Blockchain technology, social capital and sustainable supply chain management

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Kunle Francis Oguntegbe - Nadia Di Paola - Roberto Vona

Abstract

Purpose of the paper: *This study integrates social capital and resource-based theories to expound on the contribution of blockchain technology to sustainability in supply chain management through the development of social capital.*

Methodology*: This study employs an abductive approach. Empirical data were obtained from six companies participating in the recently launched Italiafashion project (a disguised name to protect anonymity) in the Italian fashion industry. A qualitative content analysis was applied to data extracts from the six cases.*

Results*: Three key sustainability objectives firms pursue with the use of blockchain technology were identified; three propositions also emerged regarding the role of that technology and social capital in sustainable supply chain management.*

Research limits: *This study relies on a case study methodology due to its exploratory nature. Future studies could extend the investigation by considering a complete supply chain network with a higher number of observations selected from each category of stakeholders, and the possibility to use quantitative approaches.*

Practical implications: *This study identifies three key sustainability objectives (product safety, brand authenticity and strategic positioning), which could guide managers when considering the use of digital technologies for supply chain management.*

Originality of the paper: *A research framework is presented that illustrates the resource-based view of social capital in a digital supply chain management system. We argue that a blockchain-enabled supply chain system bolsters partnering firms with digital supply chain social capital such as improved inter-organisational trust, patterns of connections and shared understandings.*

Key words: Blockchain, digital supply chain, digital technology, fashion industry, social capital, sustainability.

1. Introduction

The emergence of digital technologies has brought substantial improvement to firm performance and global supply chains (Jabbour *et al.*, 2020). In the field of digital technologies, blockchain stands out as one that distinctly constitutes technological disruption with its potential benefits to business operations and general supply networks, which have recently stimulated research attention in the Supply Chain Management - SCM literature (Paliwal *et al.*, 2020; Di Vaio and Varriale, 2020; Nayak *et al.*, 2019). Blockchain has been recognised as enhancing safety, cost control,

traceability, provenance and security, among other benefits to supply chains (Kouhizadeh *et al.*, 2020). The essential drivers of sustainability in a blockchain-enabled supply chain have equally been identified to include quality, accessibility, safety and decentralisation of data, among other factors (Yadav and Singh, 2020). The ability of blockchain to reduce carbon emission as a sustainability goal in supply chains has been discussed in the literature (Wang *et al.*, 2020). However, there are other objectives of sustainability that have not received adequate attention in the blockchain/supply chain management research context. Hence, this study resolves to conduct an empirical investigation of the aspect of sustainability that has received the most significant attention from firms with regards to the use of blockchain for managing supply chains. Not only will knowledge in this regard deepen the understanding of blockchain/supply chain integration, but it will also be beneficial for supply chain actors to identify the core aspects of sustainability, with blockchain resources being concentrated for performance optimisation in supply chain management.

Any discussion on supply chain management would be incomplete without considering sustainability (Jabbour *et al.*, 2020), which is the alignment of the triple bottom line of societal (people), economic (profit) and ecological (planet) objectives with corporate practices and the central decision-making processes of partnering firms to improve long-term business and supply chain performance (Krumme, 2019; Orji *et al.*, 2020). Considering the influx of digital technologies in global businesses, modern industries can no longer be sustained by traditional frameworks and management models (Yadav *et al.*, 2020). The increasing concerns of sustainability along supply chains has therefore necessitated the discovery of new strategies and technological interventions that could produce efficient and innovative solutions to sustainability challenges.

Premised on their capability to facilitate intrinsic connections between an organisation and its customers, suppliers and other actors, as well as their potential advantages of market enlargement, security enhancement, process automation, transparency and provenance along the supply chain, digital technologies like social media, AI, robotics, IoT and blockchain have certain advantages for promoting corporate performance and for supply chain sustainability (Sanders *et al.*, 2019). Furthermore, if combined effectively, some digital technologies could be complementary, and this further enhances sustainable operations through resource circularity in supply chains (De Sousa Jabbour *et al.*, 2018). However, the capability of technological integration to transform supply chain management and facilitate improved sustainability has not been sufficiently explored (Chiang *et al.*, 2021).

Some studies have attempted to test empirically the separate effects of certain digital technologies on sustainable supply chain management (SSCM) (Nasrollahi, 2018; Di Vaio and Varriale, 2020; Choi *et al.*, 2018), and supply chain management areas have been identified to include new product development, sources, making, delivery, retail, return and governance (Macchion *et al.*, 2018). Notwithstanding, a lot still remains unknown about the contributions of digital technologies to supply chain management (Wei *et al.*, 2019), especially which of the identified elements

of sustainability receives the most focus from firms in the engagement of digital technologies. Additionally, digital technologies could constitute strategic resources through which firms gain capabilities (Shibin *et al.*, 2020). However, the path to the development of capabilities has not been sufficiently explored in the literature, particularly the role social capital could play in the development of competitive advantages from the use of digital technologies. For example, the competitive advantage added through the use of blockchain is ascribable to its innovative features like decentralised storage and the consensus mechanism of reaching business agreements that accentuate the relationships between supply chain actors, thereby improving social capital in the supply chain. Social capital improvement can be traced along three basic dimensions: structural, relational and cognitive (Zhang *et al.*, 2020). This line of reasoning is, however, yet to receive adequate attention in the blockchain/supply chain management literature.

It is on this note that this study chooses to explore the role of digital technologies in SSCM, and in particular to focus on blockchain technology, highlighting the aspects of sustainability that receive more attention from firms when deploying such technologies. Thus, the following broad research question is raised: what role does blockchain technology play in implementing an SSCM system?

