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Utilizing blockchain technology for supply chain transparency: A resource orchestration perspective

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Abstract

Driven by pressures from multiple stakeholders, supply chain transparency (SCT) has emerged as a phenomenon of increased interest. To address concerns about practices and processes at point of origin locations for raw materials in global supply chains, blockchain technology (BCT) has the potential to enhance SCT. Supply chain research has started to advance the field's understanding of SCT, but many questions remain, including how SCT should be conceptualized, how firms can effectively facilitate it, and the benefits of providing it, especially when BCT is utilized. The gaps suggest the need for fundamental theoretical development about the resources and capabilities underlying the development, application, and derived value of SCT. This research designed a case study around a BCT implementation project between a small artisan coffee producer and a startup BCT service provider. Using the resource orchestration perspective, the findings result in theoretical insights about how the mechanisms in structuring, bundling, and leveraging processes operate to offer SCT to stakeholders, and the value creation derived as a result.

KEYWORDS

blockchain, resource orchestration, supply chain transparency

INTRODUCTION

Pressure from governments, activists, and consumers continues to mount, compelling companies to publicly disclose more information about their products and practices. The phenomenon that arises as a result of this intense scrutiny involves companies' willingness and ability to offer *supply chain transparency* (SCT), which refers to the communication and disclosure of supply chain information about a company's products and operations (Sodhi & Tang, 2019). Companies are realizing, however, that offering SCT to various stakeholders is easier said than done. Before SCT is possible, companies first must have *visibility*, which requires them to gather and access information related to upstream and downstream operations of members of their supply chains.

In particular, companies that produce or sell food products are facing demands for more information about the location of agricultural raw materials, upstream production processes, and sourcing practices (Fortuna & Risso, 2019). For example, global non-governmental organizations (NGOs) like Oxfam have called for multinational food producers to disclose the social and environmental impact of their upstream supply chain (Heneghan, 2016). A consistent issue that prevents companies from meeting these demands, however, is the design of agricultural supply chains. They were not originally created with visibility in mind; rather, the design goal was to coordinate an efficient conversion of inputs for the manufacture and distribution of the final product. This makes SCT especially costly and time-consuming for these companies (Kamble et al. 2020).

The difficulty of providing SCT requires food producers and retailers to develop or acquire new capabilities and solutions that provide the necessary supply chain visibility for SCT. One potential solution involves the implementation of blockchain technology (BCT). Although not a single technology, BCT includes an internet infrastructure and a protocol that create a decentralized and distributed ledger that logs transactions in chronological order to create permanent and tamperproof records (Sternberg et al. 2021; Treiblmaier, 2018). There have been a few documented use cases that demonstrate its effectiveness in food supply chains. For example, Walmart is using BCT to proactively prevent the spread of tainted produce, while Carrefour is utilizing it to provide shoppers verification of its organic poultry (Mearian, 2018). Starbucks recently launched a BCT project that allows customers to access information about the coffee's origin and to learn what the company is doing to support farmers (Johnston, 2020).

Regardless of the challenges and possible solutions, the significance of SCT has become so pronounced that recent research asserts it as a necessary supply chain performance outcome (Bai & Sarkis, 2020). Likewise, there is a call for more research to investigate how companies can effectively utilize SCT, the associated benefits of offering SCT, and the potential for BCT to facilitate SCT (Rao et al., 2021; Sodhi & Tang, 2019). While we agree that those issues are important to address, the dearth of research on SCT suggests that more theoretical development is needed. The literature offers little understanding about the resources and capabilities required for SCT. Therefore, we ask the question, *"How do companies (or managers within companies) orchestrate resources to enable SCT when they utilize BCT?"* Further, the use cases by food producers and retailers suggest that companies disclose different kinds of information. This would infer that the value created by SCT must align with how resources are orchestrated. We ask the related question, *"What is the associated value creation derived by SCT?"*.

Issues about the "black box" between possessing or acquiring resources and value creation were underscored several years ago in the strategic management literature (e.g., Grant, 1991; Priem & Butler, 2001; Sirmon & Hitt, 2003). Sirmon et al (2007, 2011) developed a resource orchestration framework to guide further theoretical development. This stream of literature emphasizes that companies have alternate paths to value creation, and it requires the synchronization of processes and managerial action. We use this literature as a foundation to theorize about the orchestration process and specifically, how BCT is utilized in the synchronization of resources for SCT in an agricultural supply chain.

Given the significance of theoretical contextualization (Craighead et al. 2016), we address the research questions using insights from a single unique case (Ellram, 1996). The study was designed around a BCT implementation project by a small Italian coffee company globally known for exclusive and expensive coffee blends. Using the BCT implementation as the unit of analysis gave us a sequential and temporal perspective, and our findings contribute to the SCT literature by offering a deeper understanding of the resource orchestration process. Likewise, interacting with both the BCT provider and with the coffee company gave us greater theoretical insight about the fit between the orchestration of resources and the value of SCT. We contribute to the SCT literature by offering conceptual clarity and distinguishing it from related concepts like visibility and traceability. On a more practical level, the study will help managers—particularly those who are involved in agricultural supply chains—gain understanding about the value associated with SCT, as well as the challenges and resource requirements in utilizing BCT.

LITERATURE REVIEW

Supply chain transparency is playing an increasingly important role for companies that have global supply chains, especially when the raw materials come from countries where poor or unsustainable practices are common. The immutability of the blockchain ledger offers many benefits, such as mitigating the risk of supply chain participants engaging in these practices (Khetri, 2018). By using BCT to enable SCT, companies can disclose supply chain data about the origin, quality, location, and other relevant information to their stakeholders. As both are emerging topics in the literature, there are gaps that need to be addressed.

Supply chain transparency

In general, transparency is the disclosure of information (Mol, 2015). For companies, it means that the impact of their actions can be ascertained and judged by outside parties. In some cases, disclosure is a matter of legal compliance. Alternately, it can provide the opportunity to voluntarily report on initiatives or strategies that stakeholders find important (Gardner et al., 2019). The general sense is that transparency is inherently positive because it reduces information asymmetry between companies and stakeholders (Egels-Zandén et al., 2015), builds trust and a positive reputation with stakeholders (Gardner et al., 2019), and improves organizational legitimacy (Carter & Rogers, 2008).

While stakeholder demands for transparency of company information is not entirely new, demands for disclosure of supply chain information, or SCT, has become more intense. For instance, the CEO of the $7 trillion asset management company BlackRock posted a letter in early 2020 calling for public companies to be transparent on climate risk, which is predominantly occurring in upstream supply chains (Cosgrove, 2020). Also, NGOs like Greenpeace, Oxfam,

and the Rainforest Alliance now regularly engage in "name and shame" campaigns to pressure companies for more SCT, and specifically to demand that companies make meaningful commitments to ethical sourcing or supplier codes or conduct (Egels-Zandén et al., 2015).

Companies under extreme pressure for SCT include food producers and retailers. This is challenging because agricultural products are often traded as commoditized, undifferentiated goods (Roth et al. 2008). They are often sourced and transported from significant distances, aggregated from multiple sources, and have layers of intermediaries (Fortuna & Risso, 2019). This underscores the long-standing hurdle to SCT: Commodity market supply chains were not designed for transparency. This hinderance means recent efforts have been largely voluntary (versus regulatory), further hampering the consistency and credibility of supply chain information (Gardner et al., 2019).

Theoretical development on SCT is emerging, but several gaps in the literature need to be addressed. Importantly, distinctions between SCT, visibility, and traceability need clarification (Egels-Zandén et al., 2015; Sodhi & Tang, 2019). We utilize the conceptualization offered by Sodhi and Tang (2019) to distinguish SCT as the *disclosure* of information about a company's products and its supply chain to various stakeholders. A necessary first step for SCT is *visibility*, or collecting information about downstream and upstream operations in the company's supply chain. This could include mapping out product supply chains, and then conducting audits, interviews, or engaging with NGOs that have "on the ground" knowledge (Mahamuni, 2019). Finally, *traceability* is a very specific kind of visibility because it infers that the company can ascertain provenance. It involves identifying and verifying the inputs of a product, and tracking the chronology of the product flows throughout the supply chain (Wowack et al. 2016). In sum, visibility and traceability reflect an internal ability to gather product and supply chain information, and SCT involves external disclosure of that information to stakeholders.

