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Digital Fashion Revolutions: Supply Chain Transparency, Digitalization and the Non- Disclosure Paradox

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Abstract

The emergence of digital technology as a ‘cure-all’ for sustainable practice has captured the imagination of observers and entrepreneurs alike. Among these technologies, blockchain has been cited as the ideal tool to optimize supply chain transparency. However, despite the abundance of effusively disseminated information in the media, the lack of blockchain applications that are universally accessible, and their negligible uptake raises doubts as to its utility. In particular, small to medium enterprises (SMEs) have for several reasons been slow to adopt blockchain technologies. ‘Digital hesitancy’; lack of common data standards; complex and tedious data collection and transfer; immaturity of the technology; no effective universal platform; lack of resources; and reluctance to share data with perceived competitors are common obstacles. This study

explores one of these barriers to adoption, that is, the reluctance to disclose supply chain information to potential competitors. Taking a qualitative approach, the study analyses the current perception of blockchain enabled supply chain transparency through interviews with small scale fashion firms and technology start-ups. Applying a lens of technology adoption theories, the study seeks to understand how supply chain transparency might be satisfactorily managed and even accelerated through technology uptake. A misunderstanding of the software's capabilities is evident. Many firms seem unaware that the software can be applied to provide managed access to information—arguably providing an advantage over extant transparency measures such as public self disclosure or reliance on third party certifications. This study identifies that because of lack of 'education', firms are ill-informed and under-utilizing technologies that are potentially more advantageous than current analogue approaches—that could circumvent the information disclosure paradox.

KEYWORDS: supply chain transparency, small-scale fashion enterprise, blockchain, trade secrets, co-opetition

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Introduction

Since the Brundtland study in the late 1980s, fashion businesses have increasingly prioritized sustainable strategies (Brundtland et al. 1987). This study focuses on one of those strategies—namely, supply chain transparency—that is, raising awareness and communication of the provenance and processing of raw materials, products, and operations, from origin through to retail consumption and beyond (Båth and Ekberg 2020; Stumberg and Vander Meulen 2019). Transparency as a form of sustainable practice was chosen for this study because disclosing all areas of the supply chain, both up- and downstream, may limit irresponsible processes and prevent some of the fashion industry's detrimental effects (Bai and Sarkis 2020; Fish 2021). To meet their sustainability objectives including the ethical, environmental and social concerns disclosed through transparency, small to medium fashion enterprises (SMFEs) are exploring a number of tools and innovations including emerging digital technologies (Sunny et al. 2020). Artificial intelligence (AI), tracking, tracing, connection to the Internet of Things (IoT), and blockchain—are among these next generation, so-called Web 3.0 technologies (Flatworldbusiness 2017; Shirky 2010; Ray 2010). Web 3.0 is the third generation of the evolution of the World Wide Web, the foundational layer for the Internet. Web 3.0 has a strong emphasis on decentralized applications such as blockchain, as well as machine learning and artificial intelligence (AI) to drive more intelligent and adaptive applications (Shirky 2010). Yet, these complex, maturing technologies are sometimes difficult to deploy without adequate training, techniques,

approach, assistance, time, budget and/or workplace infrastructure (K&L Gates 2019; Kouhizadeh, Saberi, and Sarkis 2021). Moreover a significant amount of digital resistance exists—particularly regarding suspicions around information security. Additionally, the technology poses considerable financial and operational challenges to the small-scale firm—which questions the return on investment (ROI). Emerging digital technologies are increasing rapidly in other related sectors and within larger fashion enterprises, therefore the adoption challenges faced by small-scale firms merit investigation. Indeed there is a growing pressure felt by many SMFEs to keep up with market expectations and validate their sustainable operations, through real-time digital applications (Dickson and Chang 2015).

