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Courtney Chrimes and Hilde Heim

13 The Fashion Product Passport: In Search of the “Killer App”

Abstract: A “killer app” denotes any computer programme or software that is so essential or desirable that it demonstrates the fundamental worth of a larger technology. It is portrayed as virtually indispensable or vastly superior to competing products. Supply chain transparency (SCT) has long been ripe for disruption and in need of such a technological solution. Several applications have appeared on the market – but few have coalesced the complex tasks required for full transparency. To date, there is no “killer app” for fashion supply chain transparency.

Applications that facilitate SCT including tracking and tracing mechanisms as well as data repository and distributed ledger systems like blockchain are complex and daunting for most fashion businesses. Industry powerplays and lack of trust are blocking the universal adoption of current solutions. This chapter aims to explore how SCT can be adopted by firms and facilitated at scale. We advance current knowledge of digital technology applications for SCT through the theoretical lens of organisational culture to decipher how start-ups are developing technology for adoption by fashion firms. Using a single case study methodology, we analysed one hybrid start-up (fashion and technology firm) that has developed and implemented advanced digital technology initiatives at scale. From our case analysis, we provide insights into the requirements to build a digital ecosystem – one with which most firms are not yet familiar. We discuss key implications for theory and practise, based on our findings.

Keywords: Web 3.0, blockchain, supply chain transparency, start-up, organisational culture

Introduction

Fashion system operations including sourcing, production, retailing and waste management are notoriously opaque, in many instances concealing unethical and unsustainable practises (Bai and Sarkis, 2020; Bevilacqua and Adragna, 2019; Chashchyna, 2019). Fortunately, over the last decade, fashion supply chain technology has progressed considerably. Not only is it now possible to automate previously laborious operations, but new ways for making production more sustainable and circular have also arisen. The application of advanced digital technologies for digitalising the fash-

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ion supply chain is perhaps one of the most significant technological developments of the last decade (Agrawal et al., 2021; Chang et al., 2020; Choi and Luo, 2019). Among these digital tools, blockchain was originally designed to securely transmit digital assets (cryptocurrency), but it is now also being utilised to provide verifiable information on fashion products. While the potential of blockchain technologies has been recognised, and solutions are now available, scaling these approaches across the sector remains a challenge. If one large-scale implementation or the “killer app” succeeds, it may be the incentive to inspire others to follow suit. Indeed, the influence of this pivotal technology is reflected in emerging research streams, as well as the interest of numerous companies that are investigating its potential applications and associated technologies (Casino et al., 2019; Paliwal et al., 2020; Wang et al., 2018). While pilot studies are being conducted on promising applications, investigations and practise regarding the modification of existing models and the creation of new business models that are adopting advanced technologies are still under-researched. Few pilot applications have broken the universal adoption barrier. Consequently, to better understand how digital technologies can be leveraged to improve supply chain transparency we conducted case study research on one promising application.

Previous reviews of the literature have focused on blockchain-based applications (Paliwal et al., 2020) and the impact of blockchain technology on future supply chain practises (Wang et al., 2018). This chapter considers supply chain transparency as one sustainability strategy and the implementation of digital tools to facilitate transparency at scale. This study focuses on the intersection between sustainability, supply chain transparency (SCT), Web 3.0 technologies and the ecosystem required to develop and support its successful implementation. This research advances knowledge on digitalising supply chain transparency; develops the knowledge required to grow the supply chain eco-system to improve practice and develop new business models; and informs and encourages fashion firms to take part in the evolution of transparency and technology.

We propose to illustrate with the findings how companies can use advanced SCT technologies to innovate their business models. Through the case study findings, we propose the adoption of a digital ecosystem mindset that has four aspects: factory facing, brand facing, consumer facing and product facing. However, this advancement in transparency is only possible in a fashion system that is willing to share data, has a more balanced power structure and is more collaborative than the current norm (Heim, 2022; Jordan and Rasmussen, 2018). Therefore, cultural shifts are required at the organisational as well as the broader system level. While the findings show that significant progress has been made by one company, this could be because of its unique “hybrid” position as both a tech company and a fashion manufacturer.

Indeed, a number of these hybrid, “cross-disciplinary” business models are arising and showing success (Fibretrace, 2019; Doyle et al., 2022). In doing so, they demonstrate the need to develop a digital ecosystem, in which fashion and tech companies work hand in hand in a mutually beneficial relationship – as if one company. The findings may also suggest that fashion companies of the future should equally be tech

companies if they are to be successful. Conversely, the demand for increased supply chain transparency is a significant growth factor for the success of advanced technology start-ups (Francisco and Swanson, 2018). Finally, providing universal access to this hard-won tech has become a race to be first-in-market for tech companies. This explains in part the lack of universally accessible platforms that have not yet found the ideal business model to generate revenue. To answer the ubiquitous question “who will pay” we suggest that the costs be shared – that the client pays ultimately for sustainable production and the tech company for developing the tech – which they may retrieve through subscription as a service (SaaS) revenue or similar and that the brand contributes to both costs.