The heart of SCT is disclosure, but important decisions involve what to disclose (Gardner et al., 2019), implying that SCT involves many different dimensions. For instance, Bai and Sarkis (2020) propose that SCT should include range, product, and participant dimensions. Egels-Zandén et al. (2015) call for disclosure of supplier names, sustainability conditions at supplier locations, and company purchasing practices. Gardner et al. (2019) assert that SCT involves disclosure of information related to traceability, transactions, impact, policy and commitment, activity, and effectiveness. Sodhi and Tang (2019) note that after gaining visibility and/or traceability, companies ultimately have the discretion to decide what kind and what amount of information to disclose—or they may decide not to disclose any of it.

The literature on SCT is largely related to disclosure of information about practices that demonstrate environmental and social responsibility. As we detail in this study, SCT also includes disclosure about the flows and production processes to convert raw materials into the final product. Few empirical studies that have examined companies' SCT initiatives *in practice* (Egels-Zandén et al., 2015). Likewise, the benefits of SCT are unclear, and differences in what companies choose to disclose reflect how companies understand the value created by SCT (Sodhi & Tang, 2019).

In sum, the field has made significant strides in conceptualizing SCT and addressing issues that need further refinement, but little is known about how companies put SCT into practice or how they perceive the value of it. As we discuss next, one path of discovery explores how companies are embracing BCT as a means to enhance SCT. This technology solution is especially relevant in supply chains that have problems with the credibility and reliability of supply chain information (e.g., agricultural supply chains).

BCT-enabled SCT

Blockchain technology has emerged as a potentially critical technology for companies to utilize in response to both increased complexity and risk in global supply chains. It can also provide the necessary visibility to meet stakeholder demands for SCT. Our intent is not to offer a detailed description of the technology, as this journal just recently published a special topic forum that provides a comprehensive examination of BCT (Durach et al. 2021; Falcone et al. 2021; Kurpjuweit et al. 2021; Rao et al. 2021; Sternberg et al. 2021). Our interest in BCT is the promise it holds for companies that are part of agricultural supply chains, particularly for issues related to traceability and SCT.

The potential for use of BCT to ascertain provenance is especially potent. In a recent study (Kamble et al. 2020), note many challenges that stem from insufficient, inconsistent, and unreliable information because of the number of intermediaries and the lack of trust among members of the supply chain. Companies that invest in traceability can improve the safety, quality, and sustainability of food products. Fraudulent activities are also reduced because companies are more accountable to follow regulatory and required certification processes. Companies like Walmart have found great value in having a BCT-enabled traceability capability for agricultural products because they can be proactive in providing safety checks and in tracing tainted products back to the source (Kshetri, 2018).

It is important to discern the difference in BCT use cases, so we emphasize that the previous Walmart example is related to traceability, not SCT. The context for our study is an Italian coffee company, so Starbucks and Nestle offer exemplars for enhanced SCT *because of* the traceability capability BCT provides. Starbucks developed a mobile application that shows consumers where the coffee was grown, where and

when it was roasted, and what the company is doing to support the farmers at that location (Johnston, 2020). Likewise, Nestle is using BCT for its luxury coffee to go a step further by including independent data offered from the global NGO Rainforest Alliance on the ledger (Pollock, 2020). Both companies see value in offering SCT to consumers because it helps them illustrate their commitment to sustainable and ethical sourcing.

In sum, there is encouraging news for enhanced SCT because of BCT, but theoretically grounded research from use cases is needed to reveal additional benefits and to understand its full potential (Treiblmaier, 2018). The SCT literature led us to make several assumptions that guided our theorizing: (1) companies must invest in resources for SCT; (2) those resources must enable supply chain visibility or traceability before SCT is possible, and (3) managerial decisions about the value of SCT will influence how resources are managed and leveraged. We offer that although contextual nuances will impact these considerations, a theoretically driven understanding about how companies strategically align, combine, and deploy their resources to match stakeholder expectations for SCT is needed. Due to the gaps in the supply chain literature, the strategic management literature on resource orchestration serves as a relevant foundation for further theoretical refinement of SCT.

THEORETICAL BACKGROUND

Resource orchestration theory, an extension of the resource based view (RBV), is useful in identifying firm resources and capabilities that enhance firm performance. Its underlying premise emerged in response to the assessment that companies possessing rare, valuable, inimitable, and non-substitutable (VRIN) resources do not *necessarily* create value that enables superior performance (Ketchen et al. 2014). VRIN resources must be strategically accumulated and leveraged in order for a company to realize the value creation that comes from having them (Grant, 1991; Sirmon & Hitt, 2003). This is what Priem and Butler (2001) called the "black box" between resources and enhanced performance.

Sirmon et al. (2007) offered a framework that links resource management processes to customer value creation and financial performance. The process involves managerial action related to *structuring* resources through accumulating and managing the company's resource portfolio, *bundling* resources to create or alter a company's capabilities, and *leveraging* the capabilities to exploit an opportunity in the market. They theorized that the managerial action and integration of these activities explains the "black box." Sirmon et al. (2011) conceived this framework as "resource orchestration" and extended it to include firm-level characteristics.

The resource orchestration framework offers a very general level of theorization, which opens the door for contextualized explanations for the accumulation, combination, and exploitation of resources. For this study, we are interested in the managerial actions within the resource orchestration process that help a firm achieve SCT (i.e., the first research question), and we are also interested in understanding how managers perceive the value of SCT (i.e., the second research question) because it should be aligned with the resource orchestration process. This lays the groundwork for a research design that allows for refined theorizing to address the contextual conditions and mechanisms that facilitate SCT (Stank et al. 2017).

METHOD

Given the evolving nature and novelty of the SCT phenomenon within the context of BCT, we took a qualitative approach because it was most suited to understand the resource orchestration process. The research questions also point to the significance of *theoretical contextualization*: the adaptation of theory to the underlying industry situation that offers both scientific utility and pragmatic insight (Craighead et al. 2016; Stank et al. 2017). We followed the holistic approach outlined by Gioia et al. (2013) for the necessary concept development, and we also applied the methodology practices advocated by Strauss and Corbin (1998). We employed a bottom-up approach strategy outlined by Craighead et al. (2016), where the data were the driving force for the emergent insights, and abductive theorizing involved the constant interplay between the data and the literature.

Data availability was challenging because of the importance of natural contextual conditions of the phenomenon (Stank et al. 2017). To understand how resources are leveraged for SCT *in practice* (Egels-Zandén et al., 2015) and *how* managers decide what to disclose (Gardner et al., 2019; Sodhi & Tang, 2019), a single use-case study involving a BCT implementation was warranted (Ellram, 1996; Yin, 2009). There are two additional reasons for a single case, the first being the dearth of successful BCT implementations. Second, utilizing a single case study as the unit of analysis offers both spatial and temporal elements that allow for deeper theorizing (Stake, 2008).

Case context

The first step in the case selection was to gain access to a BCT implementation project. The research team engaged with a BCT provider in Italy, Foodchain SpA, that specialized in cloud-based applications for food companies.

Compared to other global technology companies working on blockchain applications like IBM Food Trust, Foodchain is a small technology startup company launched in 2016 in the ComoNext Technology Valley. The company originated from the expertise of a hardware (Kaboom SRL) and a software (Block SRL) company involved in the tracking of agricultural products.

One of Foodchain's clients is a small Italian company, CoffeeItalia[1], a leading roaster and producer of a broad variety of coffee, including unique blends of coffee beans that originate in remote parts of the world. The company specializes in roasting single-origin and rare coffee beans, including some that are among the most expensive coffees on the market. The BCT project involved implementation of BCT in CoffeeItalia's supply chain for a specific coffee varietal grown by 12 producers in one remote area of the world. This project served as the case study and unit of analysis for the research.

Data collection

The key informants for the study were those directly involved with the BCT implementation. As such, the research team engaged with three senior-level Foodchain managers on the project: the senior project engineer, the senior project manager, and the CEO. The senior project engineer was responsible for designing the blockchain software and handling of the technical aspects of the blockchain software. The senior project manager was responsible for understanding CoffeeItalia's supply chain and ensuring the complexities were captured in the blockchain software. Foodchain's CEO had a hands-on approach and oversaw the interactions with the customer, project engineer, and project manager. The research team wanted to document the timing, details, and any changes that occurred during the blockchain implementation, so the informants provided us with written material, documentation of the process, and performance results. The team had consistent access to these managers to answer questions and provide context for understanding the project.