This question will be addressed by examining the following sub-questions:

Q1: What are the top sustainability objectives firms pursue with the use of blockchain technology?

Q2: How does technological integration influence SSCM?

Q3: Which dimensions of social capital are embedded in a blockchain-based supply chain?

The aim of this research is to investigate the sustainability objectives on which firms concentrate their efforts when using blockchain technology, as well as the role of technological integration in SSCM. The topic is investigated in the fashion supply chain, which is very fragmented and looks for new solutions that are able to improve security, sustainability and transparency throughout the chain. The results of this study will expand the frontiers of knowledge on blockchain/supply chain integration in three ways. First, in response to the call for more empirical research on blockchain/supply chain integration (Wei *et al.*, 2019), the role of digital technology, namely blockchain, in implementing an SSCM system is examined. Second, the research question is empiricised using multiple cases selected from the newly launched Italiafashion, from which, to the best of our knowledge, this is the first empirical research study to draw data. Third, while this study is not the first to integrate the resource-based view and social capital theories (See Mora-Monge *et al.*, 2019; Hsu *et al.*, 2014; Rauch *et al.*, 2012), this study contributes to theory by applying the theoretical integration to a specific research problem contextualised in the blockchain/supply chain management system, thus responding to the call by Shibin *et al.* (2020) for a consideration of supply chain social capital in the resource-based view of blockchain-enabled supply chains. Accordingly, the social capital and resource-based theories are integrated

to explain the contribution of blockchain technology to SSCM and observe if supply chain social capital plays any role in this linkage. Therefore, this study deepens the understanding of how firms' resources (including digital technology) translate into capabilities and competitive advantages, and this study explores if blockchain is an important resource for developing social capital gains by supply chain firms.

2. Theoretical background

Digitalisation and blockchain technology in SSCM

Sustainable supply chains achieve stability in terms of the triple bottom line of economic, social, and environmental factors (Orji *et al.*, 2020), which entails paying enough attention to profit, people, and the planet (Krumme, 2019). As shown in Table 1, studies have recently explored SSCM and digital technologies. For instance, while some studies were conducted broadly on the role of industry 4.0 technologies in creating sustainability (Tuffnel *et al.*, 2019; Bag *et al.*, 2018), others examined the contributions of social media and big data (Jabbour *et al.*, 2020; Sivarajah *et al.*, 2020), while some explored the link between AI and sustainability in supply chains (Dash *et al.*, 2019; Di Vaio *et al.*, 2020). The last category of studies is those that focussed on blockchain, that is "a decentralized, distributed, anonymous, time-stamped ledger of data records" (Sharma *et al.*, 2019: 3). This group of studies includes systematic reviews of the literature to examine the contribution of blockchain to SSCM (Paliwal *et al.*, 2020), those studies that utilised a combination of case study and literature review to explore the antecedents of a blockchain/supply chain management system (for example, Di Vaio and Varriale, 2020), others that presented a concept for blockchain adoption in supply chains (for instance, Saberi *et al.*, 2019) and those that theoretically investigated the success factors for a blockchain-managed supply chain (for example, Yadav and Singh, 2020).

While the link has been explored between the individual digital technologies and SSCM, there is also the possibility of exploring the potential of integrating technologies such as social media and other associated industry 4.0 technologies to further enhance sustainability in digitally enabled supply chain management. Moreover, extant studies have established that the interrelation of digital technologies for supply chain management helps improve financial performance (Ardito *et al.*, 2019) and reduce supply chain risks (Ivanov *et al.*, 2019); nevertheless, there is room for further research on the integration of digital technologies into supply chain management (Jabbour *et al.*, 2020). Furthermore, the need has also been stressed for an investigation of the blockchain-SCM linkage using empirical data (Ardito *et al.*, 2019).

Studies have attempted to provide theoretical underpinnings for the utilisation of digital technologies and other technological innovations in building sustainability in supply chain management. For instance, in the field of engineering management, Choi *et al.* (2018) proposed the "systems of systems" theory for achieving a sustainable fashion supply chain, while Kusi-Sarpong *et al.*, (2019) employed a framework known as the

"best-worst multicriteria decision making model" for evaluating supply chain sustainability in the manufacturing industry. Two theories and one framework, technology-organisation-environment (TOE), human-organisation-technology (HOT) and the best-worst framework were utilised by Orji *et al.* (2020) to identify the essential success factors for the use of social media in creating supply chain sustainability in the freights and logistics industry.

Similarly, with a focus on blockchain, the barriers of digitally enabled supply chain have been investigated through the lens of the decision-making trial and evaluation laboratory framework (Kouhizadeh *et al.*, 2020). The effects of supply chain connectivity and information sharing on SSCM have been measured through a combination of the resource-based view and institutional theory (Shibin *et al.*, 2020), while performance improvements stemming from the acquisition and control of unique resources enabled by the integration of blockchain into supply chain systems has been examined through the theoretical lens of the resource-based view (Nandi *et al.*, 2020). Interestingly, on the one hand, blockchain has been recognised as strengthening supply chain social capital through collaborative inter-organisational relationships by improving trust between partners (Rejeb and Rejeb, 2020). On the other hand, studies have considered blockchain as a unique resource that supply chain firms could leverage to gain competitive advantages and performance improvements (Gölgeci and Kuivalainen, 2020). By extension, blockchain possesses unique features that aid the assessment of product quality, environmental accounting and social impact, thereby promoting SSCM (Kshetri, 2021). However, there is still room for further research regarding the pathways to sustainability gained through the strategic use of blockchain resources in supply chains. An essential consideration in this direction could be the role of social capital in SSCM (Nandi *et al.*, 2020). In particular, traditionally, through its influence on consumers' buying intentions, social capital has been recognised as a prime driver of sustainability (Kim *et al.*, 2020). Whether or not similar information could be empirically verified about social capital in a blockchain-managed supply chain system is yet to be adequately explored. Against this backdrop, it is conjectured that it is crucial to expand knowledge in the area of blockchain-supply chain management integration by examining, through an integrative philosophical lens of the social capital and resource-based theories, the role of blockchain-enabled social capital in implementing SSCM. Integrating social capital and resource-based theories will provide a theoretical background that further boosts the understanding of the process through which blockchain, as a strategic resource, contributes to sustainability in the supply chain system. Our reasoning is that blockchain has important characteristics capable of enhancing collaborations between partners (Wang *et al.*, 2020), thereby improving supply chain social capital within the digital system. Intuitively, digital social capital constitutes sources of capabilities for firms to edge out competitors and improve sustainability. Deepening knowledge in this regard could therefore provide novel means of expounding the sustainability gains arising from the use of blockchain for supply chain management.