A number of obstacles stand in the way of technology adoption by businesses. Of concern are, security, privacy and the disclosure of commercially sensitive information. Commercially sensitive information or ‘trade secrets’ provide fashion companies a competitive edge. Trade secrets are proprietary methods, processes, or design IP that represent potential financial or market share gain, and remain undisclosed to trading partners and/or competitors (Steidman 1962). Transparency can be seen as increasing the danger of revealing business-related and personal information to competitors, including intellectual property, relationships and confidential processes. Thus, supply chain transparency presents a conundrum for enterprises that want to verify sustainability yet not reveal their commercially advantageous sources. As a consequence, blockchain-enabled supply chain transparency is perceived to threaten the industry norm of tightly held trade secrets (Zhou et al. 2022). This paper argues that transparency—or more specifically the correct management of transparency and disclosure—not technology, is the greater issue here. It contends that sufficient transparency can be achieved through a balance of openness and privacy—a feature well within the capabilities of the technology (Wang, Tao, and Wang 2021). Therefore, greater understanding of blockchain’s capabilities and safeguards are required—including a guidance and education pathway from analogue methods, to digital literacy and beyond to technology adoption. This study proposes to unravel the complexity and contradictions behind trade secrets and transparency and thus aims to contribute to the literature as well as the knowledge required by those responsible for sustainable supply chains within fashion organizations. As the fashion supply chain is facing a disruptive moment, exacerbated by the specific challenges of still maturing technologies—its transformation is viewed in this study from the standpoint of technology adoption theories (Rogers 2002; Davis, Bagozzi, and Warshaw 1989; Blut and Wang 2020).

This paper begins with a contextual overview of the fashion system and its relationship with global supply chain transparency. Then, theoretical frameworks of technology adoption are introduced in relation to

the digital transformation of the supply chain. Next, scholarly studies on blockchain technology applied to supply chain transparency are examined. The study arrives at the gap in understanding—how organizations are to reconcile secrecy and transparency if and when adopting blockchain and its related technologies. The methodology uncovers the challenges and the practices already undertaken by some firms, in order to gain insights for the broader industry and the future. Quotes from participants in the study are used throughout the paper to illustrate and evidence the current state of development. The study concludes with new understandings, recommendations, and areas for further investigation.

Large, medium, small, and micro enterprises

The fashion industry is divided by economies of scale, that is large and small scale—with each sector generating its own ecosystem of operational dynamics. Notably, medium, small and micro businesses, led by independent fashion designers and/or entrepreneurs, comprise the largest number of enterprises in the clothing and textiles industry (FashionUnited 2020; ABS 2012; Statista 2022). Although revenue is unstable, small fashion firm founders are passionate about their missions and increasingly regard purpose (such as sustainability) as the entrepreneurial driver (Heim 2019; Malem 2008; McRobbie 2004, 2015). As the SMFE is positioned in the middle of the TCF supply chain network, any changes, disruptions, or enhancements may favorably affect the rest of the sector up- and downstream, thus facilitating overall sustainability goals (FashionRevolution 2021; Payne 2020; Fletcher, Grose, and Hawken 2012). This study chose SMFEs as the object of investigation because of their agility, alternate value systems, and reputation as change agents—hypothesizing that this group is most likely to accelerate the change needed for transparency.

The success of SMFEs in accomplishing values-related goals is threatened by their lack of information, understanding, and education in areas other than fashion (Eaves 2014). The SMFE workforce is not necessarily trained in managerial practice (Fry, Faerm, and Arakji 2014) and has varying digital skills competencies (Van Laar et al. 2019; Heim 2019). Many fashion industry players are confused by digital technology and its deployment (Bye and Sohn 2010; Sheldon 1988). On the one hand, technology may prove to offer advantages that outweigh the deficits burdening small scale firms (Chalmers, MacKenzie, and Carter 2021). On the other, the challenge of facing more complex business operations as a consequence of technology adoption suggests support is needed for SMFEs.

Sustainability and transparency

Fashion causes social and environmental harm at several stages and through unmonitored processes (Niinimäki et al. 2020). Transparency seeks to provide visibility of these processes, increase stakeholder accountability, and thereby ensure good practice. Transparency addresses one of the biggest problems facing the textile industry—that is a lack of accessible information on sustainable (or unsustainable) practices along the supply chain (Thind and Jackson 2020), including social inequities and environmental damage (Kortmann and Piller 2016). Transparency is achieved by both tracking and tracing of goods, services and processes. Doorey showed in 2011 that allowing private NGOs and observers (like Fashion Revolution) to monitor and pressure company executives, can create learning and meaningful institutional change. In one study, Doorey (2011) traced Levi-Strauss and Nike’s journey from supply chain disclosure resistance to factory transparency. Nike and Levi-Strauss surprised the business sector by publishing their supplier lists as early as 1995, pushing others to follow suit. Activists believe factory transparency could increase corporate accountability for working conditions, ultimately improving labor policies. Simplifying and speeding up cross-border transactions and global relationships by tightening and standardizing compliance rules are further strategies required in a sustainable supply chain. Difficulties arise when each interaction requires administrative paperwork that is not shared with other parties up and down the line, is presented in different formats, potentially crosses border regulations, and is communicated in different languages. Currently, these operations have outgrown legacy systems and are ripe for disruption.