The other set of key informants for the study were from Foodchain's client, CoffeeItalia. We conducted in-depth interviews with the two senior managers directly responsible for the blockchain implementation process. They also had decision-making authority on what information from the blockchain would be disclosed. These interviews were conducted via Skype by a research team member who is a native Italian speaker. They lasted about 60 minutes, and the interviews were later transcribed and translated into English.

A copy of the translated interview guide is presented in Appendix A, but the researcher elaborated on these questions during the interviews to probe for further insight about SCT.

Data analysis

In order to understand broadly how BCT can facilitate SCT, acquiring knowledge about this phenomenon served as the starting point for theorizing (Stank et al. 2017). Therefore, the data analysis proceeded in several steps. The research team was first challenged to understand the BCT implementation project. The team learned how the entire flow of information was restructured to identify the sensitive information, as well as the most valuable points along the supply chain. The next step was to understand the documentation processes for invoicing, transportation, health and customs certifications, and other requirements across the supply chain. Finally, we learned what and how transactions were conducted, documented, and maintained on the distributed database across all of the participants in CoffeeItalia's supply chain.

Engaging with Foodchain to document the BCT implementation provided practical insight into the visibility (via traceability) that is a necessary prerequisite for SCT. Once we had contextual clarity about exactly what the blockchain did and how it worked, we were able to focus on the concepts and mechanisms of resource orchestration that facilitated SCT, as well as the value associated with it. Analysis then involved an interpretivist approach, whereby the research team integrated the contextual knowledge of the implementation into the insights offered from the CoffeeItalia managers. This approach offered both a retrospective and real-time understanding from the people experiencing the phenomenon of interest (Gioia et al. 2013).

The framework offered by Sirmon et al. (2007, 2011) theorizes that resource orchestration is a comprehensive process that involves a company structuring its resource portfolio, bundling its resources to build capabilities, and then leveraging its capabilities with the purpose of creating value. The literature explaining this process served as the theoretical foundation for inducing patterns in the data, and the analysis involved the continuous interplay between the data and the literature (Craighead et al. 2016). As such, we proceeded with a conceptual development method dubbed the "Gioia method" (Gioia et al. 2013). First, we utilized the data to develop initial concepts that reflected managerial actions around structuring, bundling and leveraging activities. We also developed initial concepts that explained how the orchestration process aligned with value creation as the CoffeeItalia managers perceived it. The next level of analysis involved transforming the concepts into second-order themes to offer a more gestalt narrative of the orchestration process and the value that the process created. The final step of the analysis was to abstract

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[1]Although Foodchain SPA gave the research team explicit permission to disclose its name, all other organizations are not revealed for confidentiality purposes.
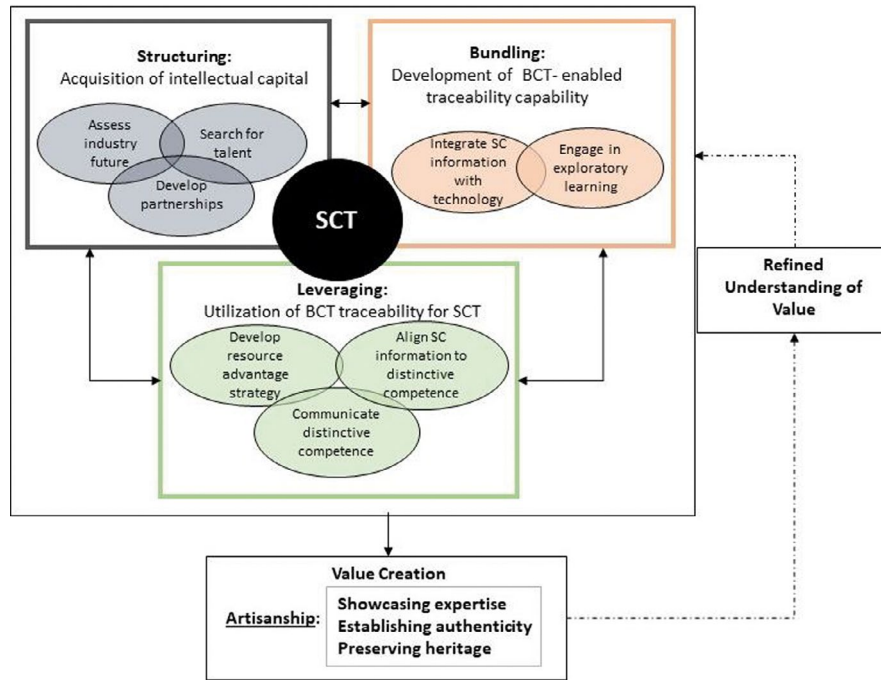
FIGURE 1 Resource Orchestration Process for BCT-enabled SCT.

further into aggregate dimensions that described the key characteristics and the perceived value.

Throughout the study, the research team took several measures to ensure trustworthiness. A senior manager from Foodchain SPA was directly involved in the drafting of the manuscript in order to ensure credibility. Dependability came as a result of gaining in-depth knowledge of the process, getting access to data, and validating the findings. Transferability was bolstered by ensuring that the case context met the criteria for understanding SCT. Finally, we offer evidence of confirmability in the subsequent findings section by providing data structure tables to illustrate the abstraction from the initial concepts to the aggregate dimensions.

FINDINGS

Based on the case results, Figure 1 offers the overarching theoretical framework for understanding resource orchestration for SCT when utilizing BCT. The figure illustrates the aggregate dimensions for the structuring, bundling, and leveraging processes. It also highlights the underlying second-order themes to reflect the managerial actions for each of the aggregate dimensions, specifically as they related to the perceived value of SCT for CoffeeItalia. In addition to the discussion offered in the subsequent sections, tables in the appendices provide the data structure for the representative first-order concepts and second-order themes. Consistent with Sirmon et al. (2007), the figure is modeled to be dynamic because SCT requires continuous adaptation.

To provide a more nuanced understanding of the study, it is important to highlight the significance of the artisan concept because it was overwhelmingly prevalent in this study. Although CoffeeItalia is a small Italian company, is it also a company made up of artisans. One of the managers started the interview with, *"We are artisans in the true sense of the word."* It is important to highlight because of the meaning associated with the artisan trade. Leissle (2017) underscores that artisans offer more "intimate" goods that are materially and ethically sound, and they are made to be appreciated. The artisan concept implies that products reveal the touch of the person who made them, and this opens up the possibilities of creating additional value that mass production does not (Heying, 2010). In this study, the findings reveal that orchestrating resources to produce SCT aligns with the value created by the company's artisanship, which the participants perceived as distinct in the production of the coffee products.

Structuring

All companies, regardless of size, have a portfolio of tangible and intangible resources that serve as the foundation for value creation (Wernerfelt, 1984). The structuring process in resource orchestration refers to how companies manage their entire resource portfolio through accumulation, acquisition, and divestment (Sirmon et al. 2007). As a small company with limited resources, we found that CoffeeItalia had to adjust its resource portfolio through the *acquisition of intellectual capital*, which is the aggregate dimension of the structuring

process. It reflects an intangible and specialized knowledge resource that the company incorporated into its resource portfolio from an external source. The implementation of BCT is a novel and arduous task that would be difficult to develop internally (Bai & Sarkis, 2020), so CoffeeItalia needed outside BCT expertise.

Acquiring those resources in the structuring process was reflected through specific managerial actions that serve as second-order themes (see Appendix B for representative first-order data). The first theme involved CoffeeItalia's *assessment of the industry's future* when considering actions for necessary resource portfolio adjustments. The managers took a longer-term perspective of the entire coffee industry, saying that, "*We all know that in ten years' time this blockchain will have an incredible base of development.*" Their focus was also on the utilization of BCT as a means for the artisan community to have long-term success in the wake of intense competition. Throughout the interviews, the managers emphasized that embracing technological advances like BCT was essential for maintaining their artisan craft. One of the managers explained, "*Try to understand that we definitely have to start to put ahead this concept, a blockchain in the future. Do you want to get on this train of the future, yes or no? The later you get on it, the worse it will be. That's the concept.*" This assessment was an important aspect for decisions about resource acquisition.

