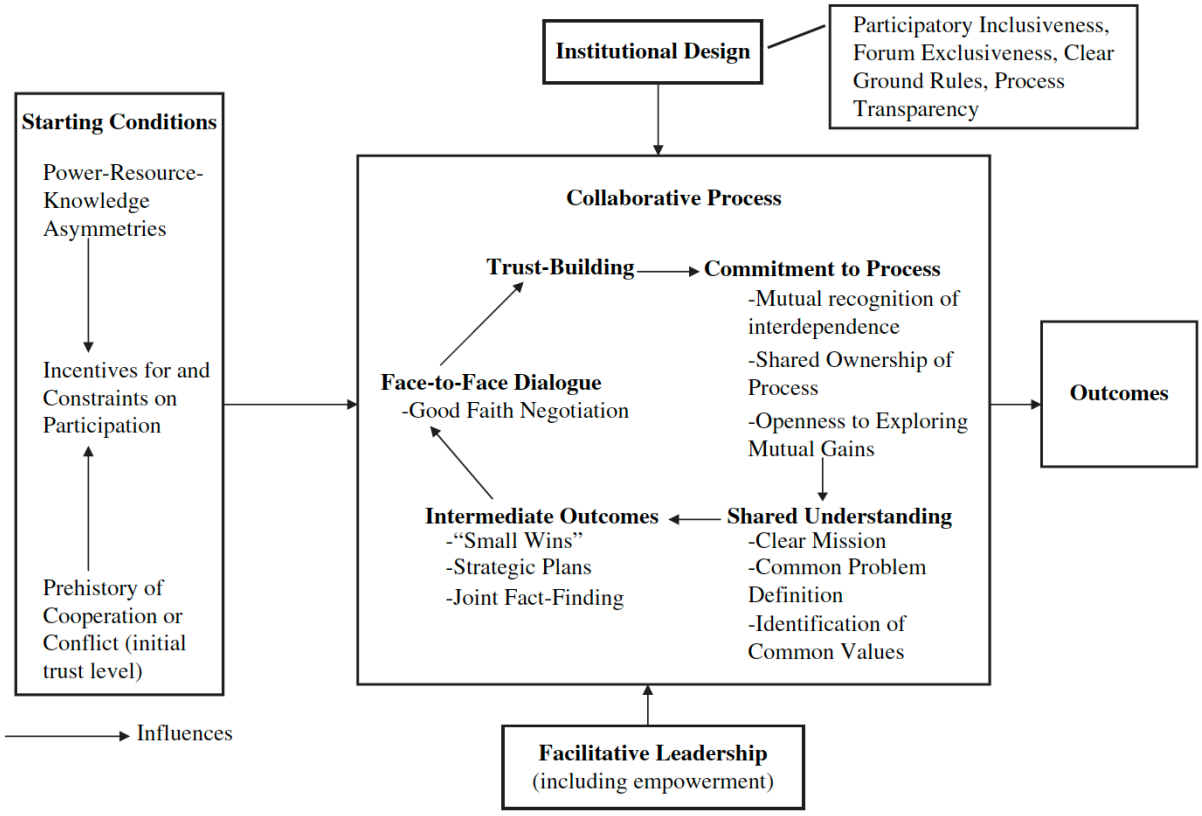
**Revisiting the Literature for a Collaborative Governance Model**

The key finding – a lack of governance frameworks to assist collaborative behavior – led to a search for collaborative governance models. For guidance, we turn to public policy research, which has a rich history of governance studies for shared natural resources. We find research that supports how good collaboration precedes good governance. One study analyzed 76 watershed partnerships in California and Washington, finding that collaborative processes allow for better responsiveness to complicated situations (Leach, 2006). In a landmark meta-analysis, authors Ansell and Gash (2007) analyzed 137 cases that explored the role of governance in managing successful relationships. Specifically, the authors state that "…'collaborative governance' promises a sweet reward. It seems to promise that if we govern collaboratively, we may avoid the high costs of adversarial policy making, expand democratic participation, and even restore rationality to public management." Other research finds that collaborative governance is often encouraged because of its potential to manage complex situations or issues (Emerson, Nabatchi, & Balogh, 2011). However, there are challenges with collaborative governance, including uneven legal foundations (Bingham, 2009), power disparities (Purdy, 2012), and uneven partner representation (Leach, 2006). These challenges require consideration and will likely depend upon the context.

It's important for trading partners to begin the conversation with a consensus definition of collaborative governance, and we turn to Ansell and Gash once again: "Collaborative governance is a type of governance in which public and private actors work collectively in distinctive ways, using particular processes, to establish laws and rules for the provision of public goods" (Ansell and Gash (2007, p. 545). Developing a framework, the authors integrated critical variables that they believe (and based on their meta-analysis) influences collaborative

governance (see Figure 9):

*Figure 9. Collaborative Governance Framework*

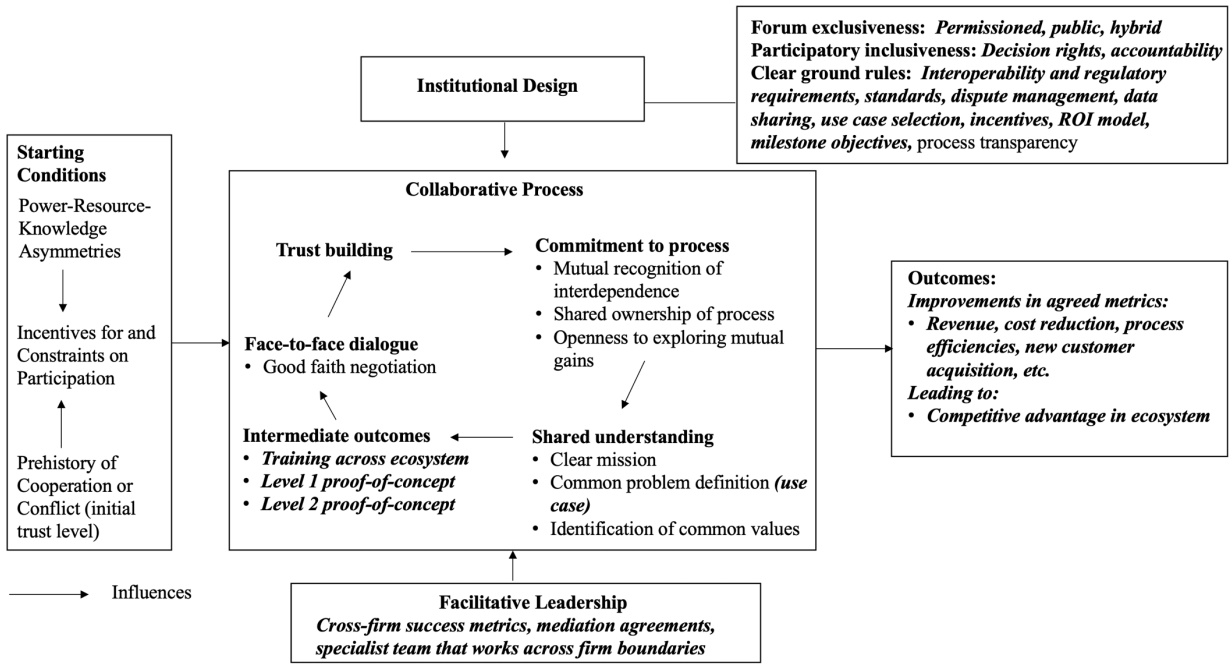



*(Ansell & Gash, 2007)*

## A Blockchain Governance Model

We find the Ansell and Gash model instructive and adapt it by incorporating observations from our research. Each variable from the Ansell and Gash's original model is explored from the perspective of blockchain technology. The variables in the adapted blockchain model are not an exhaustive list but instead represent the main points that surfaced from the data. We conclude with a collaborative governance model contextualized for blockchain (see Figure 10).

*Figure 10. Blockchain Collaborative Governance Model*




Proposed Blockchain Collaborative Governance Framework (adapted from Ansell & Gash, 2007). Note: Black italics represent changes from the original model.

### Starting Conditions

We began, as did the Ansell & Gash model, with the need to clearly understand the power-resource-knowledge asymmetries as an essential starting point. We made no blockchain-specific changes to our adapted model, as we believe the original model transferred well. But

key questions for managers include the following: Are there known asymmetries that have caused issues in the past, or may likely in the future, as it relates to resource or power imbalances? Are any of the suppliers especially critical to the success of the blockchain ecosystem? Is one firm considerably more knowledgeable in blockchain than the others (i.e., is it a blockchain supplier?). This last point is important, as we heard multiple participants express concern about potential imbalances in knowledge sharing.

Equally important is understanding (and frankly assessing) the history of existing supplier relationships. High levels of past cooperation can contribute to high levels of trust (Ansell & Gash, 2007), and past issues can cloud future relationships. Positive starting conditions can help position the ecosystem for success and pave the way for appropriate incentives for participation. This notion was supported by a number of respondents, as without clear incentives and a "what's in it for me" for each firm, sustained participation is unlikely. An important note here; the starting conditions need to be assessed for all firms in an ecosystem, not just the "gorillas in the room."

**Facilitative Leadership**

We created blockchain-specific leadership requirements in our adapted model, as the requirement for leaders who will support a blockchain ecosystem cannot be understated – firms need to be in this for the long haul. The ecosystem isn't likely to get off the ground without strong management support, and indeed, the critical role of facilitative leadership to bring disparate groups of stakeholders together and buy-in to common agenda is well established in extant literature (Ansell & Gash, 2007, p. 554) (Chrislip & Larson, 1994; Ozawa, 1993; Pine, Warsh, & Maluccio, 1998; Reilly, 1998; Susskind & Cruikshank, 1987). Firms need to honestly assess their appetite for the long game in spite of the legal and operational challenges that

blockchain is likely to produce.