Theoretical Framework

The objective of this paper is to advance the understanding of emerging digital technology adoption by SMFEs—specifically blockchain for the supply chain in relation to information disclosure. In order to analyze the path to technology adoption, it is useful to refer to some of the theories that interpret the process of digital transformation. The Technology Adoption Model (TAM) developed by Davis, Bagozzi, and Warshaw (1989) in the 1980s, discusses the opposition to end-user systems as a prevalent issue in the process of digital transformation. In the 1990s, Rogers (2003) contributed the Diffusion of Innovations (DoI) theory which explains user reluctance in technology adoption laying out a number of phases from early adopter to laggards. Although these theories grew out of the pre and early eras of Web 1.0 and Web 2.0 and indeed much of the reasoning still stands, enterprises today find themselves in a position of having some knowledge and experience of software applications—but are now faced with the even more complex programs of Web 3.0—and their integration into existing (‘legacy’) systems. According to

Hoque et al. (2021) the literature lacks investigations of technology–organization–environment and institutional theories for the adoption of technology in the apparel industry. Therefore, an updated version of the Technology Readiness Index (TRI) by Blut and Wang (2020), is applied here as an additional framework to analyze transformational change. The purpose of the TRI is to measure participants' inclination to adopt and utilize cutting-edge technologies. The basic TRI model considers four dimensions that collectively describe technology usage: innovativeness, optimism, insecurity, and discomfort (Blut and Wang 2020). The TRI postulates that the firm now requires a number of measures on the path to technology adoption.

Blockchain for the supply chain

Before analyzing the transformational changes necessary, it is important to understand the proposed systems architecture—the blockchain mechanism. Media hype promises that blockchain will offer greater transparency and more accountability (Gartner 2020). These are disputable claims. Blockchain is a back-end information systems design that permits the exchange and visibility of transaction data. Three characteristics define it. First, operators generating a 'block' of data that can manage sharing and visibility. Second, once on the blockchain, data cannot be changed. Mathematically created rules prevent record alteration (Haber and Stornetta 1990; Nakamoto 2008). This principle provides an irreversible, secure, time-stamped record of data (Pilkington, 2016). Third, information is shared over a network, not in a single database. Its processes can entail hundreds of computers globally, as it is not expected to be stored on a single cloud-based server or organization (Reuters 2021). Importantly, blockchain does not guarantee supply chain transparency—it merely validates ledger entries. Data can be in the form of spreadsheets, databases, images, measurements or design papers. Blockchain networks can be public, private, permissioned, non-permissioned, or hybrids of these. Another capability—smart contracts, can offer self-managing transactional exchanges—such as the automatic payment of an invoice on import (Cao et al. 2020; Pilkington 2016). The content stored on the blocks as well as the activities performed by the various participants on the blockchain networks can be regulated based on the blockchain's configuration and its anticipated business purpose (Shobhit 2021). For this study, important distinctions are observed in these potential configurations. In a public blockchain, anyone may join and participate in the network's fundamental operations. A private blockchain permits only the entry of selected participants who have been verified—the operator has the authority to override, edit, or delete entries as needed. A permissioned blockchain possesses both private and public blockchain characteristics (Shobhit 2021). Permissioned blockchains have grown in popularity due to their ability to grant specific clearances to different network users and thus offer the potential to solve the

transparency/secretcy paradox. Blockchain has generated a cluster of topic specific jargon and competencies, somewhat alien to the lay person. Information Technology (IT) specialists admit that this backend architecture is composed of multiple complex and challenging data exchange components and is a specialist area within the Information Systems (IS) sector (Yaga et al. 2019).