Another managerial action in the structuring process that underscored the need to acquire intellectual capital was the company's *search for talent*. For CoffeeItalia, this search involved young people in particular. The managers understood that their craft is one handed down through both tacit and explicit knowledge from generation to generation. However, using BCT required a new set of technological skills from a new generation of tech-savvy entrepreneurs. One manager offered that, "*If we talk about blockchain and the future, we have to talk about young people.*" There was a sense that SCT would provide a competitive edge for the future, and this meant that the artisans would need to search for talent outside of the industry for specialized BCT knowledge.

The third managerial action in the structuring process was *developing the appropriate partnership*. In the talent search, one of the managers regularly went to business innovation incubator events in Italy, and this is where he was introduced to the startup company that had the specialized knowledge for a BCT implementation. When asked about how CoffeeItalia got involved with Foodchain, the manager commented that, "*The idea was born almost by chance… I did this hackathon, and I said, 'Let's try to do it, it seems an interesting thing.'*" This particular hackathon emphasized how new technology could be applied to the food supply chain.

The artisans and the entrepreneurs paired up at this event and worked on how they could trace two bags of coffee. From there, they continued to work on the project. The structuring process created a partnership that was mutually beneficial because of the intangible resources that both brought to the partnership. CoffeeItalia needed Foodchain's technological resources and likewise, Foodchain needed CoffeeItalia's supply chain knowledge. The CoffeeItalia manager noted:

> I steal from them and they steal from me. They need my experience, my knowledge, and I need them.

In sum, the case reveals that structuring resources for SCT required the acquisition of resources that bolster intellectual capital. When BCT is utilized, this involved a long-term industry assessment, an intentional search for talent, and the development of and external partnership with a blockchain provider. As the extant literature points out, however, acquiring the needed resources for SCT is not sufficient (Grant, 1991). SCT requires companies to first get visibility into their upstream and/or downstream supply chain operations, so further resource orchestration was required.

Bundling

The bundling process in resource orchestration involves integrating a unique combination of resources to create capabilities. It takes on different characteristics depending on whether the company needs to make incremental improvements to extend a current capability or whether a new capability is needed (Sirmon et al. 2007). The results of this case point to the latter because the goal for the BCT implementation was the *development of BCT-enabled traceability*, which is the aggregate dimension of the bundling process. Previous research asserts that SCT requires visibility; one aspect of visibility is the traceability capability that allows a company to trace a raw material in a product to the point of origin location (Behnkea & Janssen, 2020; Sodhi & Tang, 2019). For CoffeeItalia to develop this capability using BCT, it required the integration of the company's product and production knowledge with the technological resources of Foodchain.

The traceability capability involved *integrating SC information with the technology*, a second-order theme illustrated in Figure 1. To provide context, the movement of coffee beans through the supply chain first involves the beans being collected by a local cooperative during the coffee harvest. The cooperative is supposed to guarantee the authenticity of the beans and prepare them for shipment to CoffeeItalia. The documents that assure the coffee's provenance and transport conditions are checked at departure. There is a further health analysis upon arrival, with the results then forwarded to CoffeeItalia. This documentation must also be made available to CoffeeItalia's retail customers. Figure 2 illustrates the
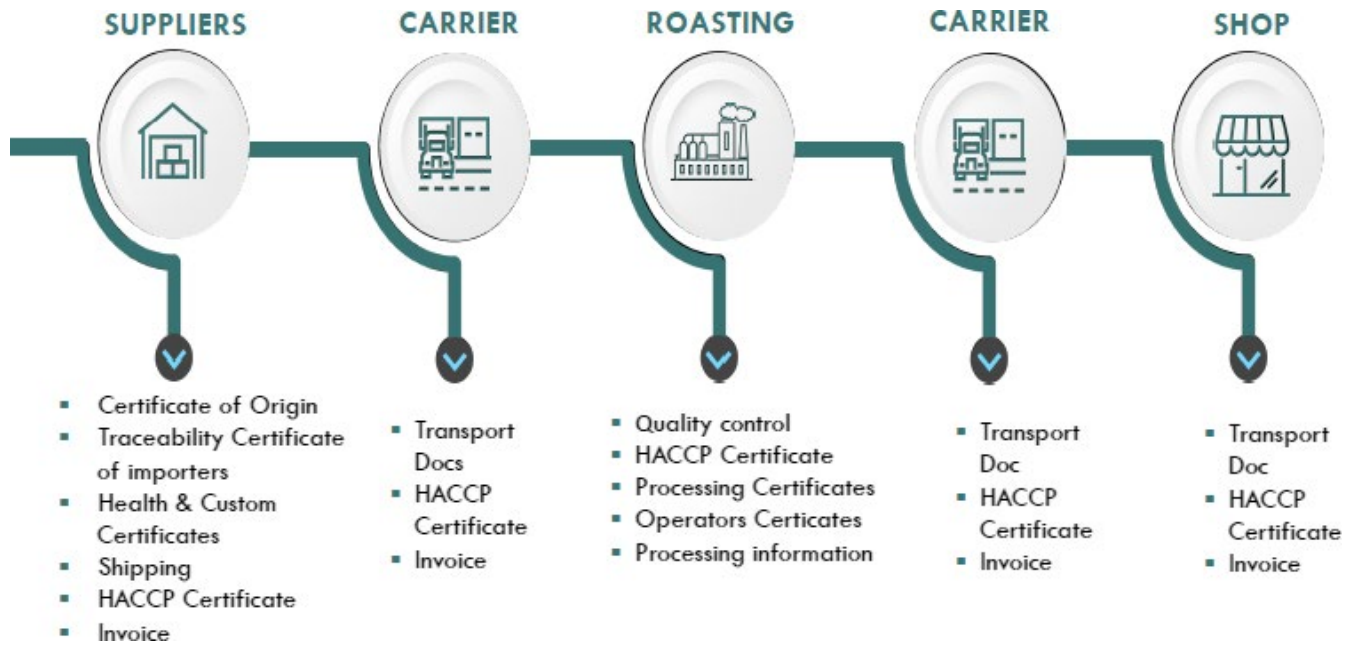
FIGURE 2 Information and Documentation Flow of CoffeeItalia Supply Chain.
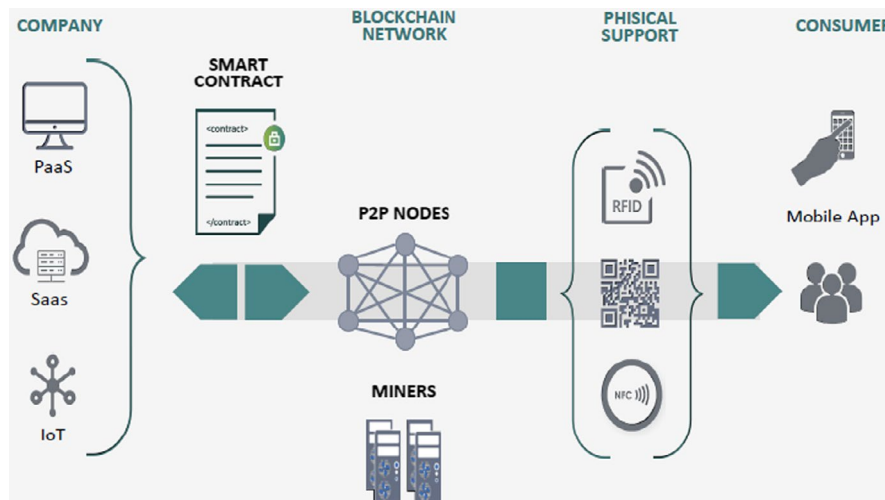

FIGURE 3 Foodchain BCT Infrastructure for the Traceability Capability.

information and documentation flows that accompany the physical flow of the materials. While the process seems relatively straightforward, the managers indicated that in reality, it was a very time-consuming, manual process fraught with errors and omissions. One manager conveyed that:

> Our coffee supply chain is complex and very distant, we used to have to go to Kenya, Mexico, and Guatemala and ask for documents and register them, which was not easy.

By partnering with Foodchain, all the information and documentation illustrated in Figure 2 could be captured and shared across the supply chain participants via the BCT platform. The Foodchain BCT infrastructure components are illustrated in Figure 3, but most important is that the combination allows CoffeeItalia to trace of all the critical transactions throughout the supply chain without the need for intermediaries to verify the documentation. This was reflected by the CoffeeItalia manager:

> Now we developed QR codes of entry that go all the way upstream to enhance traceability. The operators upstream can now easily give us certificates of origin, customs certificates, health certificates, and transport certificates.