Incidentally, the literature has stressed the need for more empirical research on how digital technologies promote sustainability in supply chains (Visconti & Morea, 2019), as well as the challenges firms encounter when utilising digital technologies to enhance supply chain management (Vona and Di Paola, 2018; Jabbour *et al.*, 2020). In light of this, the barriers to digitally enabled supply chains fall into four categories: technological, organisational, external environment and supply chain. It has been proven that technological and supply chain barriers are the most critical for both industry and academic practitioners (Kouhizadeh *et al.*, 2020). Despite these barriers, one critical consideration for the adoption of digital technology in supply chain management is its perceived benefits (Orji *et al.*, 2020). We deepen the theoretical proposition by empirically exploring the social capital gains stemming from the integration of blockchain into supply chain systems. This would enable the identification from an empirical perspective of the capabilities firms could attain with the use of digital platforms.

Tab. 1: Research trends for digital technologies and SSCM

S/N	Dimensions	References
1	Industry 4.0 and SSCM	Tuffnell *et al.,* 2019; Bag et al., 2018; Yadav *et al.*, 2020; Mastos *et al.*, 2020; Bhagawati *et al.*, 2019; Müller 2020;
2	Big data, social media and SSCM	Jabbour *et al.*, 2020; Sivarajah *et al.*, 2020; Chalmeta and Santos-deLeón 2020; Wang *et al.*, 2016; Tiwari *et al.*, 2018; Hazen *et al.*, 2016; Nguyen *et al.*, 2018; Singh and El-Kassar 2019; Bag *et al.*, 2020; Nasrollahi, 2018; Orji *et al.*, 2020; Tseng 2017
3	Artificial intelligence and SSCM	Dash *et al.*, 2019; Di Vaio *et al.*, 2020; Govindan *et al.*, 2019; Baryannis *et al.*, 2019; Sanders *et al.*, 2019; Dauvergne 2020)
4	Blockchain and SSCM	Paliwal *et al.*, 2020; Di Vaio and Varriale 2020; Nayak *et al.*, 2019; Saberi *et al.*, 2019, Cole *et al.*, 2019; Kouhizadeh *et al.*, 2020; Yadav and Singh 2020.

Source: own elaboration

Digital supply chain social capital

Social capital theory has transcended its origin in sociology to be relevant in the related fields of economics and business, and it has gained wide application in supply chain management (Johnson *et al.*, 2013) to explain how supply chain firms acquire capabilities through the deployment of valuable resources gained through strategic alliances with internal and external stakeholders (Yim and Leem, 2013). Social capital is a critical element of inter-organisational relationships such as those created between firms in a supply chain (Gölgeci and Kuivalainen, 2020). It refers to the valuable assets arising from access to resources made available through social ties (Nahapiet and Ghoshal, 1998). It is defined as the "sum of the actual and potential resources embedded within, available through and derived from relationships possessed by an individual or social unit" (Nahapiet and Ghoshal, 1998, p. 243). An individual or organisation's networks of relationship constitute valuable resources through which benefits are derived, including data sharing information access and synchronisation of activities (Kilubi and Rogers, 2018).

Three dimensions of social capital are identified in the literature: structural, relational and cognitive (Zhang *et al.*, 2020; Villena *et al.*, 2011). The structural dimension refers to the strength, pattern and frequency of connections between buyers and sellers. The denser the structure of social relations between supply chain partners, the more regular the connections between individuals in the network and the better the social capital. This connotes that a dense structural social capital helps supply chain stakeholders to collaborate more, and it provides a better medium for information exchange (Wu and Chiu, 2018).

The relational dimension of social capital involves the goodwill that is expressed in the form of the trust, reciprocity and friendship gained as a result of social interactions between buyers and sellers (Alghababsheh and Gallear, 2021). Relational social capital evolves from repeated interactions, which in turn enable trustworthiness among members of the supply chain network. Trust, therefore, is an essential element of relational capital as it reduces information asymmetry in the buyer-supplier relationship (Wu and Chiu, 2018).

The cognitive dimension has to do with shared values, codes, language and common understandings among partners (Barroso-Castro *et al.*, 2016; Lee, 2015). Supply chain actors have their rules of engagement spelled out in a formal contract to ensure orderliness in task execution targeted towards the realisation of their common goals (Jia *et al.*, 2020). Common understanding among stakeholders in a supply chain helps them share the same thinking process and establish uniform ideologies, thereby facilitating market exchange (Alghababsheh and Gallear, 2020).