How then is blockchain applied to the fashion supply chain—and more importantly how does it facilitate transparent and more sustainable or responsible fashion practice? Currently, information is recorded at various stages and in various formats along the supply chain—but intermittently information is lost, for example when cotton from various locations is mixed in a gin (cotton cleaning plant). Ideally blockchain offers the potential of an unbroken chain of information about the components within a garment. This level of detail may not be required at the moment, or by all stakeholders, but having the information and moreover the technical systems in place is important for potential future needs of cross border compliance, impending extended producer responsibility (EPR) legislation, the demands of more informed consumers and to verify sustainable practice, thus avoiding allegations of greenwashing. Without blockchain, it is difficult to communicate and share this information—if not impossible (FashionforGood 2019; Fibretrace 2019). This is one of blockchain's unique attributes. It proposes to bridge the information gap between systems and sectors, such as agricultural (Tier 3 suppliers), processing (Tier 2 suppliers), and manufacturing (Tier 1 suppliers). Currently, information recorded on paper or in non-interoperable digital files is lost because it is stored in multiple databases and specified using inconsistent terminology. Furthermore, this information is either not shared or accessible to other stakeholders on the supply chain. Certification schemes may preserve some information but are known in many cases to deploy flawed methodologies (Boiral and Gendron 2011; Brad et al. 2018), and do not offer real-time data.

Market tensions and the collaboration paradox

Blockchains need a network of willing participants for the system to work. In the opaque, competitive fashion sector, blockchain's function of connecting competing companies and outlets seems paradoxical. According to Sargeant (2017) and Arthur (2017), competitive advantage comes from perceived power and knowledge. Indeed, companies may avoid collaborating with rivals on a blockchain (Sternberg and Baruffaldi 2018). Ricciardi et al. (2022) demonstrate that the changing economic climate necessitates new corporate alliances and suggest that 'co-opetitive' collaborations are a more effective response to technological innovations. According to Ricciardi et al. (2022) planned, managed, and regulated, co-opetition can produce synergy. In one example, Egels-Zandén et al. (2015) assessed the Swedish retailer Nudie Jeans' aspirations to become the 'most transparent corporation in the world.'

Egels-Zandén et al. (2015) argue that three fundamental trade-offs, namely, threat versus collaboration, standardization versus differentiation, and means versus ends, determine a company's transparency outcomes. Egels-Zandén et al. (2015) add that managers must choose between a compliance or cooperation approach to supply chain transparency. The study also recognizes strategies and communication around disclosure. In another study, Jestratijevic et al. (2022) found the existence of four disclosure strategies: measurable, ambiguous, policy-only, and secretive. The above studies point to the complex power dynamics inherent in fashion supply chain disclosure and that transparency or information disclosure itself requires addressing—even before common data ontology or technology is applied.

Further questions include how an SMFE will 'join' a blockchain; how they will build relationships with their suppliers and entice them to take part in a blockchain; and how their blockchain will interact with other blockchains. Although suppliers and brands could benefit from the collaboration, it is an unusual request in a business relationship. Upstream and downstream suppliers may be able to work with current suppliers due to their existing relationship but are wary of unknown trading partners. Blockchain's influence, governance and regulation are also uncertain and may be another reason to resist 'outside influence' as inter-firm ties can be tenuous and closely guarded. Previous suppliers may become suspicious if new suppliers are added to albeit transactional but delicately balanced supply chain partnerships. A brand may not 'welcome' everyone.

Businesses fear having their sources appropriated or others taking advantage of discounted fees if they reveal their suppliers and producers (Radocchia 2018). Transparency can be used to deter price manipulation. Indeed, dynamic pricing markets profit from cost inefficiencies. This mechanism keeps markets competitive with participants such as suppliers and factory owners constantly negotiating, shifting deadlines and priorities to improve margins (Li 2020). Participants and counterparties are hesitant because too much transparency may expose pricing and hedging strategies. According to Båth and Ekberg (2020) supply chain openness can also affect business identity. Båth and Ekberg (2020) found that among 5 Swedish firms, corporate identity influences whether companies use transparency to conform, differentiate or exert influence, demonstrating the dynamic effect of transparency—beyond merely revealing sources. The Levi's and Nike cases above (Doorey 2011) and the Swedish (Båth and Ekberg 2020) case show that perhaps somewhat counterintuitively, transparency can also lead to market advantage.

These factors demonstrate the need for cooperation and enhancement of inter-business substructures, revised terms of cross-sector communication, competitor co-operation, and improved infrastructure between firms to optimize supply chain transparency in the first place. The above

contextual and literature reviews raise a number of concerns on the path to supply chain transparency—whereby this study is focused on the disclosure/transparency paradox.