FIGURE 4 Scannable QR Code for the End Customer.

Another important aspect of the traceability capability includes the addition of product information on the blockchain ledger. CoffeeItalia roasts and combines the raw materials to produce unique coffees that have distinctive flavors. A manager explained this further, *"These materials arrive, they are traced from the beginning, then I do the processing of the individual raw materials. Every single process is recorded on our internal blockchain and obviously will be available to the end customer."* As the quote illustrates, the traceability capability for the company facilitates SCT for the customers (Sodhi & Tang, 2019).

Because the traceability capability required orchestration of new resources, the bundling process also involved *engaging in exploratory learning*, another second-order theme in the bundling process. Both CoffeeItalia and Foodchain entered unchartered waters when they began their partnership, so there were hurdles and bumps along the way. This was largely due to building a QR code of entry that required cooperation from the upstream supply chain members and the importers that had not used BCT previously. There were also times that production was delayed or interrupted as a result of the exploratory nature of the learning process. One manager explained, *"More than an operational problem there were these eight interruptions because we created the program from scratch."* Developing the traceability capability through exploratory learning was also more costly. The managers acknowledged the cost, but also noted, *"Don't look at the costs because then they will hold you back in development."*

Overall, the case reveals that SCT required bundling resources for the development of the traceability capability. Utilizing BCT meant that a unique combination of resources from Foodchain and CoffeeItalia was required, involving both exploratory learning and integration of supply chain information with the technology platform. In sum, the bundling process to develop the traceability capability was an important step, but more action was required for SCT.

Leveraging

The leveraging process requires action to align a company's capabilities with the intent of creating value in the market (Sirmon et al. 2007). For this study, the aggregate dimension in the leveraging process was the *utilization of the BCT traceability capability* so CoffeeItalia could provide SCT through information disclosure that enhanced the company's value proposition. The findings reveal that CoffeeItalia exploited the BCT capability through actions that serve as three second-order themes: *coordinating a resource advantage strategy* to differentiate its product from competitors, disclosing information from the blockchain ledger by *aligning the supply chain information to its distinctive competence*, and *communicating its distinctive competence* to customers, other coffee artisans, and multinational competitors.

Companies utilize a resource advantage strategy when the leveraging process uses firm capabilities to highlight an advantage that cannot easily be copied by competitors (Sirmon et al. 2007). The main thrust of SCT for CoffeeItalia involved exploiting the traceability capability to underscore the advantage that coffee artisans have over their corporate competitors. Developing a strategy around the artisan concept was key in the leveraging process. This was reflected when the manager declared:

> Artisans with a blockchain can demonstrate that their product is truly artisanal and instead a multinational must apply a semi-artisan concept to their product.

CoffeeItalia's resource advantage was the knowledge and experience in producing the end product, which further reflected the time and the care of the artisans to research and create high-quality coffees. The resource advantage strategy reflected the managers' view that it was the knowledge and work

ethic of the artisan that could not be copied. One manager told a story about how multinational corporations send their executives to CoffeeItalia's facilities to see how coffee is processed. He stated, *"We who are still artisans have all the visual stages. They think the coffee is going into a can and comes out ready. They have never seen a bag of raw coffee, or the activity of loading, or how the color changes over time."* Leissle (2017) notes a sharp contrast between the artisan products and mass-produced products. This was reflected in CoffeeItalia's strategy to highlight this knowledge resource advantage.

The leveraging process also involved making decisions about how to best align the supply chain information from the blockchain ledger to the company's distinct artisanship competency. This required CoffeeItalia to decide what information to disclose and then develop the means to disclose it. As part of the BCT infrastructure, Foodchain developed a mobile application to provide access to product information verified on the blockchain ledger. As Figure 4 illustrates, the coffee packaging includes a scannable QR code that provides the country of origin of the coffee and when the beans were shipped and roasted. Most importantly, the QR code provides information about how and when the product was made, including how the final coffee product was produced by blending and mixing specific roasts. This level of detailed disclosure about the production process was new to the industry. One manager pointed out that this information was significant in highlighting the distinct competence of artisans in making the product:

> The sack of coffee, the amount of mixture we used, the percentage… We are the first to do so. A corporation says 100 percent Arabica but does not say what it puts inside.

Finally, after decisions were made about what information to disclose and the means to do it, the leveraging process involved communicating to customers. For this, we learned that CoffeeItalia would need the help of their retail customers. Their concern in using the QR code alone to communicate information was that end consumers did not yet understand what it was, nor did they necessarily want to expend the extra effort to utilize it. One manager mused:

> I thought about the packages on the shelves, but the average consumer still does not know what the QR code or blockchain means.

The other added:

> I thought about the housewife who arrives at a supermarket at six o'clock in the evening, she has to pick up the child from her grandfather and feed him; she doesn't have time to take the phone out and place it on the QR code.

To address these issues, CoffeeItalia envisioned that the retailer could provide an interactive display on the shelf that captured the blockchain information. There were plans to engage with the retailer to develop this display, and it was a critical part of being able to leverage CoffeeItalia's artisan craft effectively in the market. A manager revealed:

> A step at a time. I think the most important thing is to finish the display right now. It is the consumer who must have the interest; he has to begin to understand it not in a shocking way, but in a simple way.

In sum, the case reveals that CoffeeItalia had to orchestrate resources to leverage the traceability capability underlying SCT. The leveraging process required that the company develop and deploy a strategy that demonstrated a resource advantage not quickly or easily matched by competitors. Further, they had to understand what information from the blockchain ledger would align with the advantage. As such, SCT can be critical in helping companies convey the competency that derives value creation.

SCT and value creation

The resource orchestration perspective infers that focusing on SCT as an outcome requires linking it to the value created as a result. For this BCT implementation between Foodchain and CoffeeItalia, Figure 1 illustrates that the aggregate dimension of value creation is the artisan craft in the coffee production. The consistency of the managerial actions across the structuring, bundling, and leveraging processes demonstrates that resources were orchestrated with artisanship in mind. In exploring how SCT currently creates value in this competitive landscape, the analysis uncovered three themes that demonstrate how SCT enhances CoffeeItalia's ability to *showcase their expertise* in producing the coffee, *establish authenticity* of the materials in the coffee, and *preserve the heritage* of the artisan craft in the production of the coffee. Although the reasons for doing so differed, this value is communicated to three primary stakeholders: customers and coffee connoisseurs, other coffee artisans, and multinational competitors.

One reason for the partnership with Foodchain was so that CoffeeItalia could showcase and share the company's expertise of the coffee artisan craft with customers and coffee lovers in general. The company holds three patents on coffee, and one source of value from SCT is to help these stakeholders understand that producing the best quality coffee requires research and continuous improvement. This involves specialized knowledge of the raw materials and the coffee production process, and it also requires ongoing research to produce

new coffee blends. By showcasing CoffeeItalia's expertise within the community, the company hopes to encourage other coffee artisans to advance the craft. The managers believe that advancing the industry means shifting the mindset of a traditionally closed group of artisan stakeholders to understand the value of knowledge-sharing, as one of the managers reflected:

> People should not be afraid to talk about research and to compare themselves with another company. Why not? You can only improve; this is the concept. It then creates a system whereby research becomes a very normal thing; indeed you become hungry for research because you know that then it can serve you.

SCT also creates value derived by artisanship because it helps CoffeeItalia to establish the authenticity of its coffee products. The traceability capability of BCT allows CoffeeItalia to assure the provenance of the raw materials. To provide the distinct tastes and quality, the sourced coffee beans come from distant and sometimes remote areas of the world. Substituting counterfeit or lower quality materials could occur because of both distance and the number of intermediaries involved in moving it from point of origin to production. Utilizing BCT minimizes this risk because every transaction and the required documentation are immediately uploaded and become transparent on the blockchain ledger (Kamble et al. 2020). One manager slyly commented that with BCT, *"many old foxes who sell one product for another could have problems."*

SCT also establishes authenticity by highlighting the artisan craftsmanship and knowledge required to produce the coffee. In explaining why the company decided to work with Foodchain on the BCT implementation, one manager noted, *"Its strong point is that it focuses on the product. We developed it especially for this reason."* In addition to disclosing the authentication of the raw materials in the coffee, CoffeeItalia uses BCT to demonstrate the authenticity of the process of making the coffee. Establishing this authenticity aligns with their distinct competence, which was reflected in the comment:

> Although it may seem ridiculous, in my opinion a blockchain for artisans is an extra weapon. The artisans have an incredible product.