Other considerations include the need for agreed success metrics and a specialist team, comprised of members from all partners, that report to an "ecosystem board." This specialist team can not only ensure a sense of fair play for all firms but can also reinforce the unique nature of the ecosystem, itself a potential form of competitive advantage, as interviewee responses suggest.

**Institutional Design**

Designing a blockchain ecosystem requires agreements on foundational criteria, and these conversations should start early, as we observed in our design science experiment and as noted by our interviewees. While not an exhaustive list, the bold italicized font in Figure 11 is a compilation of blockchain-specific considerations and includes the following questions: Is any particular firm a potential "anchor tenant" or are there competing anchor tenants? What blockchain network variant do we need, and is this informed by each firm's criteria for privacy and regulatory requirements? What standards are currently in place for each firm in the ecosystem? Are there clear standards for the blockchain network of choice? Many of the technological decisions will be shaped by the type of blockchain network the firms choose, and in many ways, are the more straightforward decisions.

Less straightforward is the amount of inclusiveness each partner enjoys. Who gets a seat at the table? What are the decisions-making rights of each partner? What and where is the accountability for these decisions? What is the mechanism to resolve decisions that cross firm boundaries and results? Clarity in setting the ground rules is also important to a successful blockchain deployment, and this includes agreements on the amount of data sharing on and off the chain; dispute resolution principles; and of course, use case selection (or, "what problem are

we trying to solve").

**Collaborative Process**

We agree with Ansell & Gash that the collaborative process is iterative, and their model (and ours) oversimplifies the complexity of governance when dealing with multiple stakeholders. In order to recognize the importance of collaboration, we coopted face-to-face dialogue, trust building, and commitment to process into our model with no changes, believing that good faith negotiations and trust are essential to successful collaboration. Once trust is established, commitment to the ecosystem, in the form of shared ownership, is more likely to take place.

Shared understanding, from a blockchain perspective, can be achieved by an agreed use case, or said another way, "what problem are we trying to solve." This data is depicted in bold italics font next to "common problem definition." The importance of picking the right use case was a frequent interviewee observation and a challenge as part of the decision making in the design science experiment.

The final variable in the collaborative process is intermediate outcomes, and we adapted the original model for our purposes. We believe that immediate outcomes can be achieved with proof-of-concepts (PoCs) of various difficulties, starting with a fairly simple one that provides a base level of education for all firms. A simple proof-of-concept can also test the use case for viability prior to tackling the more robust one. After a simple proof-of-concept is completed, and the learnings are shared by all, a more robust proof-of-concept is recommended as the next tangible outcome. This stepped process is important because of the number of concerns surfaced by the respondents that the existing PoCs did not sufficiently test the true concerns that they had. Identifying these concerns by all partners is important, as it can provide a better understanding of what drives each firm, but also the extent in which they will be motivated to support the proof-

of-concept (and the blockchain ecosystem in general).

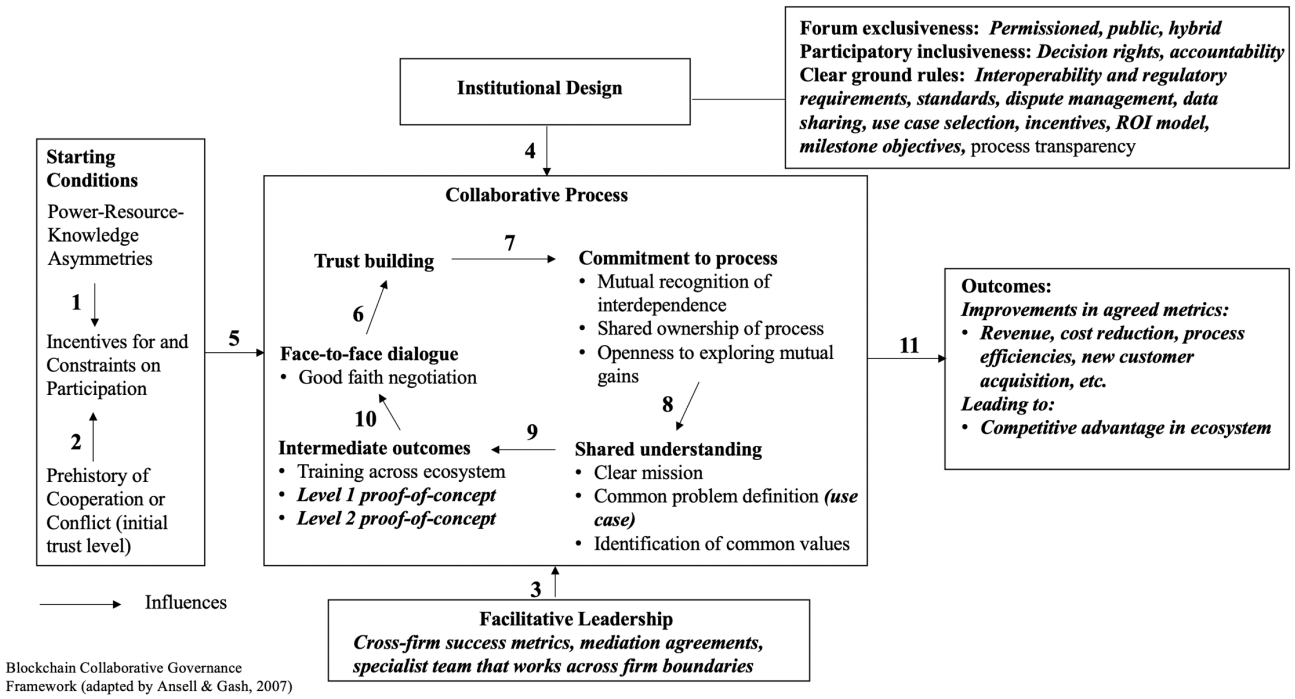
**Outcomes**

Many respondents, per the data, believe that the use of blockchain technology can reduce operational costs and/or enhance new forms of revenue. It's possible that these improvements can lead to an advantageous competitive advantage, not only for one firm, but for all the firms in a blockchain ecosystem. These successful outcomes can only be explored and measured if and when permissioned blockchain-enabled supply chains are widely deployed. However, in order to achieve these outcomes, a sustained level of commitment to the entire collaborative framework is required. We agree with Ansell & Gash's views on the iterative nature of the model; the more time, trust, and interdependence occurs inside the collaborative process, the more likely positive outcomes will result.

## Implementing the Blockchain Collaborative Governance Model

In order to provide practical direction, we revisit the model and develop technological rules to accompany each variable. Technological rules can be thought of as general guidelines, defined as "If you want to achieve Y in situation Z, then perform something like action X" (van Aken, 2003). The general nature of the rules allows for shaping by practitioners based upon their specific context (Denyer, Tranfield, & van Aken, 2008). Thus, the blockchain collaborative model provides activities important for each particular rule without being too prescriptive. For example, rule ten lists cross-ecosystem training and two types of proof-of-concepts as activities to support intermediate outcomes, but it doesn't prescribe specific training programs, which are dependent upon the industry and use case. Figure 11 represents the blockchain-adapted governance model with the technological rule placement.

*Figure 11. Blockchain Collaborative Governance Artifact with Technical Rules*



**Proposed Technological Rules**

The technological rule summary (Table 18) provides suggested guidelines for each variant. For each rule, the situation Z is the "the adoption of blockchain technology" and will not be restated for brevity. For example, technological rule number one can also be stated as "In order to establish incentives for participation when adopting a disruptive technology such as blockchain, alleviate potential power-resource-knowledge asymmetries." The rules are followed by managerial considerations.

*Table 18. Technological Rule Summary*

| | **Technological Rule** | **Managerial implications:** |
|---|---|---|
| **Starting Conditions** | **Design for starting conditions (1)**: In order to establish incentives for participation, alleviate power-resource-knowledge asymmetries. | Requires an honest and accurate assessment of within-firm shortfalls and strengths of ecosystem partners (consider the use of survey instruments to assess asymmetries). Carefully explore the blockchain knowledge, distribution capabilities, market share, addressable market, capital investment, etc. of each firm in the ecosystem. What are the skills, expertise, technical knowledge gaps? Identify the "table-stakes" incentives for participation, to include financial transfers, knowledge-share programs, and regulatory requirements for each firm. |
| | **Design for starting conditions (2):** In order to remove constraints for participation, resolve prior sources of conflict. | Requires firms to identify areas of past conflicts and to take active steps to remedy their relationships. This may include informal relationship-strengthening activities or more formal mechanisms (i.e. dispute mediation and/or resolve litigation). |
| | | |
| **Facilitative Leadership** | **Design for facilitative leadership (3):** In order to encourage collaborative behavior, develop an ecosystem culture that reinforces the across-firm "we" instead of the within-firm "me." | Requires firms to clearly identify the processes that support agreed outcomes, with the understanding that ecosystem processes may supersede within-firm/internal processes (however, a cautionary note on individual regulatory requirements). This implies a shift in mindset for firms in highly competitive industries. The challenges of creating an ecosystem culture should not be underestimated. |
| | | |