Methodology

This study seeks to understand how SMFEs may safeguard their competitive edge through non-disclosure of commercially sensitive information while implementing supply chain transparency using blockchain technology. Following the technology studies frameworks (TAM, DoI, and TRI) qualitative interviews were considered suitable to gain knowledge on participants' willingness and level of disclosure as well as readiness for technology acceptance and adoption (Guba and Lincoln 1994). To this end, qualitative interviews were conducted with two stakeholder groups: Fashion firms and technology startups. These groups were chosen as central to the field of study. Fifteen interviews were conducted with the proprietors of small to medium fashion firms and/or suppliers, plus technology providers and software developers. Fashion firms were selected that demonstrated transparency values, for example through self-reporting of garment process and raw materials provenance and/or the reliance on certifications to verify their sustainable supply chain. The interviewees within the firms were chosen based on their knowledge and/or professional roles. Technology providers were selected based on their blockchain experience and/or offerings. Notably some firms are both fashion and technology producers—an emerging entrepreneurial phenomenon that is outside the scope of this paper—but warrants further investigation. It is important to note that blockchain is a small subset of IS and blockchain programming is currently a highly specialized skill within the broader IS industry (Yaga et al. 2019). Information on participants is outlined in Table 1. Participants are identified by position and number for anonymity.

In 45-min recorded video link interviews, participants were asked a range of questions around their core philosophies on sustainable supply chains. Questions probed their use and investment in technology; approaches to due diligence and disclosure of supply chain information, their relationships with competitors in the industry; and their recommendations for other small-scale firms who wish to implement technology to optimize and/or digitalize supply chain transparency. The interview data was interpreted using emergent theme coding after the recording was transcribed. In this way, core themes were identified based on response patterns and led to inductively arriving at grounded theory analysis (Corbin and Strauss 2014; Creswell et al. 2007; Thomas 2006). Themes arose across process and information flows, standardization, disclosure, skills and knowledge requirements as well as trade secrecy.

Table 1. Participant list.

Interviewee position and code	Industry	Business details
Proprietor 1	Fashion AU	Circular fashion micro label, niche market established 5+ years
Founder 1	Fashion AU	Manufacturing premium (certified ethical) denim, established 30+ years
Proprietor 2	Fashion AU	Importer (certified) sustainable products, established 15+ years
Founder 2	Fashion/Technology UK	Tech service provider of digitized patternmaking and garment fit software
Founder 3	Fashion/Technology AU	Textile waste recovery start-up, certified B-Corp
CEO 1	Blockchain Technology AU/CN	Platform that authenticates Australian beef provenance, security, payments; records transactions and incentivizes purchasing
CEO 2	Blockchain Technology	Platform that provides open source blockchain applications
Founder 4	Blockchain Technology AU	Platform that aggregates government and public resources such as citizen entitlements, registers and natural assets
Founder 5	Blockchain Technology AU	Blockchain start-up platform. Small-scale. Now closed
Consultant 1	Blockchain Technology IT	International blockchain platform in FinTech
Founder 6	Blockchain Technology/ Agriculture AU	Embeds nanotechnology particles into fibers for supply chain tracing. Also cotton farm proprietor
Proprietor 3	Agriculture/raw fiber producer AU	Cotton farm proprietor
CSR officer 1	Fashion UK	Mid-market, medium size manufacturer/retailer
CSR officer 2	Fashion UK	Mid-market, medium size manufacturer/retailer
CSR officer 3	Fashion UK	Luxury leather goods designer/ manufacturer

Findings

Applying the Technology Readiness Index (TRI) to the findings, Blum and Wang (2020) suggest TRI is most effectively characterized as a two-dimensional notion that distinguishes between motivators (innovation, optimism) and inhibitors (insecurity, discomfort). These play out in the three basic themes that emerged from the study. The themes point to a

lack of alignment on process and information (1) flows, (2) standardization, and (3) disclosure. In detail the study found misalignment of:

1. Process and information flows:
Blockchain information and processing flows do not align with supply chain flows. ‘Blockchain doesn’t see both sides,’ according to one participant (CSR officer 2).
2. Process and information standardization:
The global fashion supply chain has no standardized terminology. This is important because data must be ‘clean’ and standardized for information systems design to work (Cao et al. 2020). Many participants advocated for more ‘education’ on digitalizing the supply chain since, as one participant remarked, ‘blockchain is still a black box to a lot of people’ (CEO 2).
3. Process and information disclosure:

Not all stakeholders are willing to share their data. For example: ‘some retailers don’t share audit reports and very much keep them to themselves. Others are a lot more willing, so I think there is a big conversation around how we can do that’ (CSR officer 2).

Expanding on these themes, the comments offered by interviewees are analyzed below.