Finally, CoffeeItalia understands multinational companies to be rival stakeholders, so the value created by artisanship is important to the managers as a way to preserve Italy's rich heritage in coffee production. They noted that artisanship was a source of competitive advantage over industrial coffee production, but there was also a sense of deep concern that corporations are *"stealing the concept of craftsmanship."* Because of that, the

value of SCT not only communicates the company's distinct competence to customers and coffee lovers, but it also serves as a reminder to the large multinationals that Italy is home to true coffee artisans. The significance of this was obvious in one of the stories about how the dominance and success of Starbucks is grounded in the Italian coffee heritage. *"A person like Schultz comes to Italy in the seventies, sees the bars and says, 'Heck, how nice the bar is. In America there aren't any,' so he steals a typically Italian concept that we could not export and adapted it to the situations of each nation. He stole a huge concept from us. If you talk about bars in the world today, it's Starbucks, it's not Italy, it's not an Italian company. It's ridiculous."* CoffeeItalia believes that communicating the value of artisanship will help to preserve this heritage and in turn make it more difficult for corporations to hijack the artisan concept.

Summary

The resource orchestration perspective provided a theoretically grounded means to further understand SCT, and a case study involving a BCT implementation project created the means to see it in practice. Using this case to frame SCT as an outcome facilitated by structuring, bundling, and leveraging processes offers contextualized knowledge, and it also provides broader theoretical insight. Throughout the study, the analysis revealed that the value of SCT is realized when resources are orchestrated in alignment with both internal capabilities and external factors like the nature, competitiveness, and history of the industry. Consistent with Sodhi and Tang (2019), it appears that SCT will manifest itself in different ways because resources are orchestrated based on how a company defines and perceives the value it creates. Because of the time and cost involved, companies that utilize BCT must be especially strategic and thoughtful in aligning the structuring, bundling, and leveraging processes with the value offered by SCT.

ADVANCING THEORY FOR SUPPLY CHAIN TRANSPARENCY

The importance and novelty of the SCT phenomenon open many avenues of inquiry for supply chain research. This study builds on the call to establish conceptual consistency for SCT, to address questions about strategic actions required to provide SCT, to understand decisions about information disclosure, and to highlight the benefits of SCT (Egels-Zandén et al., 2015; Sodhi & Tang, 2019). Likewise, a related stream of research has called for additional research to examine the adoption of BCT, the associated challenges of implementation, and how BCT can be used to enhance SCT (Bai & Sarkis, 2020; Rao et al., 2021; Treiblmaier, 2018).

The objective of this study was to address some of these unanswered questions, and this level of theorizing positions the study around a contextualized domain of knowledge, clarifies and extends previous research, and explicitly focuses on the "black box" between mechanisms and outcomes that are embedded within their specific contexts (Stank et al 2017).

The specific motivation for this study was to understand the managerial actions and processes required when BCT is utilized to provide SCT (i.e., *how?*), as well as to understand the value that was derived by providing SCT (i.e., *why?*). Answering these questions requires reflection of SCT in practice by examining specific use cases of BCT-enabled SCT. Immersion into a BCT implementation project created an appropriate case study opportunity, and implementation in an agricultural supply chain provided the context for a "critical case" (Flyvberg, 2006, p. 229) because of the historical barriers inherent in supply chain design.

The lack of empirical research on SCT required taking a bottom-up approach (Craighead et al. 2016), and the resource orchestration framework provided a general theoretical perspective to assist in conceptual development (Sirmon et al. 2007, 2011). We used this literature specifically because it helped frame the research questions around managerial actions and processes, and it provided established concepts to better utilize inductive and abductive reasoning to guide emerging data patterns. The study resulted in a model (Figure 1) that offers new knowledge and deeper insights that contribute to both theory and practice.

Theoretical conceptualization of SCT

This study highlights the need for a conceptualization of SCT that will facilitate further theoretical development and empirical testing. A common understanding and definition of SCT has been lacking, so we emphasize that the defining characteristic of SCT is *information disclosure* (Sodhi & Tang, 2019). It is reflected in a company's willingness to share information to various stakeholders about operations and flows of product materials throughout the supply chain. Our findings underscore that visibility is a *prerequisite* to SCT, inferring that a company must first possess information about its upstream and downstream product flows and operations. The nature of visibility varies, meaning that a company can possess general information about the suppliers and customers in its supply chain (e.g., names and locations), or it might have deep knowledge about its supply chain (e.g., investments in training and best practices).

Traceability is a specific visibility capability, characterized by the ability to *identify and verify* specific locations, movements, and conversion of materials throughout the supply chain (Wowack et al. 2016). Therefore, traceability is not a prerequisite of SCT, but rather, it can be used to enhance

visibility. The extent of traceability can vary, too. For instance, many final products require conversion of a combination of materials, so companies must choose how many and which raw materials to trace.

Conceptually, SCT requires that firms decide *what* information to disclose (Sodhi & Tang, 2019). In other words, companies may have visibility and/or traceability, but what they disclose publicly involves a completely different consideration. For instance, they may possess supply chain information that is harmful if disclosed, or they may conclude that disclosing certain kinds of information could put them at a competitive disadvantage. Likewise, there may be supply chain information that would not be important or relevant enough to stakeholders to disclose. In sum, it is important to make the theoretical distinction between what a company knows (i.e., visibility or traceability) and what information it discloses (i.e., SCT).

> P1: SCT is limited to a company's visibility/traceability of the supply chain, but the company's visibility/traceability of the supply chain can exceed the degree of the company's SCT.

When SCT is desired, this research underscores that companies must purposefully orchestrate and align resources to provide it. First, companies must structure their portfolio to include the resources necessary for visibility. They may develop the resources internally, but the specialized knowledge for BCT implementation likely requires the acquisition of intellectual capital through partnerships with BCT providers. Companies must take managerial action to bundle resources into specific capabilities for visibility, and a specific combination of resources is required to develop a traceability capability derived by BCT. Finally, companies must coordinate and deploy a plan to leverage the available information to relevant stakeholders. Although actions and relevant stakeholders will be specific to individual companies, SCT requires companies to develop a set of underlying processes for resource orchestration. Therefore,

> P2: Processes to structure, bundle, and leverage resources are required to provide SCT to stakeholders.

Value creation of SCT

The assumption that SCT is an important outcome infers that resource orchestration creates value for the company. Therefore, to capitalize on the investment of those resources, it is important to ensure a fit between structuring, bundling, and leveraging processes and value creation. While this has not been offered explicitly, the supply chain literature suggests that alignment between orchestrating resources for SCT

and value creation can come through disclosure of companies' sustainable supply chain practices (Bai & Sarkis, 2020; Egels-Zandén et al., 2015; Gardner et al., 2019; Mol, 2015). This includes information related to environmental impact, labor conditions, safety standards, and other sourcing practices across the supply chain, particularly those at specific point of origin locations. Through these managerial actions in resource orchestration, SCT can address concerns associated with a company's commitment to reduce the environmental and social harm that occurs in the supply chain.

This research revealed that resource orchestration can also be aligned with the value created from information disclosure about companies' production processes. While SCT might involve disclosing the place of origin, value is emphasized by offering more information about how and when materials travel through the supply chain, as well as detailed disclosure about how the final product is made. The importance has been noted in literature addressing supply chain difficulties of agricultural products in particular (Fortuna & Risso, 2019). In this case, value is created when SCT addresses quality, safety, or fraud-related concerns of product movement and production.

In sum, Proposition 1 underscores that SCT involves making decisions about what and how much information to disclose. Further, the decisions and managerial actions in resource orchestration should be driven by the kind of value created by SCT. These differences are reflected by the value derived by sustainable practices and production processes.

> P3: The extent and content of SCT is related to the value associated with disclosure of a) sustainable practices and/or b) production processes throughout the supply chain.

BCT-enabled SCT

This study offers additional insight into SCT when it is leveraged by development of a BCT traceability capability. Resource orchestration will be more complex because the structuring process involves acquiring knowledge and technology resources from outside parties. This study underscores the need for additional assessment and search activities, and partnership development with a BCT service provider. The bundling process requires the integration of knowledge resources from both the company and the service provider, and the partnership involves exploratory learning. However, once a company successfully develops the traceability capability for one product, the partnership should yield more explicit knowledge that that can be useful to overcome challenges in future implementations for other product types or categories.