| | | |
|---|---|---|
| **Institutional Design** | **Design for the institutional blockchain ecosystem (4):** In order to support the collaborative process, establish clear ground rules for all firms in the ecosystem. | Blockchain technology assumes all firms in an ecosystem will participate in the blockchain network to some degree (for example, as an active or passive node.) Some ecosystems may have an "anchor" tenant, while other ecosystems may have participants of a similar size and with comparable resources. Regardless of the makeup, designing for a blockchain ecosystem requires full transparency and broad participation. The design questions (see Appendix A) can be viewed as an initial set of guidelines to assist the ecosystem as they explore design options. |
| | | |
| **Collaborative Process** | **Design for collaborative process (5):** In order to have an effective foundation and starting point, design incentives for all participants and resolve pre-existing adversarial relationships. | Due to the iterative nature of the collaborative process, face-to-face and good faith negotiations can be enhanced by a strong starting position. This implies creating incentives that have a "WIIFM" or "what's in it for me" for every firm in the ecosystem. Equally important is resolving prior historical conflicts between all firms in the ecosystem. |
| | **Design for trust building (6):** In order to create trust amongst ecosystem partners, implement activities that encourage interdependence and frequent communications. | Trust in ecosystem partners, especially if there are preexisting adversarial relationships, can be elusive. Building trust requires a long-term and sustained commitment (as well as complete transparency). Regularly scheduled review meetings can help facilitate trust as can more informal trust-building mechanisms. |
| | **Design for commitment to process (7):** In order to promote commitment for the process, operate with full transparency with the ecosystem partners. | Collaborating firms must have a high degree of trust in the (blockchain) decision-making process. A commitment to meetings where decisions are made, sending the right resources, and actively adhering to the process will imply compliance – and therefore trust – to the process. In other words, it's not enough to talk; each firm must demonstrate that they are "walking the walk." |
| | **Design for shared understanding (8):** In order to achieve a shared understanding across the ecosystem, commit to agreed blockchain processes and measure (and share) the effectiveness of the processes. | This requires firms to inculcate a sense of ownership for the ecosystem itself rather than within-firm. In some instances, one or more ecosystem partners may benefit more than others (i.e., access to new customers may outweigh cost efficiencies). The firms involved in a blockchain ecosystem will need to ensure that the urge to compete amongst each other in an ecosystem is redirected to pride in the blockchain process (even if partners do compete outside their blockchain network). |
| | **Design for intermediate outcomes (9):** In order to successfully design intermediate outcomes, invest the time and resources in choosing a use case that "has something for | Firms in the ecosystem must have a clear idea of the problem they are trying to solve. This is often manifested in the use case selection. The use |

| | | |
|---|---|---|
| | everyone" for all firms in the ecosystem and supports the ecosystem outcomes. | case is critical, because it not only underlines the mission, but also allows the ecosystems to begin testing the use case, and to transfer knowledge. |
| | **Design for face-to-face dialogue (10):** In order to encourage a virtuous cycle, secure and communicate quick wins. Uncritically share failures to enhance learning for all firms in the ecosystem. | Due to the iterative nature of the collaborative process, face-to-face and good faith negotiations can be enhanced by ensuring all firms have a baseline level of knowledge across the blockchain ecosystem. This baseline knowledge lends itself to shared terminology and a common language for all firms in the ecosystem. Training programs must be implemented across the ecosystem. Successful (and successive) proof-of-concept deployments can also contribute to this shared understanding/best practices. |
| | | |
| **Outcomes** | **Design for outcomes (11):** In order to achieve agreed outcomes, commit to the collaborative process with the required resources (investment and human capital) and most critically, leadership support. | This requires firms an upfront investment in the ecosystem relationship and the collaborative process, which implies (as Ansell & Gash stated), sustained time, trust, and interdependence. |

**Evaluation Plans for the Blockchain Collaborative Governance Model**

Our evaluation strategy for the original design science artifact changed greatly over the course of the research, given the artifact's partial deployment and the need for field engagement. What started as a purely technical strategy to understand interoperability shifted to a revised artifact (the collaborative governance model) which contains uncertain social and use issues, thus adhering more to the Human Risk and Effectiveness strategy (Venable, Pries-Heje, & Baskerville, 2016). Given the nature of the model, we cannot test it in a lab, though as future research we will share the model with potential users to determine if the artifact possesses validity, utility, quality, and efficacy (Gregor & Hevner, 2013; A. R. Hevner, S. T. March, J. Park, & S. Ram, 2004; Peffers et al., 2007). The proposed questions for evaluating the collaborative model can be found in Table 19:

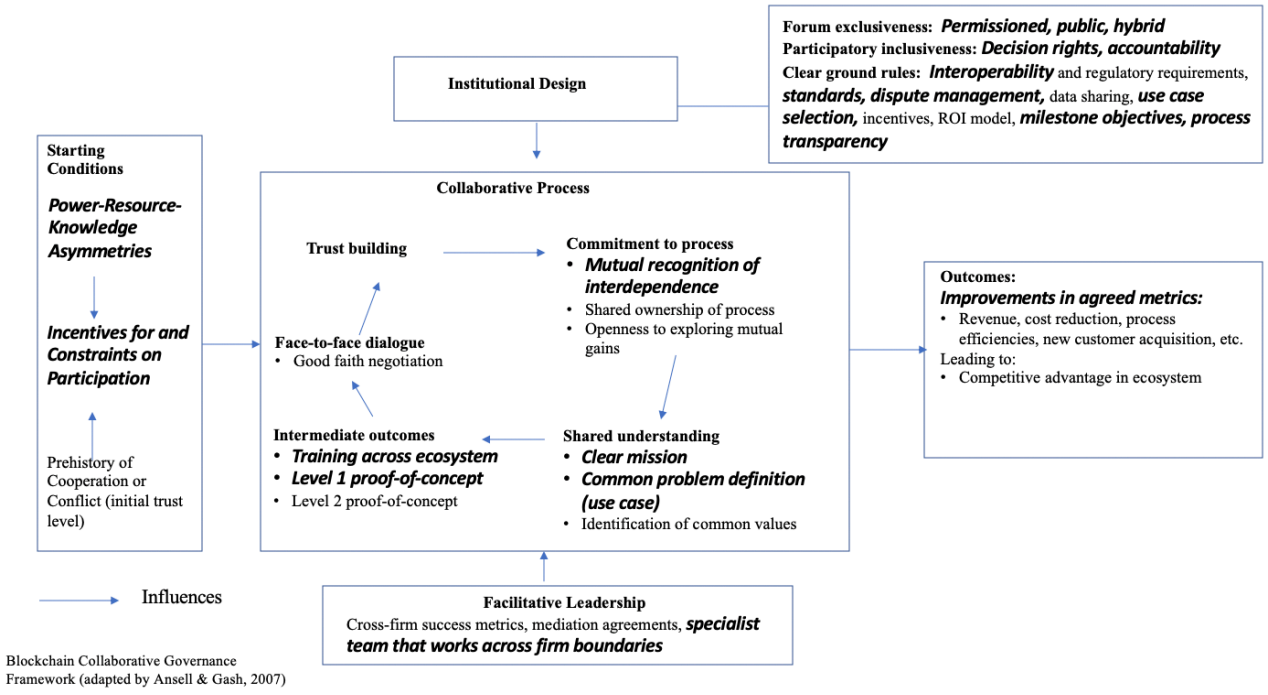
*Table 19. Proposed Questions for Evaluating Blockchain Governance Model*

| **Question:** | **Pertains To:** |
|---|---|
| Do you have an existing governance model? Is it reusable for a blockchain ecosystem? If not, what is missing? | -- |
| How closely does this model align with your existing governance model? | Utility of model |
| Could you apply this blockchain governance model to your firm? To your blockchain ecosystem? | Quality of model |
| What additions would you make to this model to be more useful to your firm/ecosystem? | Quality of model |
| Do you think this model could drive a successful ecosystem? Why or why not? | Efficacy of model |
| Would this model require more or less collaboration than your existing models? | Utility of model |
| Would this model change your existing operating model with your partners? | Disruption to business |
| How difficult would this model be to implement given your existing staff, culture, mindset? | Organizational change |
| Do you believe a blockchain ecosystem may be a separate legal entity? | Validity of model |
| What is the importance of proof-of-concepts for your firm/ecosystem? | Utility of model |

Note: Evaluate artifact for validity, utility, quality, and efficacy, (S. Gregor & A. R. Hevner, 2013).

What we can evaluate, however, is how the use of the collaborative governance model may have solved problems with the original design science artifact. Figure 12 depicts this, with the bold italicized font representing how the design science research could have been improved with the use of the model and technology rules:

*Figure 12. Design Science Artifact using Blockchain Collaborative Governance Model*




First, as part of the starting conditions variable, the DappyChain team would have discussed our particular skills (or lack thereof), any resource constraints, and vetted our thoughts on what good collaboration looks like early on in the development process. We found that scoping the skill set to the use case was an iterative and time-consuming process; with a mobile app, a public blockchain, and a permissioned blockchain, we needed skills in Ethereum, Hyperledger Fabric, and mobile APIs. Too often, we were "flying by the seat of our pants." Though some of these discussions can be described as solid project management, having this

upfront knowledge would have helped later in the design cycle.

From a facilitative leadership perspective, having a specialist team that understood the roles across the functional areas (in DappyChain's case, manufactuer, retailer, shipper, and consumer roles) would have been enormously helpful. This particular challenge would likely be less of an issue in the "real world" with subject matter experts who are well-versed in their industries.