Theme 1: Process and information flows

SMFEs that were interviewed for this study have actively undertaken supply chain mapping for their Tier 1 suppliers (ready-made clothing/manufacturing) and are now working towards mapping Tier 2 suppliers upstream (textile weavers and finishers). However, they cite the power interplay with larger firms as a concern in gleaning information from their Tier 2 suppliers.

... our leverage with those factories is very, very small. It might be that they get two or three orders from us in a season, whereas obviously a bigger company will have more pull (CSR officer 1).

However, while firms remain cautious of exposing their information—they would prefer others to comply to facilitate the progression to transparency. Firms also see that as soon as upstream Tier 3 suppliers (raw materials, farmers, etc.) add their information to public platforms, it will be easier to connect the information through the chain.

It will become easier for people to get (information for) further down the chain as transparency requirements increase... that would obviously give you that traceability back to farmers and where that’s coming from. (CSR officer 2)

The firms find their supply chain mapping an onerous and time-consuming task that could be more efficient. Efficiencies could be facilitated through collaborations and sharing. Stumberg and Vander Meulen (2019) study on government procurement of textile products demonstrates that those who collaborate in consortia to maximize visibility and economies of scale can maximize their leverage. This aligns with many small firms' suggestions to build alliances not previously required.

It's very much at that Tier 2 level—where it's more about leverage and being able to ask those questions... if you could get the five of us together ... that's a much better prospect for the supplier and they are likely to go through the audit and provide the transparency information we can all share (CSR officer 3).

In attempts to improve the perception of their transparency reporting, stakeholders are looking to each other's publicly available due diligence information to add to their own disclosure statements. The due diligence process is also bringing strategic advantages to the firm:

...we also have a due diligence process in place looking at self-assessments, so we can decide where high risks are and what we need to do to make sure that we're monitoring those risk areas (CSR officer 2).

Regarding the mechanics of blockchain and its associated technologies, some are concerned with its feasibility—or more specifically, are concerned about the element of human error or potential mal-practice. For example, speaking of GPS trackers:

...the challenge with that is although it's on someone's phone and you can track their movements, we don't know if it's not been somewhere else, and they just brought it back into the factory... how well does technology adapt to that scenario and the fact that people are still entirely necessary (Proprietor 2.)

It's still entirely relying on the people in the process, so you've got to make sure that they are tracking it and tagging it, and therefore that's always open to an element of manipulation, which I think is also a challenge (CSR officer 1).

Others are concerned with the capability of the technology altogether. Following TRI's second characteristic—inhibitors (insecurity, discomfort) around 50% of the responses demonstrated hesitation towards the technology.

...with the fashion garment ... it's a lot more complex to bring that together and at the minute I don't think the technology is in the place that it needs to be for that to be feasible (CSR officer 2).

I just don't think the technology is there to be able to bring together so many different components and to make it kind of fully traceable ... it would be incredibly complex and quite confusing for people (Proprietor 1).

This has to do with the operators' understanding of the complexity of the industry and lack of understanding or information on how the technology can accommodate this complexity.

Theme 2: Process and information standardization

The SMFEs interviewed are persistently seeking standardized and affordable means to achieve their sustainability goals. All felt their businesses would benefit from these customer facing applications. Turning the conversation to blockchain enabled technology many would say— 'oh I'm no good at technology' or they would 'wait and see' what the others are doing. This points to the characteristic business phenomenon of market-competitor advantage (D'Aveni 2010) and suggests that uptake will only accelerate once a critical mass of other firms have taken on the technology.

I think it will be good to be able to utilise that technology to give us that visibility for longer, particularly with the new legislation coming in... just support us with giving us that end to end process from kind of farm all the way through (CSR officer 3).

Yet firms are already using more accessible technologies. QR codes and NFCs have been in circulation for some time and are offering the bridge to incremental digital transformation:

We do have a QR code, we put that on every label, the story of how our garment was made ... it would basically take me back to that product on our website where you could see the whole story—you can look up where the fibre was grown ... It's very manual and nothing like fancy or foolproof and you know there's a lot of room for error, it's not foolproof (Proprietor 1).

The emphasis here on fearing information error points to the undercurrent of existing angst in the fashion industry—that is the fear of being exposed for greenwashing (Delmas and Burbano 2011; Freeman 2012; Torelli, Balluchi, and Lazzini 2020). Yet the connection to blockchain's immutable system was not cited by the respondents, suggesting further knowledge on the attributes and capabilities of blockchain are required.