Intentionally established networks, such as the supply chain, facilitate the accumulation of the relational, structural and cognitive dimensions of social capital (Ali and Gölgeci, 2021). It is important that supply chain firms create a dense social capital structure that enables a constant flow of knowledge and information sharing by building networks and maintaining frequent interactions, thus fostering cooperation (Gölgeci and Kuivalainen, 2020; Chu *et al.*, 2017). Likewise, the relational dimension of social capital is equally important to supply chain firms because of the need to develop trust and reciprocity from long term partnerships and repeated transactions, thereby reducing transaction costs (Villena *et al.*, 2011; Lee, 2015). In the same vein, supply chain actors need to pay attention to the cognitive dimension of social capital, which includes resources that help them develop shared representation, meanings (Polyviou *et al.*, 2019), goals, visions and understandings regarding the contracting rules and management principles guarding the network (Zhu and Lai, 2019). Therefore, building upon this theoretical foundation, the three dimensions of social capital present in a digital supply chain are investigated.

The literature has linked social capital to firm performance (Lins *et al.*, 2017; Barroso-Castro *et al.*, 2016; Krause *et al.*, 2007) and supply chain sustainability (Zhang *et al.*, 2020; Chu *et al.*, 2017). Social capital has also been acknowledged as one of the strategic resources that supply chain firms can leverage to create competitive advantages and hedge against risks (Gölgeci and Kuivalainen, 2020). The introduction of digital technologies into supply chains has given rise to digital social capital. Social capital is

generated from relationships through exchange (Nahapiet and Ghoshal, 1998). Similarly, supply chain social capital is created through relationships between supply chain partners (Yim and Leem, 2013); one way such relationships are serviced is through the exchange of information (Gölgeci and Kuivalainen, 2020). Digital technologies facilitate the exchange of information between supply chain partners, thereby strengthening the structural and relational dimensions of supply chain social capital. For instance, the blockchain improves the relational dimension by enhancing transparency, trust, safety and provenance in the supply chain, while social media applications such as Facebook, Twitter and Instagram affect the structural dimension of social capital by increasing the volume of transactions and the strength of social ties, influencing the pattern of connection between supply chain actors. Therefore, the term "digital supply chain social capital" indicates the dimensions of social relationships (in terms of connection pattern, inter-organisational trust and common understanding) between partners that are enabled by the use of digital technologies for supply chain management.

Conceptual model

The resource-based view, which takes its origin from the strategic management literature (Barney, 1991), holds that a firm can attain sustainable competitive advantages by harnessing its unique resources and capabilities (Das and Teng, 2000).

The resource-based view provides the best framework for explaining the pathway to competitive advantages gained through resources (Shibin *et al.*, 2020). Resources in a firm may be tangible (people, assets) or intangible (information, partnerships) and provide useful means for firms to attain capabilities. Studies have identified technology as one of the strategic resources that improves firm value (Sabherwal *et al.*, 2019; Lioukas *et al.*, 2016). Using the resource-based view, Nandi *et al.* (2020) model the performance improvement resulting from a blockchain-enabled supply chain system. We extend the theoretical proposition in this study by arguing that a blockchain-enabled supply chain system bolsters partnering firms with digital supply chain social capital such as improved inter-organisational trust, patterns of connections and shared understandings.

This is expounded on through a combination of social capital theory and the resource-based view. It is posited that the three dimensions of social capital could be accumulated from an integrated blockchain/supply chain system and that these include digital structural capital (connection patterns enhanced by smart contracts), digital relational capital (inter-organisational trust enabled by distributed ledger technology) and digital cognitive capital (common understandings enabled by the peer-to-peer mechanism through which blockchain operates).

3. Method

To answer the research questions, this study employs an abductive approach, which is a research process in which real life issues are explained

through an iterative juxtaposition between existing theory and empirical data (Nandi *et al.*, 2020). This approach becomes necessary since this study investigates a complex, emerging phenomenon in which data collection and the search for relevant theories proceeded simultaneously; hence, it is not fit for deductive or inductive approaches (Dubois and Gadde, 2002). Additionally, the abductive research approach is appropriate for this study since the aim is to make propositions that could aid theory development (Brodie *et al.*, 2017). Moreover, this study seeks to explore a phenomenon (blockchain implementation in supply chain management) that is still in a budding stage.

In line with the abductive research process, this research employs multiple case study analyses, an approach that has been employed in previous sustainability studies of this nature (see Formentini and Taticchi, 2016; Macchion *et al.*, 2018). Case studies are more suitable for answering how, why and what questions in exploratory, explanatory or descriptive research involving contextual conditions where little is known about the subject of enquiry (Baxter and Jack, 2008) as it allows the generation of valuable insights as well as testable propositions that can be subsequently subjected to further empirical validations. Moreover, findings from a multiple case study design are more convincing, and this type of study is generally regarded as more robust compared to a single case design (Yin, 2003). Exploring the contribution of digital technologies to supply chain sustainability using a multiple case study methodology would not only help explicate the pathway through which blockchain influences SSCM but also allow the replication of findings across cases and comparisons with empirical explanations for organisational differences in the use of digital technologies to foster sustainability objectives. Moreover, the specific sustainability objectives firms seek to achieve through the utilisation of blockchain for supply chain processes could be established from multiple sources, just as the role of technological integration in SSCM can be investigated.