Some of the institutional design considerations didn't apply for our DappyChain simulation, but many did. What we didn't fully realize during the design science experiment is that many of our decisions would ultimately shape the type of blockchain network we chose to deploy. Decision rights surfaced with the use case selection; having an agreed decision-making process could have saved some cycles. Also, we needed subject matter experts that understood the technical aspects of interoperability, and we definitely needed off-the-shelf standards. These two areas are likely to be issues for practitioners, as neither cross-blockchain interoperability nor standards are available at this point in time.

Our shared outcome – completing the artifact in time to successfully present for a final grade – was helpful. This time constraint gave a strong sense of team unification as it provided a clear mission. With competing and/or overlapping goals, the task to complete the artifact, given all of our challenges, would have been quite difficult. I believe this shared and clear mission (shared is the key word) is critical for blockchain deployment. Without it, you'll see fracturing along the way.

# Chapter 6: Discussion

This study addresses the research question "What is the role of collaborative governance in blockchain-enabled supply chains." Though the extant literature supports the importance of governance to support interfirm relationships, the lack of empirical studies prevents firms from advancing their digital transformations. This research, specific to blockchain-enabled supply chains, closes this governance model gap, with the development of a blockchain collaborative governance model borrowed from public policy. Using the Design Science paradigm followed by significant field engagement in the form of twenty interviews, this research uncovers the critical governance and technical challenges for firms in a shared supply chain using blockchain technology.

## Contributions to Relational View Theory

The findings of this study contribute to the Relational View (Dyer & Singh, 1998), finding that the interfirm collaboration required by blockchain is likely to be a form of competitive advantage, as seen through the eyes of the interviewees. Additionally, this research emphasizes the importance of effective governance as one of the four determinants of competitive advantage and highlights the need for additional subprocesses as described by Dyer & Singh in technologically networked environments such as blockchain.

Dyer & Singh concern themselves with competitive advantage from a dyadic perspective. However, what happens with the Relational View theory in an inter-ecosystem world, one where blockchain networks interoperate? Might the better performing blockchain ecosystems – the super firms - have increased relational rents? There are interesting implications to this concept which warrant further exploration. Will these new "pods" of ecosystems now compete with each other as "super firms?" How will firms organize within themselves to support this super firm?

What happens to the smaller, less competitive blockchains ecosystems? It's conceivable that the "better" blockchain ecosystems may have competitive advantages that extends to all participating firms in that ecosystem. Undoubtedly, we have to walk before we run, but it's worth thinking ahead to what a vastly different landscape a blockchain environment may be. There are many unknowns, and it's not a stretch to observe that the governance and legal frameworks do not yet exist to support this new world order, should it come to pass.

**Contributions to Collaborative Governance**

This study extends the Collaborative Governance model, as developed by Ansell & Gash (2007), to a blockchain ecosystem. The experiences from the design science research and the field engagement interviews confirm the need for more governance models for permissioned blockchain networks. The model we present is an initial view of firms participating in a blockchain ecosystem. Additional permissioned models are likely required for different types of governance, such as a model for a large anchor tenant who can dictate terms, or a model for multiple firms of similar size who do not "call the shots." If interoperability *across* blockchain networks is realized, then a governance model for inter-ecosystems type is also a likely requirement. In any event, these different "flavors" of blockchain governance models will need to address the intense collaboration that blockchain requires.

**Contributions to Practice**

First, this study provides practical considerations required by firms to successfully deploy blockchain in shared supply chains. This includes extensive blockchain design guidelines for firms as they consider blockchain (Appendix A). These guidelines will help firms assess a broad range of potential ramifications to their operating models. This research also developed a reusable supply chain artifact, complete with smart contract code, as seen in Appendix D. This

smart contract code can be reused in its entirety (or partially) for firms if they have a similar supply chain use case, for either training or production purposes. Finally, a blockchain-inspired governance model was developed to assist firms as they work with their ecosystem partners to deploy blockchain. As a high-level overview, the model focuses on the collaborative decisions from a non-technical perspective, as the research supports the critical nature of governance in blockchain technology. Finally, this study suggests technological rules to accompany the blockchain collaborative governance model to assist practitioners as they embark on their blockchain journey.

**Limitations**

There are a number of limitations with this research. The design science artifact was evaluated but not tested end-to-end as designed. The blockchain collaborative governance model and associated technological rules have not been evaluated by practitioners. As the research is exploratory in nature, the conclusions reached are generalized and not targeted to specific industries. American firms are overrepresented; global blockchain ecosystems will likely have additional regulatory and logistical complexities that need rigorous research. Finally, comparisons between providers and non-providers of blockchain solutions, though mentioned, are not fully explored.

**Future Research**

Primarily, this research is exploratory in nature. We covered a wide range of topics that could, in and of themselves, be fruitful research material. The bulleted questions below provide a useful starting point for future scholars. Ultimately, the viability of the proposed blockchain collaborative governance model to improve interfirm collaboration is left for further research, as is the potential competitive advantage due to improved interfirm sharing.

- To what extent does the use of blockchain technology improve supply chain performance?
- How does the use of blockchain technology support the Relational View, i.e. that inter-firm resources can provide a competitive advantage?
- Is there a need for contextualized blockchain models? What is the effectiveness of each model, and how do these blockchain models compare (to each other?)
- What does this research mean to emerging/foreign entities? What are the governance implications for global interoperability?
- What are ways to prepare for the expected disruption projected to accompany blockchain adoption? What are the potential human capital impacts? How can these impacts be mitigated?
- Do some blockchain ecosystems perform better than others? Will this translate to better firm performance? How might these improvements manifest? How will these improvements be measured?
- Will a firm's stock performance and bond rating be tied to a particular blockchain ecosystem?
- From a quantitative perspective, does firm size and the use of blockchain technology affect competitive advantage?

## Conclusion

This study began as a quest to understand blockchain technology much better, especially from a supply chain perspective. With limited knowledge coming into the study, the researcher needed to understand how blockchain technically operated. But the quest wasn't just for basic technical purposes; included in the research was a desire to understand how to design blockchain interoperability, and to capture the types of decisions firms need to make to jointly deploy blockchain. Taking the shape of a simulation and using the design science paradigm, the researcher closed the design experiment with a much better understanding of how public and permissioned blockchains work, and how to write smart contracts. The research team also experienced substantive collaborative challenges that firms will likely experience themselves as they pursue blockchain initiatives. These challenges included resource constraints of the team, picking an appropriate use case that everyone agreed on, choosing the blockchain network type, and making sure that everyone on the team had a baseline level of knowledge in blockchain. The combined learnings of the design science experiment led to a desire to determine if our experiences were typical in the "real world," and not just a product of a simulation in a blockchain lab. Informed with what we believed were the relevant questions, we turned to supply chain blockchain experts for their views.

The real world is of course more nuanced than an artifact born in a lab. We discovered that yes, interoperability is indeed critical, per the interviewees, for widespread blockchain adoption. We had suspected as such and believe our interview findings confirmed the importance of blockchain interoperability. We thought the technology of blockchain might be a major stumbling block. What we found is that the participants are much more concerned with how to deploy blockchain from a governance perspective, given that they feel blockchain is

inevitable, and that governance is hard. These governance issues loomed larger than the technical considerations. In our interviews, we also discovered the importance of managing the human capital concerns, and the lack of emphasis – one might say disregard - despite its complexity. We uncovered the need for training, given the widescale redeployment some anticipate, and a need for process change *across* firms. Collectively (but not exhaustively), these components require more cooperative and intense collaboration than many firms employ today.

Thus, the uncertainty of how to work with firms in a blockchain ecosystem, and a lack of governance frameworks to assist, was the core issue that emerged from the interview data. It is not just the ecosystem with the partner firms that surfaced; if we think governance is difficult within a blockchain ecosystem, let's consider the potential difficulties ACROSS ecosystems, which is what interoperability suggests. Though the internet provides some guidance, blockchain requires much more intense collaboration and cooperation at the social level, and this requires governance models that differ from the present ones. Though we can codify governance rules as much as possible (which requires the standards to do so), we will still have a large number of challenges that do require human intervention. Because the technical work required to deploy blockchain in a shared supply chain ecosystem is underway and will likely be resolved, we believe the richer vein of research lies in *how* organizations may need to change their governance models, given the depth of cooperation required.

We close with an adapted artifact to assist firms that need the guidance when navigating the intense collaboration which blockchain requires. It is our hope that future scholars and practitioners will further refine the Collaborative Governance framework, as inspired by Ansell & Gash. This model – the intense collaborative model – is designed to open the discussions for newer and better governance frameworks that are specific to blockchain. If we believe that

better governance can be a competitive advantage, than we need better governance models for blockchain.