Theme 3: Process and information disclosure

Regarding sustainability credentials, some firms rely on certification agencies but have a fractured relationship here. For example, one founder complains:

It's a discussion we've been having with potential investors because they are basically saying why am I paying fees to these organisations for accreditations when we've got more than enough credibility based on what we've been doing for so many years. So, I see blockchain as helping us with the weight of the accreditations (Proprietor 2).

I've never had the resources to prove any claims that we've made on our supply chain, and we rely on that, but if blockchain can actually help us you know, not rely on those certifications and actually proved our social impact and minimising our environmental impact we would be interested. (Proprietor 3).

They are not convinced that the slew of certifications and sustainability awards their brand carries is any guarantee of firm success. Meanwhile, others point to the changing trend in willingness to share information.

Most of us are selling the same jeans and T shirts just with a different label in the back of them ... There's a lot less nervousness now around sharing that information ... we talk to the retailers regularly when we're in factories and we work with them to solve problems (CSR officer 3).

... we all know we work in everybody else's factories; but there's still lots of that secretive cloak and dagger stuff, like 'I'm not sharing my factory list with you because I don't really want to play with you' and that's the ethos from the 90s (CSR officer 2).

there are challenges to that because some retailers don't share audit reports and very much, you know, keep them to themselves but others are a lot more willing (CSR officer 1).

I can walk into any factory that I work with and see the labels of everyone else they work with. It is not a secret, you know. It just isn't. And it hasn't been for a long time ... At the end of the day, the majority of the rest of us are just selling jeans and T shirts (CSR officer 2).

Following the TAM model, the effort required to adopt the technology must not only be commensurate with—but significantly outweigh its perceived disadvantages to the firm.

I think if we could utilize the OAR (Open Apparel Registry) to kind of pull a collective of who's in each unit so we could then work together, I think that would be really helpful (CSR officer 2).

The pattern emerging here follows the TAM model, that is, that ease of access, affordability, and significant return on investment are factors that may entice a small-scale enterprise to adopt emerging technology.

That also allows us to share that information with suppliers with customers with other retailers and so that's obviously a centralised database which is entirely, you know, managed and independent, which makes that a lot easier for us, so it's definitely something that we are happy to carry on supporting (CSR officer 2).

Finally, the firms are very sensitive to watchdogs and allegations of greenwashing.

We know the NGOs are more likely to not be as hard on us because we are in the OAR and we have that kind of commitment to publicly putting stuff out there, which I think is useful (CSR officer 1).

... as a garment retailer you are expected to be on the OAR so we are. However, we are not just a garment retailer and 50% of our supply chain doesn't fall within the scope of the OAR and therefore ... we also publish a list on our website (CSR officer 2).

I don't think you can have greater transparency and just be comfortable having listed everything. I think you then need a good due diligence program in place to be monitoring that and understanding where the risks (of environmental and social harm) are (CSR officer 3).

The above findings provide evidence of the current state of supply chain digitalization within fashion. Factors affecting digital transformation include 'digital hesitancy' (Heim et al. 2022), and lack of digital literacy; lack of common data standards and preparedness for digital transformation; complex and tedious data collection and transfer; immaturity of the technology; no effective universal platform, or 'killer app'; lack of resources including time, costs, and priorities; and reluctance to share data with perceived competitors. These factors will be analyzed in the following section in relation to technology acceptance theories. Furthermore, analyzing the above data, some answers for the research

question are emerging, demonstrating how SMFEs can rationalize competitive advantage and sustainable practice through blockchain enabled supply chain transparency.

Discussion

Evidence is emerging that transparency and trade secrecy can be managed simultaneously—as can competitor collaboration—and that a willingness to do so does exist. However, although these changes appear to be evolving spontaneously, there is a call for more informed management of the digital transformation process. This means that although challenges of the complex Web 3.0 technologies are significant, each organization has a greater or lesser understanding of the capacities (and incapacities) of selected technologies.

Beyond technology adoption, there is a pressing desire to ‘share-and-share alike’. Despite some current limitations observed by participants in this study, open-source platforms are laying the groundwork for global collaboration and offering a ‘neutral,’ non-commercial zone for managed disclosure. These platforms, such as Source Map, Open Apparel Registry (OAR) and Provenance data capture framework (Provenance 2021) include free-to-use and/or affordable databases for the fashion industry. Even though these are not yet blockchain enabled, their data gathering mechanisms position them well for transfer to blockchain when the time is right. Further, the concept of managed disclosure may answer the paradoxical situation of supply chain transparency and need for competitive advantage. It is very possible for example to allow only a limited number of people above and below a firm’s position in the supply chain to disclose information. This may be sufficient because as one participant observed— ‘the customer just wants to know that we know’ (Proprietor 3).