The research team engaged with Foodchain to learn about the BCT implementation with CoffeeItalia in 2017, which was prior to BCT implementations by global food production and retail companies. Since then, however, major technology software companies like Microsoft and IBM have joined the blockchain provider ecosystem, and there is substantive investment pouring into development of streamlined cloud-based BCT solutions (Mearian, 2018). As a result, there should be adjustments in the structuring and bundling processes for companies developing the BCT traceability capability because knowledge resources will become more explicit and standardized. Therefore,

> P4: The extent of exploratory learning required for the BCT traceability capability will decrease as a) the company utilizes BCT across more products, and b) the adoption of BCT across the industry accelerates.

SCT opens opportunities to communicate and to potentially develop trust among stakeholders (Bai & Sarkis, 2020; Falcone et al. 2021; Sodhi & Tang, 2019), but companies must weigh the value of providing it with the associated costs and risks. *Ascertaining* provenance may be beneficial, but *disclosing* provenance may create additional risk. In other words, if companies want to disclose provenance, they should consider the trustworthiness and consistency of information as the materials flow through the supply chain. This is particularly relevant for products at risk for food fraud, which involves the intentional substitution, tampering or misrepresentation of raw materials in food products (Spink & Moyer, 2011). As the case findings underscore, utilizing BCT for traceability provides additional assurance because all the transactions on the ledger occur in real-time, and they are also auditable, immutable, and verifiable (Kamble et al. 2020). As such, orchestrating resources for BCT-enabled traceability should enhance the value of SCT.

> P5: The BCT traceability capability enhances the value of SCT because of (a) verification of the provenance of raw material, (b) inclusion of additional information related to point-of-origin, and (c) documentation of real-time material flow throughout the supply chain.

Finally, the findings document that the leveraging process in SCT requires companies to take specific actions in order to disclose the information made available by BCT. If companies decide that disclosure requires communication to end consumers, the leveraging process will be impacted by their degree of control or influence over the downstream supply chain. For instance, CoffeeItalia acknowledged that consumers may not understand and utilize the QR code on the packaging, so they were dependent on the retailer to develop an interactive shelf display. A small company like this one may have more difficulty or need to expend more effort in the leveraging process due to its lack

of influence. Alternately, multinational companies like Nestle have a greater degree of influence over the downstream supply chain, so retailers are more likely to assist with information disclosure. Finally, companies like Starbucks that own their own storefronts have the most control of the downstream supply chain, reflecting the most straightforward way to leverage information disclosure. In short, when companies consider how to communicate SCT to end consumers, decisions and planning should incorporate how the leveraging process will be impacted by downstream supply chain participants.

> P6: The degree to which BCT-enabled SCT can be effectively leveraged to reach consumers is dependent upon the level of control over the downstream supply chain.

To conclude, the case study integrates insights from the supply chain literature to further theoretical refinement of the SCT phenomenon. Theorizing grounded in resource orchestration provides flexibility for additional development or empirical testing, and it offers practical insight for companies that are being pressured for SCT. The framework we offer also opens up future research avenues related to the structuring, bundling, and leveraging processes. For instance, additional theory is needed to understand how partnerships are developed with BCT providers. Successful BCT implementation requires a well-organized supply chain between participants in order to integrate supply chain information (Behnkea & Janssen, 2020), and more research is needed to understand the mechanisms or incentives to establish BCT-enabled traceability. Finally, we illustrate a feedback loop in Figure 1 because resource orchestration involves continuous adaptation that aligns the management of resources with changes in the environment and new market opportunities (Sirmon et al. 2007). This feedback loop can be captured with a longitudinal examination of SCT.

CONCLUSION

Limitations and future research

A possible limitation of this research is the use of a single case because it constrains the generalizability of the findings, but we offer two points. First, single cases are appropriate when they represent a unique situation or when they reveal a previously inaccessible phenomenon (Yin, 2009). A small number of successful BCT implementations met this criterion at the onset of the study, but the numbers are increasing. This opens the possibility for future research on SCT to utilize a multiple case design to predict either similar results among replications or conflicting results based on theoretical reasoning (Ellram, 1996). Since this study was contextualized around an agricultural supply chain, a logical next

step would be to examine several BCT implementations as individual cases. The case context could be different kinds of agricultural supply chains or in other industries pressured for increased SCT.

The second point relates to the kind of generalizability that different research designs offer. When considering statistical-probabilistic generalizability concerned with the representativeness of the sample to allow for broader inferences, single case studies are limited. However, the goal of case study research is *analytical* generalizability, intended to expand a theory or concept rather than a context (Smith, 2018). SCT is a relatively new phenomenon that requires deeper conceptual and theoretical framing, which was the intent of the study. Future research should seek to empirically examine SCT with the goal of generalizing the results.

Another limitation of this study is the narrow lens for understanding SCT because we examined it through the context of a BCT implementation. This limitation is further enhanced because it involved a small startup technology company for a small Italian coffee producer. Future studies could build on these findings by applying the resource orchestration framework in varying contexts to examine the mechanisms operating within the processes. We expect that the structuring, bundling, and leveraging processes involve different managerial actions based on the size and resource availability of both the company and the BCT provider. Managerial action would also be different when there are varying degrees of product or supply chain complexity.

Examining SCT through the use of BCT is also a limiting factor. Companies can leverage SCT without BCT, so it would be useful for future studies to contrast how resources are orchestrated for SCT when BCT is not part of the solution. Additionally, this study was limited to addressing how BCT can facilitate SCT, but a successful implementation requires integration of the technology across all the members of the supply chain (Sternberg et al. 2021). This research did not address how CoffeeItalia convinced the cooperatives, importers, and shipping companies in its supply chain to utilize BCT. It most likely involved leveraging relational resources in the structuring and bundling processes, so that orchestration issue should be addressed in future research. Finally, we would offer that the traceability capability could enhance other supply chain outcomes as well. The resource orchestration framework would likewise be a useful theoretical perspective to understand how other desirable supply-chain related outcomes like agility, alignment and resilience can be enhanced by the use of BCT.

Implications for practice

Our study carries several managerial implications. We offer a first-hand account for managers to see how a company can achieve SCT through BCT. The processes for the acquisition of intellectual capital (i.e., structuring), the development of

BCT-enabled traceability (i.e., bundling), and the coordination and application of strategy to effectively communicate SCT to stakeholders (i.e., leveraging) all highlight the processes required for SCT. We explored what SCT looks like *in practice*, so companies under pressure to disclose their supply chain practices can gain insight about how to develop it. It also gives managers a use case that demonstrates how BCT facilitates a traceability capability. For small companies, especially those in the artisan community, the study highlights how SCT can be leveraged to allow them to compete with large corporations.

The alignment of SCT to the company's larger set of goals is also important to emphasize because managers must decide what information should be disclosed. That is, just because enhancing visibility or traceability may give companies the ability to disclose more information, the content and extent of the information disclosed should be consistent with the company's broader stakeholder management strategy. In the same vein, we illustrate how strategic decisions in developing SCT should be aligned with the value derived from offering it. For example, CoffeeItalia leveraged SCT to showcase the expertise, authenticity, and heritage in producing the product as a reflection of the value of artisanship in the company's products. While disclosing provenance information helped convey that, environmental and social information related to specific practices at the point of origin was not disclosed because it did not align with the value created by CoffeeItalia. Therefore, managers should approach SCT with the understanding that they should carefully consider the value creation of SCT to ensure alignment with strategic planning and the appropriate managerial action.

Finally, the study underscores that enhancing SCT requires investment and some level of exploratory learning, so it may be difficult to justify the "business case" for utilizing BCT. For that reason, we conclude with a brief discussion about the benefits of BCT that go beyond the enhancement of SCT for stakeholders. Foodchain reported to the research team that the BCT implementation has yielded a return on investment of 8%. CoffeeItalia increased production 20–25% due to increased operational efficiency, largely due to several benefits that come from BCT: (1) the time required to access data and documentation for transport documents reduced from 1 to 2 days to a few seconds; (2) the amount of raw materials meeting the standards for certification has increased by 5% relative to the amount of coffee produced; (3) the cost for the validation of a single transaction was reduced to being an insignificant amount of the final product cost (0.0015%); and (4) the number of errors has been reduced while the reaction time to error detection has drastically increased. In sum, this study supports previous research notes that BCT can also enhance operational performance (Franciso & Swanson, 2018).