# Chapter 5: Appendices

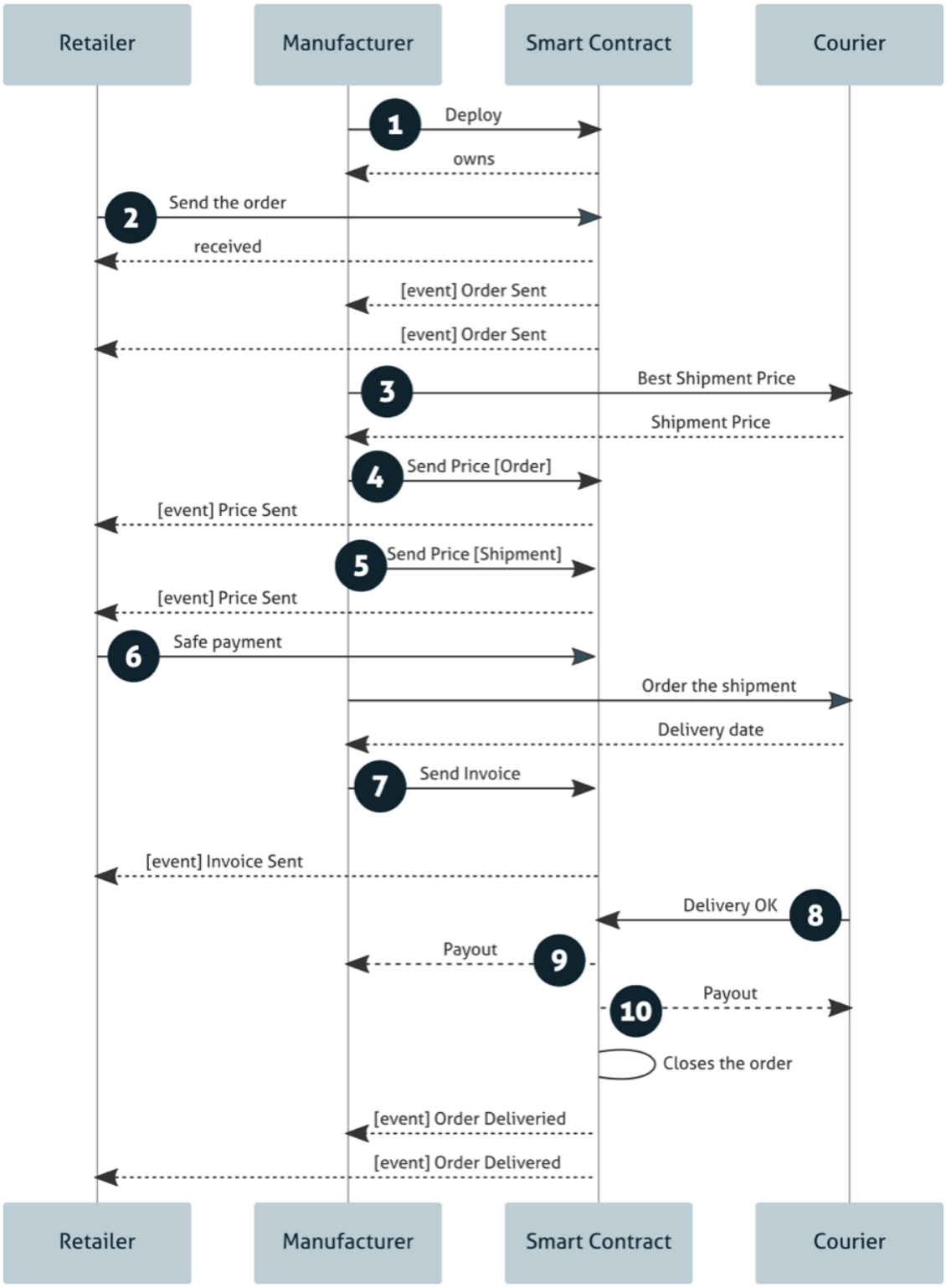
## Appendix A – Extended list of Design Considerations

| Category | Design consideration |
|---|---|
| Technical | Hardware requirements |
| | Software requirements |
| | Consensus protocols |
| | Speed (size of block) |
| | Legacy system concerns |
| | |
| Governance | Ecosystem size - who gets to join? |
| | What assets will be on the shared blockchain? |
| | How do you onboard firms? Offboard firms? |
| | Who manages the blockchain ecosystem? Administers it? |
| | Who has access rights? |
| | How are mistakes communicated? Corrected? |
| | How much data will we share? How do we treat competitive data? |
| | How do we measure success? |
| | Will we use SLAs (service level agreements)? If so, which ones? |
| | What does "good" look like and how do we back off with all firms? |
| | How do we enforce the rules? |
| | What supply chain performance metrics will change? |
| | How will firms agree on changed supply chain performance metrics? |
| | How do you handle a firm leaving the ecosystem? |
| | How do you introduce a new firm to the ecosystem? |
| | How much disruption is this likely to cause to my existing business? |
| | |
| Security | What are the security guidelines? |
| | How do we ensure everyone is using the guidelines? |
| | What happens if a firm violates these? |
| | What happens to my data? |
| | How do we treat sensitive data? |
| | |
| Commercial | How do we price for firms in the ecosystems? Customers? Others? |
| | What are the start-up costs? Who bears the cost? |
| | What elements of existing systems can be re-used? |
| | How much are the capex and opex for a fully functional system? |
| | How do we measure costs? |
| | When can old systems be decommissioned? |
| | How will you know when you're there/ability to safely decommission? |
| | What happens if firms do not migrate to the new blockchain ecosystem? |
| | Do we agree on success metrics regarding ROI? |

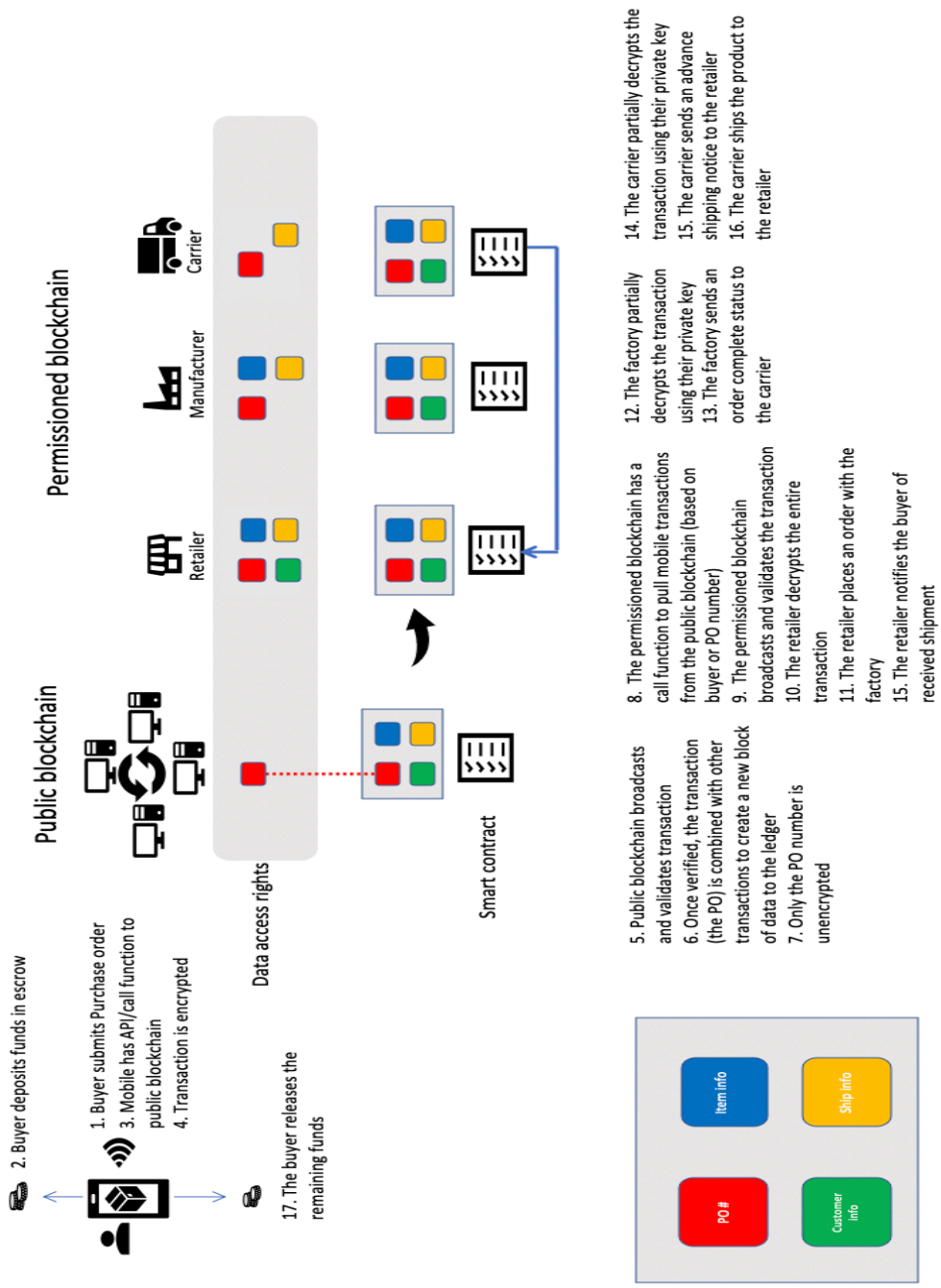
| | |
|---|---|
| | What incentives do we use to gather firms to the ecosystem? |
| | How do I align incentives across the ecosystem? |
| | Will we share costs via revenue share model? Who manages this? |
| | |
| Legal | Who bears the risk for network outages? Cancelled orders? |
| | What happens when something goes wrong? |
| | How do we ensure compliance with regulators (industry-specific) |
| | What happens if firms have conflicting requirements? |
| | What happens if and regulatory bodies have conflicting requirements? |
| | Are smart contracts legally binding or triggers to an external contract? |
| | How do we enforce compliance to smart contracts? |
| | What happens if a firm violates smart contracts? |
| | What happens if a customer violates a smart contract? Who bears the risk? |
| | How do we ensure privacy requirements? KYC requirements? |
| | How are the ramifications of GDPR? Other international entities? |
| | How do smart contracts get approved by all firms in the ecosystem? |
| | How do we ensure new smart contracts won't overwrite existing ones? |
| | What happens if a firm does overwrite existing smart contracts? |
| | |
| HR | How compatible are the cultures of the firms? |
| | What skills do my people need to have? |
| | Do I have these required skills across the business? Where are the gaps? |
| | What training does my firm need to consider? |
| | Do I have the transformation skills required to pull this off? |
| | Is my culture open to change or resistant? |
| | How disruptive is blockchain to my existing supply relationships? |
| | |