The rise of blockchain and other mass data-based technologies has produced new opportunities but also new requirements for communication, engagement, collaboration, and understanding across players in the global fashion industry. Fosso Wamba and Guthrie (2020) remark that not only technical but process and relationship innovation can lead to company success. Relational innovation may involve a business policy, strategy and attitude change (cooperating and exchanging data with competitors). This appears to be taking place in the small-scale, values-driven sphere according to the evidence provided by participants in this study. Separate from relational innovation, process innovation might come from new resources, embracing alternative values, improving systems, adopting technology, or a combination of these elements. The study argues that the technology will provide the correct balance of disclosure—beyond the current analogue methods of either self-reporting or third-party certifications. Indeed, the technology can automate this ‘managed disclosure’.

Finally, many other Web 3.0 systems already exist that can be integrated into current networks—for example dynamic QR codes, product passports and digital IDs. Generating these digital assets are well within the capabilities of SMFEs and could be implemented immediately—offering a sense of transparency and digital inclusion and thus providing immediate customer facing solutions.

... we put QR codes under labels that give you more transparency in traceability as you go through the process. But obviously that would only give us visibility as it moves through the manufacturing process rather than from raw material all the way through, and I think that's where the gap is for us at the minute (Proprietor 1).

And

we have a take back scheme with a company ... and one of the things we've been talking to them about is if we put a QR code into our labels we could track it through our journey. They could then update that QR code when they get it, that would mean that they could then carry on tracking that product after it's left us and left our customer (CSR officer 2).

The results show that a combination of better understanding and 'education' is required for all stakeholders before the technology will be fully adopted for supply chain transparency.

I think it's just that—it's the educational piece around it. If you wanted to bring in something like blockchain, I think there's still misunderstanding.... I still don't really understand how this works (CSR officer 2).

Limitations and further research

Although this investigation has a limited number of participants, repetitions and patterns were beginning to emerge that provide some rigor to the study. Further investigation with more participants would confirm the results. The industry's stance on disclosing information appears to be splitting into two camps—those that share and those that do not. Some other hidden aspects have arisen, such as concerns around data management and regulation. These topics each merit deeper investigations as Web 3.0 technologies and their adoption evolves. Furthermore, some firms are emerging as both fashion and technology producers—a developing phenomenon that is outside the scope of this paper—but warrants further investigation. Importantly, further questions arise regarding the changing organizational culture shifts including

Technology Readiness and the increasing need for digital literacy and ‘education’. Indeed, many stakeholders are calling for guidelines or a roadmap to digital transformation.

Conclusion

This study sheds light on the changing dynamics of competitor cooperation within the context of disclosure/non-disclosure of trade secrets (supply sources) and supply chain digitalization. It confirms that blockchain can be a useful tool in managing this delicate balance but adds that potential users are unaware of Web 3.0 technology capabilities and limitations. Despite blockchain interfaces not yet being widely available to all supply chain stakeholders, and users not understanding its full potential, the system’s needs have taught lessons that can be adopted immediately, ahead of complete digital transformation. This process has already started with several SMFEs accessing and adopting the more user-friendly Web 3.0 related technologies such as QR codes and NFCs embedded in smart tags and sharing information on open-source platforms.

The study found that ‘transparency mindset’ is as pivotal as ‘digital mindset’. Among other factors, supply chain openness is a prerequisite for blockchain adoption, but firms are inconsistent in their sharing policies. This connection between users, software configuration and supply chain transparency requirements have until now been under reported. Yet blockchain could be an ideal instrument to verify supply chain information while providing a ‘disclosure management’ mechanism if implemented correctly—using the public and private key system. Thus, this paper argues that blockchain offers the potential of discretionary disclosure management and thereby may solve the transparency/secretcy paradox. However, most fashion supply chain stakeholders do not seem fully versed in its capabilities, which points to the need for greater understanding and ‘education’ on the technology’s capabilities. Knowledge is still to be gained once the more complex versions of the software are deployed. If (and/or when) blockchain technology is universally adopted, it may lead to revolutionary supply chain transparency.

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