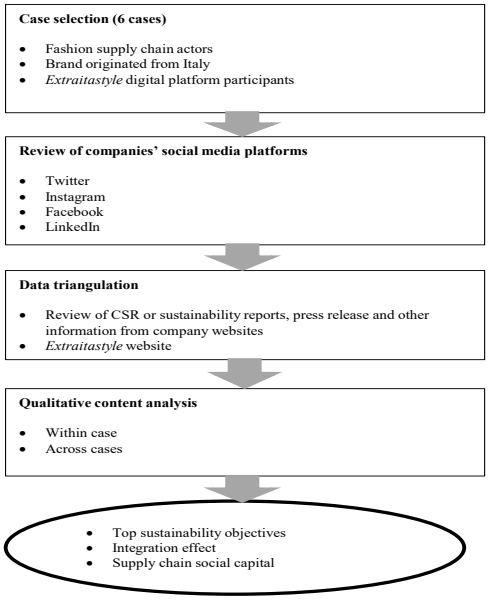
To contextualise the research question, the focus here is on the fashion supply chain, where sustainability is essential because of the heavily fragmented and globally dispersed nature of the chain (Choi *et al.*, 2018). More importantly, the adoption of blockchain is gaining importance in the fashion industry due to the need to ensure trust, security and transparency among supply chain partners (Macchion *et al.*, 2018). The significance of the fashion sector to the Italian economy cannot be overemphasised as the phrase "made in Italy" has become synonymous with the Italian luxury industry. To further promote the "made in Italy" brand in the United States of America and across global markets, an Italian institution recently launched a project named Italiafashion, a disguised name used to ensure anonymity. Italiafashion provides a digital platform consisting of a virtual boutique, 3D animations, social media integrations, music, and compelling stories in which designers, retailers, consumers and other stakeholders of the supply chain can connect for business transactions, whether B2B (business-to-business) or B2C (business-to-consumer). Hence, Italiafashion is considered a good proxy for technological integration because of its rich blend of digital technologies, blockchain in particular.

Against this backdrop, cases were selected from companies participating in the project.

Data for this study were collected in two phases. First, between March and August 2020, prior to the launching of Italiafashion project, the Twitter pages of fashion companies were tracked on an application programming interface known as "followerwonk" using the keywords "fashion", "blockchain" and "sustainability". To ensure that only firms operating in the fashion supply chain were captured, Twitter handles were regularly reviewed to verify the pages with information available on the companies' official websites. The second phase of data collection took place between September and October 2020, when Italiafashion was already operational. We focussed on companies participating in Italiafashion, leveraging the information available on the project website. Data collected from the platform were triangulated with other sources, including social media pages (Facebook, LinkedIn and Instagram), as well as the 2019 corporate responsibility and sustainability reports of the selected companies.

Following the methodological framework presented in Figure 1 and the procedure for conducting multiple case study research, established in Baxter and Jack (2008) and Yin (2003), cases were selected by focussing on companies operating in the fashion supply chain, specifically brands originating in Italy. The criteria for case inclusion were that the company should be participating in the Italiafashion project and, by implication, be a stakeholder in the fashion supply chain, and such company must be operating in a blockchain-managed supply chain system. The information obtained from secondary sources was continually reviewed to identify the firms that met these two criteria.

Fig. 1: Methodological framework



Source: (Adapted from Macchion *et al.*, 2018)

Following this process, from a total of 80 companies participating in the project, only six fashion brands made it into the final analysis. They are labelled A-F for the sake of anonymity, as shown in Table 2.

Tab. 2: Cases

Case	Year of establishment	Firm size (No of employees)	Digital technologies
A	1913	Large (14,000)	Blockchain, social media
B	1921	Large (13,030)	Blockchain, social media
C	1925	Large (3,000)	Blockchain, social media
D	1975	Large (7,309)	Blockchain, social media
E	1985	Large (519)	Blockchain, drones, social media
F	1978	Large (1,250)	Blockchain, social media

*Social media here comprises Facebook, Instagram, Twitter and LinkedIn.

Source: own elaboration

Using the keywords stated previously, the selected firms' social media and sustainability reports were explored for communications bordering on blockchain and supply chain sustainability. The data extracts were prepared and imported into Nvivo-12, where qualitative content analysis was performed.

For the data analysis, each firm's sustainability objectives were coded with respect to the use of blockchain. Other digital technologies the firms integrated with blockchain in their pursuit of sustainability objectives were also identified. Based on the measures defined in Table 2, the dimension of social capital embedded in the sustainability objectives targeted by the blockchain/supply chain system of each firm was identified. Table 3 gives a summary of the constructs and measures employed in this study.

Tab. 3: Constructs and measures

Constructs	Measure	References
Digital technology	Blockchain adoption	Saberi *et al.*, 2019; Kouhizadeh *et al.*, 2020
Brand authenticity	Product quality	Moulard *et al.*, 2016; Beverland *et al.*, 2010
Product safety	Risk level	Zhu *et al.*, 2019
Positioning	Advertising	Iyer *et al.*, 2019
Digital structural social capital	Social connection pattern	Gölgeci and Kuivalainen 2020; Lee, 2015;
Digital relational social capital	Trust	Villena *et al.*, 2011, Yim and Leem 2013
Digital cognitive social capital	Shared understanding	Barroso-Castro *et al.*, 2016

Source: own elaboration

A comprehensive assessment of sustainability objectives was conducted to identify the social capital measures contained in each. For example, a consistent indicator of relational social capital in the literature is trust (Weiss *et al.*, 2019; Zhang *et al.*, 2017); therefore, firms whose sustainability efforts are concentrated on improving trust were coded as being focussed on relational social capital, those with the core objective of reshaping the pattern of connection among the supply chain partners were coded as being

focussed on structural social capital while those with sustainability goals bordering around common understanding or mutual vision were coded as being oriented towards cognitive social capital. Again, the multiple data sources were continually triangulated to ensure the consistency of the findings. The previously identified sustainability objectives were further integrated with the social capital dimensions to develop the propositions.

4. Results

Top sustainability objectives targeted with the use of blockchain

With respect to the first research sub-question, from the case analyses, three categories of sustainability objectives emerged based on firms' use of digital technologies. These are product safety, brand authenticity and strategic positioning.