Overall, SCT is an important supply chain outcome, and we are encouraged that the resource orchestration framework creates an avenue for more theoretically driven research. Further,

utilizing BCT offers more opportunities for disclosure, and it also allows companies to better detect poor practices in the supply chain (Corciolan et al. 2019). Importantly, the permanent tamper-proof record of supply chain transactions can potentially even deter unethical behavior or unsafe practices. For companies under pressure for SCT of raw materials, disclosing the provenance and processing of those materials can build trust with stakeholders and enhance responsiveness to address safety issues or environmental concerns.

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APPENDIX A

Interview protocol

Opening

- Introductions of interviewer and interview participant
- Overview of the purpose of the study
- Confidentially assurance/permission to audiotape

Demographic data

- Title/responsibilities/role of interview participant

Questions to address reasons for BCT implementation

- What prompted your firm to explore blockchain?
- What were the specific factors that initiated the decision to implement blockchain?

- How did you select the blockchain provider (i.e., Foodchain)?

Questions to address perceptions of problems or challenges

- What challenges/problems did your firm experience before the implementation that blockchain could help eliminate?
- What challenges/problems did your firm experience during or after the process of blockchain implementation?

Questions to address benefits and lessons learned

- What benefits have come from utilizing blockchain?
- How has/can blockchain enhance the relationship you have with your retail customers and other stakeholders?
- What were some of the experiences/lessons learned, and what advice would you share with others?

APPENDIX B

Data structure for resource orchestration structuring: Acquisition of intellectual capital

Second order themes	Representative data for first order categories
Assess industry future	It's wrong, you have to think in terms of research of seven, eight years, in the worst cases and throw yourself
	We have a future that is very fast and if we start to understand it maybe we have a chance. Of course, we must eliminate all these fears about the future
	We all know that in ten years' time this blockchain will have an incredible base of development. You might as well jump in. It's not about being visionary, it's about understanding and looking at what's happening in the world
	Try to understand that we definitely have to start to put ahead this concept, a blockchain in the future. Do you want to get on this train of the future yes or no? The later you get on it, the worse it will be. That's the concept
Search for Talent	My luck is to teach, for example, to always work with young people
	If we talk about blockchain and the future, we have to talk about young people
	The advice I would give is to use many young people, not to use old people like me
	Every so often I go to these incubators where there are the young people who are the future
Develop partnerships	The idea was born almost by chance, sincerely speaking, but, attending the environments, I did this hackathon, I said "let's try to do it, it seems an interesting thing."
	(Question): How did you select Foodchain? (Answer): Because we practically met in this hackathon
	During a hackathon at the incubator of the Polytechnic of Turin we traced, as a joke, two bags of coffee from the islands of Sao Tomè and Prince in three days. It was an experiment, logically in three days we have only laid the foundations of concepts and development, but, if you can do with it two bags, you can do it with two million
	From there we continued to develop and in 2017 we have an internal tracing that allows us to reach the bagging cooperative
	As I say, I steal from them and they steal from me. They need my experience, my knowledge, and I need them

APPENDIX C

Data structure for bundling process: Development of BCT-enabled traceability capability

Second order themes	Representative data for first order categories
Integrate supply chain information with technology	Our coffee supply chain is complex and very distant, we used to have to go to Kenya, Mexico, and Guatemala and ask for documents and register them, which was not easy. Now we developed QR codes of entry that go all the way upstream to enhance traceability. The operators upstream can now easily give us certificates of origin, customs certificates, health certificates, and transport certificates
	In addition to roasting, for example, we have storage and in storage we combine two, three raw materials to then make the mixture. These two or three subjects must be linked together through the blockchain
	These materials arrive, they are traces from the beginning, then I do the processing of the individual raw materials. Every single process is recorded on our internal blockchain and obviously will be available to the end customer
Engage in exploratory learning	During a hackathon at the incubator of the Polytechnic of Turin we traced, as a joke, two bags of coffee from the islands of Sao Tomè and Prince in three days. It was an experiment, logically in three days we have only laid the foundations of concepts and development
	More than an operational problem there were these eight interruptions because we created the program from scratch
	The QR code also created problems for us because we had to build the entrance. When the bags arrive, every sack of coffee has its QR code, but we did it, in the end we did a good job
	Stopping production at other times, starting from scratch, zeroing, while now running the whole platform, has had costs

APPENDIX D

Data structure for leveraging process: Utilization of BCT traceability for SCT

Second order themes	Representative data for first order categories
	Artisans with a blockchain can demonstrate that their product is truly artisanal and instead a multinational must apply a semi-artisan concept to their product
	The nice thing is that we can show the end user that he drank a high-end coffee, worked in certain ways and with certain procedures and did not drink a coffee from a corporation
	In some multinationals do you know what happens? They bring me the executives here to see how the coffee toasts. Do you know why? Because multinationals have only one trainer and everything is closed, you do not understand how to process coffee. It all goes through pipes, it's all boxed in, the machine works. We who are still artisans have all the visual stages. They think the coffee's going into a can and comes out ready. They have never seen a bag of raw coffee, or the activity of loading, or how the color changes over time
Align supply chain information to distinctive competence	We note that however it is also a great marketing operation, giving transparency. Logically, those who have a bad product will hardly make a blockchain or will be held with very low limits of transparency, because maybe he will not show everything that his product is
	He says: "I want to know who roasted it." Tac! In two seconds he knows who roasted him. "I want to know when the source was roasted, when it was shipped, when it was produced and sent to the shops or bars, to cafes"
	We are the only company that has all the data open to the public and that we provide to the customer
	In practice you have the security that this is Guatemala, that is Ethiopia, you have the origin of coffee and, in some cases, we have a botanical storytelling of that type of coffee
	Quality reports, the coffee selection report you [customer] had and everything… can be a great weapon for artisans
Communicate distinctive competence	I thought about the packages on the shelves, but the average consumer still does not know what it means QR code blockchain.. Apart from the fact that in my opinion this interactive sales totem will also become a normal thing for all the retailers
	The retailer must change with more projects by 2020. We are in 2020, we are no longer in the 60s of the shelf. Here there must be interaction, knowledge, transparency
	A step at a time. I think the most important thing is to finish the totem right now. It is the consumer who must have the interest; he has to begin to understand it in a not shocking way, but in a simple way
	In my opinion the interactive display is very important, because we are forgetting that the consumer is the final person and no one is worrying about it yet, in my opinion

APPENDIX E

Data structure for value creation from artisanship

Second order themes	Representative data for first order categories
Showcasing expertise	There's a very closed environment here. Everyone does their own, and moreover does not disclose it and is a problem. We have to tell everyone, not have this break. It almost seems that everyone is waiting for a medal for what he does, but they never tell anyone. Instead, the development of a project, even mine, is more fortunate if it is disclosed and made known to all, because it will certainly be improved and amplified and will also have greater success
	People should not be afraid to talk about research and to compare themselves with another company. Why not? you can only improve, this is the concept. It then creates a system whereby research becomes a very normal thing, indeed you become hungry for research because you know that then it can serve you
	What may seem like a Cinderella, a craft company with highly educated staff and not as generic as perhaps an S. p. a. [corporation], was the first to make a coffee blockchain in the world in 2016
	But the main problem is that research isn't known by everyone at 360 degrees. They [artisans] don't communicate with each other. It is very important to communicate because everyone needs the other
Establishing Authenticity	Although it may seem ridiculous, in my opinion a blockchain for artisans is an extra weapon. The artisans have an incredible product
	The damage from counterfeiting is enormous on Italian products.
	Its strong point is that it focuses on the product. We developed it especially for this reason
	With a simple click I show that that sack there is an original bag that comes from Ethiopia with health documents. If there is a problem, let's see if the ship was perfect. Do you understand? It's an enormous speed
	The blockchain is very useful also for export. If the Italian products that go abroad are tracked with the blockchain the foreign consumer says "Well, you have the blockchain? Then you are Italian." It is not so?
Preserving heritage	We are real craftsmen of coffee. We are a totally different reality from the rest of the world
	To give more history to a product, they try to give wrong information. The "artisan" concept is something to be taken into account
	They are moving a bit now because they have these Yankee invasion that arrived in Italy and they are a bit scared, but they are late
	There are those who still have not understood that big companies and multinationals are stealing the concept of craftsmanship