(Adapted by Chainyard, 2018)

## Appendix B – Purchase Order for Supply Chain Use Case



## Appendix C – Design Science Artifact with Supply Chain Processes




(Jose, 2018)

**Appendix D – Solidity Purchase Order Smart Contract Code**

```
pragma solidity ^0.4.18;

contract Deal {

  /// The seller's address
  address public owner;

  /// The buyer's address part on this contract
  address public buyerAddr;

  /// The Buyer struct
  struct Buyer {
    address addr;
    string name;

    bool init;
  }

  /// The Shipment struct
  struct Shipment {
    address courier;
    uint price;
    uint safepay;
    address payer;
    uint date;
    uint real_date;

    bool init;
  }

  /// The Order struct
  struct Order {
    string goods;
    uint quantity;
    uint number;
    uint price;
    uint safepay;
```

```
    Shipment shipment;

    bool init;
  }

  /// The Invoice struct
  struct Invoice {
    uint orderno;
    uint number;

    bool init;
  }

  /// The mapping to store orders
  mapping (uint => Order) orders;

  /// The mapping to store invoices
  mapping (uint => Invoice) invoices;

  /// The sequence number of orders
  uint orderseq;

  /// The sequence number of invoices
  uint invoiceseq;

  /// Event triggered for every registered buyer
  event BuyerRegistered(address buyer, string name);

  /// Event triggered for every new order
  event OrderSent(address buyer, string goods, uint quantity, uint orderno);

  /// Event triggerd when the order gets valued and wants to know the value of the
payment
  event PriceSent(address buyer, uint orderno, uint price, int8 ttype);

  /// Event trigger when the buyer performs the safepay
  event SafepaySent(address buyer, uint orderno, uint value, uint now);

  /// Event triggered when the seller sends the invoice
```

```
  event InvoiceSent(address buyer, uint invoiceno, uint orderno, uint delivery_date, address courier);

  /// Event triggered when the courie delives the order
  event OrderDelivered(address buyer, uint invoiceno, uint orderno, uint real_delivey_date, address courier);

  /// The smart contract's constructor
  function Deal(address _buyerAddr) public payable {

    /// The seller is the contract's owner
    owner = msg.sender;

    buyerAddr = _buyerAddr;
  }

  /// The function to send purchase orders
  ///   requires fee
  ///   Payable functions returns just the transaction object, with no custom field.
  ///   To get field values listen to OrderSent event.
  function sendOrder(string goods, uint quantity) payable public {

    /// Accept orders just from buyer
    require(msg.sender == buyerAddr);

    /// Increment the order sequence
    orderseq++;

    /// Create the order register
    orders[orderseq] = Order(goods, quantity, orderseq, 0, 0, Shipment(0, 0, 0, 0, 0, 0, false), true);

    /// Trigger the event
    OrderSent(msg.sender, goods, quantity, orderseq);

  }

  /// The function to query orders by number
  ///   Constant functions returns custom fields
```

```
  function queryOrder(uint number) constant public returns (address buyer, string goods, uint quantity, uint price, uint safepay, uint delivery_price, uint delivey_safepay) {

    /// Validate the order number
    require(orders[number].init);

    /// Return the order data
    return(buyerAddr, orders[number].goods, orders[number].quantity, orders[number].price, orders[number].safepay, orders[number].shipment.price, orders[number].shipment.safepay);
  }

  /// The function to send the price to pay for order
  ///  Just the owner can call this function
  ///  requires free
  function sendPrice(uint orderno, uint price, int8 ttype) payable public {

    /// Only the owner can use this function
    require(msg.sender == owner);

    /// Validate the order number
    require(orders[orderno].init);

    /// Validate the type
    ///  1=order
    ///  2=shipment
    require(ttype == 1 || ttype == 2);

    if(ttype == 1){/// Price for Order

      /// Update the order price
      orders[orderno].price = price;

    } else {/// Price for Shipment

      /// Update the shipment price
      orders[orderno].shipment.price = price;
      orders[orderno].shipment.init  = true;
    }

```

```
    /// Trigger the event
    PriceSent(buyerAddr, orderno, price, ttype);

  }

  /// The function to send the value of order's price
  ///  This value will be blocked until the delivery of order
  ///  requires fee
  function sendSafepay(uint orderno) payable public {

    /// Validate the order number
    require(orders[orderno].init);

    /// Just the buyer can make safepay
    require(buyerAddr == msg.sender);

    /// The order's value plus the shipment value must equal to msg.value
    require((orders[orderno].price + orders[orderno].shipment.price) == msg.value);

    orders[orderno].safepay = orders[orderno].price;
    orders[orderno].shipment.safepay = orders[orderno].shipment.price;


    SafepaySent(msg.sender, orderno, msg.value, now);
  }

  /// The function to send the invoice data
  ///  requires fee
  function sendInvoice(uint orderno, uint delivery_date, address courier) payable public {

    /// Validate the order number
    require(orders[orderno].init);

    /// Just the seller can send the invoice
    require(owner == msg.sender);

    invoiceseq++;

    /// Create then Invoice instance and store it
    invoices[invoiceseq] = Invoice(orderno, invoiceseq, true);
```

```
    /// Update the shipment data
    orders[orderno].shipment.date    = delivery_date;
    orders[orderno].shipment.courier = courier;

    /// Trigger the event
    InvoiceSent(buyerAddr, invoiceseq, orderno, delivery_date, courier);
  }

  /// The function to get the sent invoice
  ///  requires no fee
  function getInvoice(uint invoiceno) constant public returns (address buyer, uint orderno,
uint delivery_date, address courier){

    /// Validate the invoice number
    require(invoices[invoiceno].init);

    Invoice storage _invoice = invoices[invoiceno];
    Order storage _order     = orders[_invoice.orderno];

    return (buyerAddr, _order.number, _order.shipment.date, _order.shipment.courier);
  }

  /// The function to mark an order as delivered
  function delivery(uint invoiceno, uint timestamp) payable public {

    /// Validate the invoice number
    require(invoices[invoiceno].init);

    Invoice storage _invoice = invoices[invoiceno];
    Order storage _order     = orders[_invoice.orderno];

    /// Just the courier can call this function
    require(_order.shipment.courier == msg.sender);

    OrderDelivered(buyerAddr, invoiceno, _order.number, timestamp,
_order.shipment.courier);

    /// Payout the Order to the seller
    owner.transfer(_order.safepay);
```

```
    /// Payout the Shipment to the courier
    _order.shipment.courier.transfer(_order.shipment.safepay);

  }

  function health() pure public returns (string) {
    return "running";
  }
}
```

Provenance Smart Contract

```
// contract to allow supply chain parties and consumers to check the provenance of goods
contract Provenance {
    address admin;
    mapping (address => Producer) producers;
    mapping (string => Product) products;
    struct Producer {
        string name;
        uint phoneNo;
        string cityState;
        string country;
        bool certified;
    }

    struct Product {
        address producer;
        uint[] locationData; // array containing lat & long
        uint timeStamp;
    }
// constructor - runs once when contract is deployed
function Provenance() public{
        admin = msg.sender;
}

// modifier to allow only admin to execute a function
modifier onlyAdmin() {
    if (msg.sender != admin) revert();
    _;
```

```
}

// function for producer to add their details to database
function addProducer(string _name, uint _phoneNo, string _cityState, string _country)
public returns (bool success) {
// don't overwrite existing entries and ensure name isn't null
if (bytes(producers[msg.sender].name).length == 0 && bytes(_name).length != 0) {
    producers[msg.sender].name = _name;
    producers[msg.sender].phoneNo = _phoneNo;
    producers[msg.sender].cityState = _cityState;
    producers[msg.sender].country = _country;
    producers[msg.sender].certified = false;
    return true;
}
else {
    return false; // either entry already exists or name entered was null
}
}
// function to remove producer from database (can only be done by admin)
function removeProducer(address _producer) public onlyAdmin returns (bool success){
    delete producers [_producer];
    return true;
}
// function to display details of producer
function findProducer(address _producer) public constant returns (string, uint, string,
string, bool) {
    return (producers[_producer].name, producers[_producer].phoneNo,
producers[_producer].cityState,
producers[_producer].country, producers[_producer].certified);
}
// function to certify producer as legitimate (can only be done by admin)
function certifyProducer(address _producer) public onlyAdmin returns (bool success) {
    producers [_producer] .certified = true;
    return true;
   }

  // function for producer to add their product to database
function addProduct(string serialNo, uint[] _locationData) public returns (bool success)
{
// ensure no duplicate serial numbers and serial number isn't null
```

```
    if (products[serialNo].producer == address(0) && bytes(serialNo).length != 0) {
        products [serialNo].producer = msg.sender;
        products[serialNo].locationData = _locationData;
        products[serialNo].timeStamp = block.timestamp;
        return true;
    }
    else {
    return false; // either serial number already in use or serial number entered was null
        }
    }

// function to remove product from database (can only be done by admin)
function removeProduct(string serialNo) public onlyAdmin returns (bool success) {
    delete products [serialNo];
    return true;
}

// function to display details of product
function findProduct(string serialNo) public constant returns (address,uint[], uint) {
    return (products[serialNo].producer,products [serialNo] .locationData,
products[serialNo] .timeStamp);
    }
}
```