Product safety is the reduction in the tendency of a product to cause harm, illness, injury, death or other negative consequences to its intended users, property or equipment (Marucheck *et al.*, 2011). Product safety concerns are capable of creating disruptions in supply chains and can result in product recalls; hence, it is widely considered an integral sustainability objective in the fields of operations, risks and supply chain management (Speier *et al.*, 2011). With regards to the fashion industry, safety issues might arise from the use of adulterated supplies, such as harmful chemicals, poor production mechanisms or incorrect packaging in the preparation of textile materials. It is therefore essential for partnering firms to reach consensus on appropriate supplies, adequate packaging and acceptable textile designs with the aim of identifying likely negative consequences for corrective measures before production. Product safety as a sustainability objective that firms target with the use of digital technologies was drawn from sample data:

In order to promote widespread safety awareness, thanks in part to regulatory developments on this matter, the Company uses on-line safety courses with specific IT platforms that are easy and simple to use. (Firm#, sustainability report 2019)

Brand authenticity is a known strategy in the field of marketing and has been incorporated into supply chain management due to the increasing need to curb the problem of counterfeiting in supply chains (Li and Yi, 2017). In the fashion industry, counterfeiting results from deliberate changes to labels, poor branding and other unsustainable practices by one or more elements of the supply chain. Fashion firms therefore desire to safeguard their brands by ensuring that their genuineness is not compromised throughout its movement along the supply chain. Table 4 shows that the objective of brand authenticity is the most prevalent among the studied cases, as it is indicated by four (approximately 67%) of the companies.

Tab. 4: Sustainability objectives, digital supply chain social capital and data extract

Cases	Sustainability objectives	Digital supply chain social capital	Reference from cases
A	Product safety	Relational	'In order to promote widespread safety awareness, thanks in part to regulatory developments on this matter, the Company uses on-line safety courses with specific IT platforms that are easy and simple to use'.
B	Brand authenticity	Relational	'Protect your Brand from counterfeit, use Authlink to issue a verifiable certificate of authenticity to all products and safeguard your Brand.
C	Positioning	Structural	'Smart Contracts, Blockchain and hidden advertising on social Media" Conference at Brand# Exploring next generation solutions for luxury business. Great Job...'
D	Brand authenticity	Relational	'One of the best advantage of #BlockChain is that #Companies can ensure there is no counterfeit products reaches to any consumer.'
E	Brand authenticity	Relational	'Luxury Brands Authenticity Flourishing with Blockchain http://Blockchain.luxury Premium Domain For Sale.'
F	Brand authenticity Sample cases: 35.8%	Relational	'Agreed! Check out how Brand 1, Brand 2, Brand 3, Brand 4, Brand 5 use digital #authentication to protect consumers now. It solves the problem of #counterfeit links to #digital records, so when #Blockchain is ready for prime time, they are too'.

Source: own elaboration

Here is an example of data from which brand authenticity was identified:

Luxury Brands Authenticity Flourishing with Blockchain http://Blockchain.luxury Premium Domain For Sale. (Brand#, Posted on social media, 7th January 2020)

Strategic positioning, which relates to the development of new products or the discovery of new markets, refers to the way in which a business differentiates itself from its competitors and offers value to a specific category of customers (Guo *et al.*, 2018). In the contemporary business world, where competition is inevitable across supply chains, companies need to develop supply chain differentiation strategies either with respect to price, quality or design in order to increase their chances of long-term survival (Iyer *et al.*, 2019; Aktan and Akyuz, 2017). With more than 80 brands currently competing for the global market on the Italiafashion virtual boutique, positioning strategy remains key for supply chains to attain competitive advantage. An example of data from which positioning was identified as a sustainability objective targeted with the use of blockchain is the following:

Smart Contracts, Blockchain and hidden advertising on social Media" Conference at Fendi Exploring next generation solutions for luxury business. Great Job. (Brand#, Posted on social media, 31st January 2019)

Summarily, as shown in Table 3, In terms of the primary sustainability objectives sought by businesses in their use of blockchain to manage

supply chain systems, four of the six cases (B, D, E, and F) prioritise brand authenticity; one (C) specifies strategic positioning; while one (A) recognises product safety as key to its supply chain sustainability.

Effect of technological integration on SSCM

With reference to the second research sub-question, the Italiafashion platform facilitates collaborations along the supply chain, thus enhancing digital supply chain social capital by improving the pattern of connection and increasing the strength of social relations between supply chain stakeholders.

Prior to the launching of the Italiafashion digital platform, there existed a lack of integrated digital platforms for supply chain collaborations. However, with Italiafashion, supply chain collaborations are enhanced by the digital platform.

This is further illustrated by the sample data:

Of course, in the aftermath of the pandemic, with social distancing guidelines and travel restrictions still in place, this opportunity is a major boost for many designers. The digital discovery platform will also seek to help these bright stars grow their businesses in the United States by connecting them with the media, retailers, and consumers. (Italiafashion Website)

The Italiafashion digital platform represents a mix of digital technologies, allowing the exploration of the joint influence of integrated technologies on SSCM, taking references from the data extracts. The findings indicate that the Italiafashion digital platform facilitates supply chain collaborations, which is an indicator of supply chain social capital. By extension, improved collaboration is necessary to sustain the economic and ecological gains resulting from social interactions between supply chain firms. Intuitively, this connotes that technological integration improves sustainability in supply chain management by increasing supply chain social capital.

The importance of integrated digital platforms like Italiafashion cannot be overemphasised, especially in the post-pandemic period where there are social distancing guidelines and less physical interaction is required of businesses and their stakeholders. Essentially, because of the nature of traded goods, the fashion industry is one that requires more interactive and holistic digital platforms with which actors can visualise products and ensure provenance by tracking products' movement along the supply network. Consistent with the findings of Bertola and Teunissen (2018), an ecosystem of digital technologies helps firms to be more customer-oriented, maintain a good positioning strategy, and capture new markets, thereby making the supply chain more sustainable. Hence, a first proposition is made:

Proposition 1: Compared to individual digital technologies, technological integration is more likely to advance SSCM through improved customer orientation, better positioning strategy and increased market access.

Dimensions of social capital in a digital supply chain

In answering the third research sub-question, two dimensions of supply chain social capital were found in the blockchain-managed supply chain system investigated. These are here called digital structural social capital and digital relational social capital. The dimensions differ in the aspect of sustainability that enjoys the most significant focus by the firm in the management of supply chains.

Digital structural social capital

Digital structural social capital in this case refers to the blockchain-enabled pattern of connections and the nature of contracts existing within an organisation and its supply chain partners. Table 3 shows that one of the cases (C) is committed to improving the structural dimension of social capital by using blockchain to develop a positioning strategy for its supply chain. A major constraint on traditional supply chain management systems is the complexity of business processes brought about by the presence of multiple and geographically distributed actors (Sauer and Seuring, 2019). The blockchain, through its decentralised, peer-to-peer system, has brought considerable transformation to the pattern of connection in supply chains by removing the need for intermediaries and facilitating business processes, thus making the system less complex. Moreover, the smart contract feature of the blockchain, which is a set of rules guiding transactions between supply chain participants, operates through consensus mechanisms (Saberi *et al.*, 2019) in which transactions are ratified by all parties involved and no actor can alter business processes without the agreement of all partners. Moreover, with the digitised supply chain systems, buyers could trade directly with suppliers, thus significantly altering the pattern of connection and increasing the strength of social relationships between supply chain partners. Similar results were reported by Kim *et al.* (2021), who found that digital healthcare supply chains improve structural capital. Based on this understanding, a second proposition is made:

Proposition 2: Digital supply chain systems are more likely to strengthen structural social capital through smart contracting, which facilitates direct buyer-seller transactions without the need for intermediaries.

Digital relational structural capital

Digital relational structural capital has to do with the trust and reciprocity resulting from long-term partnerships. Supply chains are global in nature, involving the participation of several stakeholders, which reduces visibility and transparency along the chain (Di Paola, 2018; Ruta *et al.*, 2017). With the use of digital technology such as blockchain, transactions are managed in a distributed ledger technology that enables verifiability and transparency of business processes (Manupati *et al.*, 2020). More importantly, one of the critical issues blockchain addresses in supply chain management is a lack of trust between partnering firms and end users; blockchain ensures the creation of an immutable record of reliable data (Choi, 2019). The smart contract ensures that consensus is reached for transactions to be validated, and every partner has a digital record of the transaction. Similar advantages are available to end users as the blockchain enables them to verify the origins of products.

Table 3 shows that four of the cases indicate brand authenticity as their top sustainability target with respect to the use of blockchain. Embedded in the concept of brand authenticity is trust, which is a key element of relational social capital. This is because for a brand to be considered authentic, consumers need to have a certain level of trust, believing that the product must have been made with acceptable levels of honesty and transparency, without compromising quality and necessary ethical standards. To ascertain the authenticity of a brand, blockchain provides a robust, immutable system suitable for tracing the movement of products along the value chain. Another sample case (A) recognises product safety as of major concern in blockchain/supply chain integration. Zhang *et al.* (2020B) similarly reported that digital supply chains increase relational social capital. The blockchain enables the monitoring of business processes, thus ensuring compliance with safety standards by all supply chain entities and enhancing transparency and security along the chain. It is on this note that a third proposition is made:

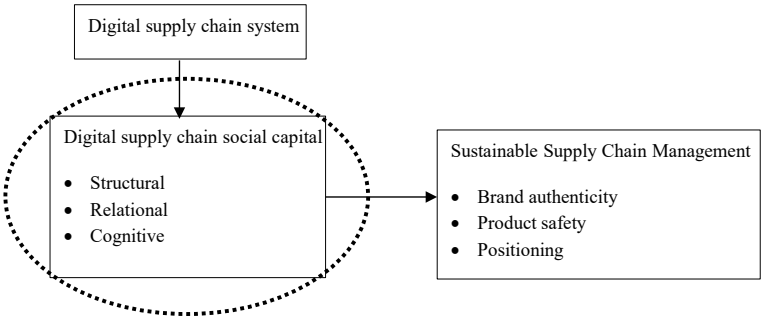
Proposition 3: By improving trust amongst stakeholders, digital supply chain systems are more likely to increase relational social capital than non-digital supply chain systems.

Integrating digital social capital with sustainability objectives

The digital social capital identified is further integrated with the sustainability objectives pursued by firms as identified from the cases. The results are presented in Table 4.

Table 4 shows that two sustainability objectives are associated with the relational dimension of digital supply chain social capital, and these objectives include brand authenticity and product safety, while only one sustainability objective (positioning) is connected with the structural dimension of digital supply chain social capital. Generally, the two sustainability objectives that are focussed on relational social capital are shared by five of the six companies considered in this study, which is an indication that firms may be more interested in using digital technologies to achieve relational social capital than structural social capital in their supply chains. Implicitly, inter-organisational trust is more important to supply chain firms than their patterns of connection.