Tracking Smart Contract

```
// contract to allow supply chain parties to track shipment of goods
and automatically execute payment in tokens
contract Tracking {
address admin;
uint[] contractLocation; // array containing lat & long
uint contractLeadTime; // in seconds
uint contractPayment; // in tokens
mapping (string => Shipment) shipments;
mapping (address => uint) balances;
mapping (address => uint) totalShipped; // total number of
shipments made
mapping (address => uint) successShipped; // number of shipments
successfully completed
struct Shipment {
```

```
string item;
uint quantity;
uint[] locationData;
uint timeStamp;
address sender;
}
// events to display messages when certain transactions are
executed
event Success(string _message, string trackingNo, uint[]
_locationData, uint _timeStamp, address _sender);
event Payment(string _message, address _from, address _to,
_amount);
event Failure(string _message);

// constructor - runs once when contract is deployed
// determine initial token supply upon contract deployment
function Tracking(uint _initialTokenSupply) {
admin = msg.sender;
balances[admin] = _initialTokenSupply; // all tokens he
admin initially
}
uint
ld by
// modifier to allow only admin to execute
modifier onlyAdmin() {
if (msg.sender admin) throw;
_;
}
// function to send tokens from one account to another
function sendToken(address _from, address _to, uint _amount)
returns (bool success) {
if (balances[_from] < _amount) {
Failure('Insufficient funds to send payment');
return false;
}
balances[_from] -= _amount;
balances[_to] += _amount;
Payment('Payment sent', _from, _to, _amount);
return true;
}
```

```
// function to show token balance of an account
function getBalance(address _account) constant returns (uint
_balance) {
return balances[_account];
}
// function to recover tokens from an account (can only be done by
admin)
// in the event that the sendToken function gets abused
function recoverToken(address _from, uint _amount) onlyAdmin
returns (bool success) {
if (balances[_from] < _amount) {
Failure('Insufficient funds for recovery');
return false;
}
balances[_from] -= _amount;
balances[msg.sender] += _amount;
Payment('Funds recovered', _from, msg.sender, _amount);
return true;
}
// function to set contract parameters for next leg of shipment
(can only be done by admin)
function setContractParameters(uint[] _location, uint _leadTime,
uint _payment) onlyAdmin returns (bool success) {
contractLocation = _location; // set next location that will
receive shipment
contractLeadTime = _leadTime; // set acceptable lead time for
next leg of shipment
contractPayment = _payment; // set payment amount for
completing next leg of shipment
return true;
}
// function for party to input details of shipment that was sent
function sendShipment(string trackingNo, string _item, uint
_quantity, uint[] _locationData) returns (bool success) {
shipments[trackingNo].item = _item;
shipments[trackingNo].quantity = _quantity;
shipments[trackingNo].locationData = _locationData;
shipments[trackingNo].timeStamp = block.timestamp;
shipments[trackingNo].sender = msg.sender;
totalShipped[msg.sender] += 1;
```

```
Success('Item shipped', trackingNo, _locationData,
block.timestamp, msg.sender);
return true;
}
// function for party to input details of shipment that was
received
function receiveShipment(string trackingNo, string _item, uint
_quantity, uint[] _locationData) returns (bool success) {
// check that item and quantity received match item and
quantity shipped
if (sha3(shipments[trackingNo].item) == sha3(_item) &&
shipments[trackingNo].quantity == _quantity) {
successShipped[shipments[trackingNo].sender] += 1;
Success('Item received', trackingNo, _locationData,
block.timestamp, msg.sender);
// execute payment if item received on time and location
correct
if (block.timestamp <= shipments[trackingNo].timeStamp
contractLeadTime && _locationData[0] == contractLocation[0] &&
_locationData[1] == contractLocation[1]) {
sendToken(admin, shipments[trackingNo].sender,
contractPayment);
}
else {
Failure('Payment not triggered as criteria not met');
}
return true;
}
else {
Failure('Error in item/quantity');
return false;
}
}
// function to remove details of shipment from database (can only
be done by admin)
function deleteShipment(string trackingNo) onlyAdmin returns (bool
success) {
delete shipments[trackingNo];
return true;
}
```

```
// function to display details of shipment
function checkShipment(string trackingNo) constant returns
(string, uint, uint[], uint, address) {
return (shipments[trackingNo].item,
shipments[trackingNo].quantity, shipments[trackingNo].locationData,
shipments[trackingNo].timeStamp, shipments[trackingNo].sender);
}
// function to display number of successfully completed shipments
and total shipments for a party
function checkSuccess(address _sender) constant returns (uint,
uint) {
return (successShipped[_sender], totalShipped[_sender]);
}
// function to calculate reputation score of a party (percentage
of successfully completed shipments)
function calculateReputation(address _sender) constant returns
(uint) {
if (totalShipped[_sender] 0) {
return (100 * successShipped[_sender]
totalShipped[_sender]);
}
else {
return 0;
}
}
}
```

**Appendix E – Interview Protocol**

| | | |
|---|---|---|
| **Participant Background Questions: "***These first few questions provide us some simple background information on you and Company Name Here."* | | |
| **1.** | What is your job title and how long have you held this position? | |
| **2.** | How long have you been in your industry? | |
| **3.** | How familiar are you with blockchain technology? Where would you place yourself on a scale of 1 to 5, with 5 a high? | |
| **4.** | Do you have a blockchain-related role in your organization? If so, can you describe it? *(probe for experience here)* | |
| **5.** | Are you a member of a blockchain consortium? If so, which one(s)? If not, are you planning to join in the next 6-12 months? What is/was your motivation for joining? How do/did you determine which one(s) to join? | |
| **6.** | How would you describe your company's adoption of blockchain technology?<br>• Our firm is observing blockchain from a distance<br>• Our firm is actively investigating blockchain<br>• Our firm is starting a blockchain proof-of-concept this year or next<br>• Our firm has completed a blockchain proof-of-concept<br>• Our firm has or is in the process of deploying blockchain in our firm<br>*(Interview note: Probe here – have them elaborate about their adoption, how it's going, what's proving to be most difficult and why, what's working)* | |
| **7.** | Why did your firm choose to adopt blockchain? What were your key drivers? What was your motivation to adopt blockchain? | |
| **Relational View Questions:** *"These next few questions discuss what blockchain means to your firm and why you chose this technology."* | | |
| **8.** | Do you believe that deploying blockchain will give your company a competitive advantage? If so, why is that? If not, why? | |
| **9.** | Do you believe that blockchain will require more or less interdependence with firms in your blockchain ecosystem (network)? What are the implications to your answer? | |
| 9.1. | Do you believe the costs of coordination across your blockchain ecosystem is low *(contained; link self-contained modules),* medium *(higher levels of coordination; output of one partner is input to another),* or high *(complex and overlapping division of labor; continuing mutual adjustments; partners linked to specific activities)* | D&S 2018, p. 3145 |
| **10.** | Do you believe blockchain will require more or less financial investments in shared assets with the firms in your blockchain ecosystem (network)? If yes, to what extent? | |

| | | |
|---|---|---|
| 10.1. | Do you believe blockchain will require more (or less) investments in shared tangible assets? *(hardware, software, people. State which ones)*<br>In knowledge-sharing routines? *(could be information; easy to codify **or** know-how; difficult to codify and more complex. State which ones)*<br>Governance? *(could be legal constructs **or** self-enforcing, either goodwill/personal trust or smart contracts)* | D&S 2018, p. 3146 |
| **11.** | Do you believe that blockchain will require your firm to conduct more or less knowledge sharing with the firms in your blockchain ecosystem? If yes, to what extent? | |
| **12.** | To what extent, if any, do you believe deploying blockchain will lend itself to more or less sharing in the future (with the firms in your ecosystem/network?) | |
| 12.1. | If yes to the above, do you believe blockchain will spur additional investments over time in hard assets, knowledge sharing, or governance? | D&S 2018, p. 3146 |
| 12.2. | Do you feel that being a blockchain ecosystem could lead to future revenue opportunities for your firm? | D&S 2018, p. 3150 |
| **13.** | How will blockchain change your relationships with your suppliers in your ecosystem? Suppliers out of your ecosystem? | |
| **Technical Questions:** *"Now, let's spend some time talking about the technical aspects of your firm's blockchain solution."* | | |
| **14.** | What were the largest technical challenges you encountered in your firm's blockchain implementation (or do you anticipate)? How did you resolve those? What issues were unresolvable and why? | |
| **15.** | What blockchain type did you use (or are considering), Ethereum, Corda, HLF, Quorum, Bitcoin, etc. What decision criteria did you use? | |
| **16.** | What type of consensus protocol did you use/planning to use? PoW, PoS, PBFT, etc. What influenced this decision? *(Probe this – why?)* | |
| **17.** | What programming languages and devops tools did you use/planning to use for your blockchain implementation? *(i.e. solidity, go, python, etc.)*<br>Why did you choose them? | |
| **18.** | What standards did you use, or do you plan to use? etc. Why did you choose these standards? Did you consider others? If so, what are these? What is the importance of blockchain standards to you/your firm?<br>*(ex. ISO, GS1, ANSI, NIST, IEEE, X12, vertical-specific, not sure)* | |
| **19.** | Are you using/plan to use smart contracts? If yes, why did you choose to use them? What are the implications to your business model? If not, why not? What languages and devops tools did you use/plan to use? | |
| **20.** | Do you have a mobile API, or a requirement for one? | |