Fig. 2: Resource-based view of social capital in a digital supply chain management system



Source: own elaboration

Figure 2 shows that the dimensions of social capital in a digital supply chain system are valuable resources that can be leveraged by firms to gain capabilities and are key to implementing SSCM as they influence the achievement of the sustainability objectives established in the supply chain network.

5. Discussion and conclusions

Employing a multiple case study approach, this study has explored the role of digital technologies, particularly blockchain technology, in SSCM through the integrated theoretical lens of social capital theory and the resource-based view. Secondary data were obtained from six fashion firms participating in the Italiafashion project by retrieving the information made available on their social media accounts, particularly Twitter, which was accessed using an application programming interface. Also, companies' Facebook, Instagram and LinkedIn pages were considered, triangulated with other sources such as sustainability reports, as well as the *Italiafashion* project website, to ensure that the information obtained was genuine. The results of qualitative content analysis conducted on the data extracts suggest that there are three top sustainability objectives firms seek to achieve with the utilisation of digital technology: brand authenticity, product safety and strategic positioning.

Of the three dimensions of social capital considered in this study, only two (structural and relational) were found to be relevant in a blockchain-based supply chain system. This suggests that blockchain has a profound influence on both structural and relational social capital, but its effect on cognitive capital might be negligible. The rationale behind this is that blockchain, through its unique features such as smart contracts and immutability, can influence the structural and relational dimensions of social capital but has little or no significant influence on shared meanings or common understandings among supply chain partners. A plausible explanation for this finding is that understanding is subjective and can rarely be influenced by a third party application or technology as it depends solely on the subjects. Hence, the influence of blockchain on cognition is rarely felt.

Although not a direct objective of this study, comparisons are drawn across cases to determine which of the three dimensions of social capital are of most importance to firms in the use of digital technologies. The results indicate that the relational dimension of digital supply chain social capital is more important to firms than the structural and cognitive dimensions. Hence, firms are more interested in achieving inter-organisational trust than influencing the pattern of social connections in their supply chains.

In line with the findings of this study, it is recommended that supply chain firms consider the blockchain as a key enabler of social capital and as a major strategic resource that could be integrated with other digital technologies to gain capabilities over competitors and promote the sustainability of the supply chain.

Theoretical and practical implications

This study, which stands at the intersection of digitalisation and SSCM, lends some relevant contributions to the theory and practice of sustainability in supply chains. As a theoretical contribution, this study has synthesised the social capital theory and resource-based view to advance a framework that explicates the contribution of digital technologies to SSCM through the development of social capital, culminating in the emergence of capabilities in an integrated blockchain/supply chain system. Furthermore, this study has also demonstrated that digital technology, specifically blockchain, through its smart contract, helps strengthen structural capital; improves relational capital through its immutability features, which boost trust among supply chain participants; and that technological integration enhances SSCM through improved customer orientation, better positioning strategy and increased market access.

Another theoretical contribution of this study is the advancement of the concept of digital supply chain social capital, which is defined as the dimensions of social relationship (in terms of connection pattern, inter-organisational trust and shared codes and languages among partners) enabled by the use of digital technologies for supply chain management.

As a practical implication, this study identifies three key sustainability objectives (product safety, brand authenticity and strategic positioning), which could guide managers when considering the use of digital technologies for supply chain management. Invariably, the sustainability objectives identified in this study could constitute the focal points for supply chain managers in the use of blockchain for promoting sustainability. Moreover, extant literature has identified blockchain as a strategic resource that firms can leverage to edge out the competition (Nandi *et al.*, 2020,). This study advances this school of thought by showing that the ability of blockchain to boost social capital and enhance sustainability offers a more lucid explanation to the competitive advantage gained through its use. Consequently, this new line of reasoning holds that the dual complementary roles of blockchain as a strategic resource and a key enabler of social capital help improve sustainability in the supply chains, and this could provide further incentives for stakeholders to consider investing in blockchain for supply chain management.

Therefore, blockchain is not just a vital technological resource but a means of accumulating social capital in supply chain systems, and it can be leveraged to attain competitive advantage. Additionally, this study illustrates the greater influence of integrated technologies on SSCM rather than engaging one type of digital technology. This encourages firms to consider multifunctional digital platforms that holistically incorporate the attributes of different technologies for the management of supply chains. For example, firms could engage blockchain alongside social media platforms to have a more sustainable supply chain.

Limitations and suggestions for further research

This study has certain limitations. First, blockchain remains an emerging technology with an abundance of anecdotes but few real-life use cases, even in the fashion industry where it seems to have gained prominence. Despite

the fact that this study considers a real-world experience, however future studies could extend the investigation by considering a complete supply chain network with a higher number of cases selected from each category of stakeholders. Second, this study relies on a case study methodology due to its exploratory nature. Another interesting avenue for further research is to consider a quantitative approach in which surveys could be conducted to collect primary data for a more robust empirical analysis. Particularly, it is suggested that the three propositions made here should be quantitatively investigated such that the impact of digital technologies on SSCM may be measured while also testing the mediating effect of social capital on the blockchain-SSCM relationship. In this regard, hopefully, pragmatic implementation of blockchain will have matured sufficiently in fashion and other industries in the near future, such that additional studies can heavily rely on interviews with supply chain managers to gain a better understanding of the roles of digital technologies in driving supply chain sustainability.

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Academic or professional position and contacts

Kunle Francis Oguntegbe
PhD Student
University of Naples 'Federico II' - Italy
e-mail: kunlefrancis.oguntegbe@unina.it

Nadia Di Paola
Assistant Professor of Management
University of Naples 'Federico II' - Italy
e-mail: ndipaola@unina.it

Roberto Vona
Full Professor of Management
University of Naples 'Federico II' - Italy
e-mail: rvona@unina.it

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