| **Governance Questions:** *"Now let's shift to non-technical questions."* | | |
|---|---|---|
| **21.** | Can you describe your blockchain strategy? What were the drivers to this strategy? What are the business model implications to this strategy? | |
| 21.1. | What is the best way to provide governance in a blockchain ecosystem, in your opinion? What is the ideal governance model? | |
| 21.2. | What are the ideal qualities you look for in blockchain partners? *(in your ecosystem)* | |
| **22.** | What were the largest non-technical challenges you encountered in your firm's blockchain implementation (or do you anticipate)? How did you resolve those? What issues were unresolvable? *(Interviewer's note: Be sure to get an answer to why?)* | |
| **23.** | How much disruption is blockchain likely to cause to your existing business operations? What type of disruptions are these (anticipated?) How did you handle these (or plan to handle?) | |
| **24.** | How will you introduce blockchain in your firm? Across your ecosystem? How did you gain agreements with your ecosystem? | |
| **25.** | To what extent did blockchain require large organizational changes within your company (or did you anticipate these?). Can you describe these changes? *(i.e. org changes, retraining, downsizing, culture, etc.)* | |
| **26.** | Do you have any security or data sharing concerns? If so, can you elaborate on these and how you resolved them? Can you describe any unresolved security or data sharing concerns? | |
| **27.** | Can you describe any process changes you encountered (or anticipate) because of your blockchain implementation? Can you elaborate on any unresolved process changes? | |
| **28.** | Did blockchain require a large number of system changes (or did you anticipate these?) Can you describe these? *(i.e. purchase new systems/services, retire legacy, etc.)* | |
| **29.** | Can you describe any legal or regulatory concerns you encountered (if any) and how you handled them? Did other members in your ecosystem? | |
| **30.** | Describe for me how you onboard members for your ecosystem (or plan to do so). What lessons did you learn? What would you do differently/same? | |
| 30.1. | Do you feel you can unwind your blockchain ecosystem easily or with some difficulty? *(i.e. if a new technology suddenly unfolds, or a supplier goes under or joins a competitor's ecosystem)* | D&S 2018, p. 3149 |
| **31.** | Have you or do you plan to connect to other blockchain networks? What are the major reasons to do so? What are the biggest challenges you foresee? How ready is your company (or their industry) to do this interconnect? *(probe for technical, operational, governance concerns)* | |

| | | |
|---|---|---|
| **32.** | Once blockchain is launched in the ecosystem, how do you (plan to) manage change within your firm? How will you manage change across the ecosystem (inter-firm)? | |
| **33.** | Do you plan to have a shared set of tools (MIS) across the ecosystem? | |
| **34.** | What is the importance of regulatory support for you/your firm? | |
| **35.** | Do you have a need for blockchain globally? | |
| **36.** | To what extent does going international with blockchain change things? | |
| **37.** | What recommendations would you make to improve governance? | |
| **38.** | What age cohort do you identify with – Baby Boomer (1946-64), Gen X (1965-81), Gen Y/Millennial (1982-2004) | |
| **39.** | On a scale of 1 to 5, how ready is your company to implement blockchain, with 1 being 'not at all' and 5 being 'very ready'? | |

For face to face interview: For the final step of the interview, I have 7 index cards with the following terms in alphabetical order: Costs, Governance (across ecosystem), HR, Interoperability, Legal, Security, Technical. Please place these in order of importance, with the top card representing the highest concern for you.

For phone interview: For the final step of the interview, can you tell me which category is the most important to you? They are, in alphabetical order: Costs, Governance (across ecosystem), HR, Interoperability, Legal, Security, Technical. Would you like me to repeat those?

**Appendix F – Informed Consent Form**

Title: How can organizations renew their business models to successfully deploy blockchain into a shared supply chain?

Principal Investigator: Karen Loch
Co-Investigator: Denise McCurdy

**Introduction and Key Information**
You are invited to take part in a research study. It is up to you to decide if you would like to take part in the study. The purpose of this study is to understand the technical and governance decisions that firms make to deploy blockchain in shared supply chains. Your role in the study will last approximately one hour over a seven-month time span. You will be asked to answer semi-structured interview questions. Participating in this study will not expose you to any more risks than you would experience in a typical day. This study is not designed to benefit you. Overall, we hope to gain information about the decisions that firms must make together to deploy the emerging technology of blockchain.

**Purpose**
The purpose of our research is to help businesses understand the challenges of implementing blockchain technology. You are invited to take part in this research study because you are or have been involved in a blockchain implementation. A total of 45 people will be invited to take part in this study.

**Procedures**
If you decide to take part, you will be asked to participate in an interview. The interview will contain questions which investigate, from your perspective, your organization's blockchain journey. There will be one study-related activity, and it is this one, in the form of an interview. Each interview will take approximately one hour. No additional activities will be requested. We will be conducting interviews between June – December 2019 with a plan to finalize our research in 2020.

The interview will be conducted by the co-investigator
The interview will be conducted by phone or in person. If the interview is conducted in person, it will take place at your place of work, in a closed conference room.
The interviews will take place between the months of June through December 2019.
The interview should take no more than an hour of your time.
There are no right or wrong answers to questions asked in the interview. Please answer the questions honestly.
Notes will be taken by investigator during the interview. With your consent, your interview will also be audio-recorded to facilitate data collection.
This study involves no compensation to the you.

**Future Research**
Researchers will remove information that may identify you and may use your data for future research. If we do this, we will not ask for any additional consent from you.

**Risks**
In this study, you will not have any more risks than you would in a normal day of life. No injury is expected from this study, but if you believe you have been harmed, contact the research team as soon as possible. Georgia State University and the research team have not set aside funds to compensate for any injury.

**Benefits**
This study is not designed to benefit you personally. Overall, we hope to gain a better understanding of the governance decisions required by firms to deploy blockchain technology. We believe organizations and society will benefit from a deeper understanding of this ability in this context.

**Alternatives**
The alternative to taking part in this study is to not take part in the study.

**Voluntary Participation and Withdrawal**
You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip questions or stop participating at any time. You may refuse to take part in the study or stop at any time, and this will not cause you to lose any benefits to which you are otherwise entitled.

**Confidentiality**
We will keep your records private to the extent allowed by law. The following people and entities will have access to the information you provide:
Dr. Karen Loch and Denise McCurdy
GSU Institutional Review Board
Office for Human Research Protection (OHRP)

Each interview will be assigned a random identification number. We will use this number rather than your name on both paper and electronic study records. A code sheet that links the participant ID with the name will be created and stored separately from the study data to protect your privacy. The investigators will be the only persons who will have access to this code sheet. All electronic materials related to interviews (digital audio recordings, transcripts, etc.) will be stored as password-protected files on the investigators' computers. These computers are protected by a username, password and firewall. The code sheet, all paper documents and digital audio recordings produced for this research will be retained until the project is completed and no further analyses are necessary. Any facts that might identify you will not appear when we present this study or publish its results. The findings will be summarized and reported in group form. You will not be identified personally.

**Contact Information**
Contact Dr. Karen Loch at 404-409-8988 or email to: kloch@gsu.edu.
If you have questions about the study or your part in it
If you have questions, concerns, or complaints about the study

The IRB at Georgia State University reviews all research that involves human participants. You can contact the IRB if you would like to speak to someone who is not involved directly with the study. You can contact the IRB for questions, concerns, problems, information, input, or questions about your rights as a research participant. Contact the IRB at 404-413-3500 or email to irb@gsu.edu.

**Consent**

We will give you a copy of this consent form to keep. If you are willing to volunteer for this research, please sign below.

_____

Printed Name of Participant

_____ _____

Signature of Participant Date

_____ _____

Principal Investigator or Researcher Obtaining Consent Date

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# VITA

Denise L McCurdy

Denise McCurdy is a technology professional who owns a boutique consulting company and counts among her clients, the Gates Foundation/Center for Global Development, P&G, British Telecom, and a mobile money start-up in Argentina. With a background in strategy formulation, Denise has extensive experience in assembling and managing global teams to resolve challenging business problems for multinational clients.

Denise also has a keen interest in emerging technologies. Passionate about mentoring, Denise enjoyed working with her team members to secure a first place win at GSU's Blockchain Innovation Competition with a supply chain solution.

In addition to her Doctorate in Business Administration, Denise holds a Master of Science degree in Strategic Management from Georgia State University and a bachelor's degree in Telecommunications from Michigan State University.

Denise has traveled extensively overseas, and enjoys meeting people from all parts of the world. Calling Vinings, GA home, Denise is a transplant from the Midwest and enjoys the Atlanta sunshine.

## Qualifications

- Georgia State University, Robinson College of Business, Doctorate in Business Administration, 2020
- Institut de Français, Villefranche-sur-Mer, French Immersion program
- Georgia State University, Master of Science, International Strategic Management and Entrepreneurship, Magna cum laude. Authored thesis: "Large Global Start-ups: A Comparative Study"
- Michigan State University, Bachelor of Arts, Telecommunications, Dean's List.

## Certifications

- Georgia State University, Master Teacher Program, 2019
- Mini-MBA in Finance, Office of Executive Programs
- 6 Sigma Green Belt certified

## Publications

"Hot or Cold... How Ready are Third Party Logistics Cold Storage Companies to Implement Blockchain?" Johnson, A., McCurdy, D., Schechter, D., & Loch, K. (2020, January). In Proceedings of the 53rd Hawaii International Conference on System Sciences.

Pisa, M., & McCurdy, D. (2019). Improving Global Health Supply Chains through Traceability. *CGD Policy Paper 139*.