This chapter begins with reviewing the current literature on supply chain transparency and the advanced digital tools that have emerged in the last decade that facilitate transparency. It presents several pilot studies during that time that have offered proof of concept/ feasibility studies and arrives at the gap in current knowledge, that is, the information and implications of full implementation of the technology at scale. We discuss the single case-study methodology applied to this research as well as the theoretical constructs underpinning the research. We present our case as an exemplar of a “killer app,” discuss the challenges and opportunities encountered, findings, discussion and conclusion.

Literature Review

Supply Chain Transparency (SCT)

The United Nations’ sustainable development goals (UNSDGs) are a “blueprint to achieve a better and more sustainable future for all” (UN, 2020). Sustainability measures are generally categorised into three pillars – economic performance, social performance and environmental performance. Economic performance calls for economic viability and consideration of finite resources. Social performance requires a democratic system that safeguards the rights and needs of all stakeholders. Environmental performance calls for ecological protection. Considering these three pillars, supply chain transparency (SCT) offers one of many sustainable strategies. SCT is a fundamental component of good corporate governance and facilitates the development of trusting relationships with a company’s business partners by monitoring corporate efforts to achieve economic, social and environmental sustainability. Transparency is achieved through sustainability reporting, a form of internal monitoring, management and external communication that enables organisations of all sizes to satisfy the expanding information requirements of their various stakeholders. Relationships with local communities, protection of human rights and corporate governance are among the key reporting areas. In addition, transparency helps strengthen the internal capacity to engage the entire orga-

nisation in defining a corporate sustainability strategy, establishing public targets, implementing plans and evaluating results (Chashchyna, 2019). From the perspective of the customer, product information such as origin, production, modifications and chain-of-custody provides much-needed assurance (Montecchi et al., 2019). According to Casino et al. (2019), it is anticipated that research into technologies that facilitate reporting and transparency will contribute to the United Nations' sustainable development goals and support businesses in becoming more sustainable.

Digitalising the Supply Chain for Transparency

Fashion firms are investigating several tools and innovations including emerging Web 3.0 technologies to digitalise and thus improve supply chain transparency (Sunny et al., 2020). Web 3.0 consists of technologies that facilitate connectivity and communication between a multitude of devices. Artificial intelligence (AI), tracking and tracing mechanisms, connection to the Internet of Things (IoT) and blockchain are among the so-called Web 3.0 technologies required for digitalised transparency (Flatworldbusiness, 2017; Shirky, 2010; Ray, 2010). Transparency begins with tracking the journey of products from raw materials to finished goods (Casino et al., 2019). Consumer preferences regarding three technological systems supporting traceability, namely Near Field Communication (NFC), Radio Frequency Identification (RFID), and Quick Response (QR) codes, differ due to the cost impact of adopting these complementary technologies. “Infotracing” refers to the integration of product attribute information and traceability information (Figorilli et al., 2018). This can be accomplished by employing a variety of technologies; first, the original fibres must be identified, and second, the data on the fibres must be entered, stored and retrieved before they can be separated and assigned to various processes further downstream. Fibres can be identified through textiles embedded with electronic sensors (see Loomia.com), electronic product codes, RFID tags, NFCs or QR codes and more recently DNA nanotechnology markers – in which the fibres are embedded with tracking capability. Geo trackers and DNA markers can be applied when sourcing the raw fibre on farm, and processing yarns (Fibretrace, 2019). IoT devices such as RFID Threads (CirCloLink, 2022) can be added during garment production and provide information about the products' movements through the distribution system (Blackstock and Lea, 2014; Chanson et al., 2019; Majeed and Rupasinghe, 2017). Once this is accomplished, data can be associated with the identifier and stored on the blockchain. This not only provides upstream information on the supply chain, but also provides information to end-of-life recyclers (Morlet et al., 2017).

Beyond tracking and tracing, blockchain technologies can chronologically record and store transactional data in a transparent, tamper-resistant and standardised format that is accessible to all (and/ or selected) parties involved in the transaction. The blockchain structure contains a secure, verifiable ledger of all transactions. Applications and

transactions that previously required centralised architectures or trusted third parties to verify them are now able to operate in a decentralised manner with the same level of assurance through robust, auditable and secure capabilities (Agrawal et al., 2021; Anjum et al., 2017; Bevilacqua and Adragna, 2019). Blockchain technology is the component of Web 3.0 that ensures the validity of traceability, transparency, trust, fault tolerance, immutability, tamper prevention and data integrity. A supply chain that uses a blockchain-based solution reaps these fundamental benefits. Within the supply chain, where a lack of trust is a significant barrier to collaboration, the potential for blockchain to foster trust resonates strongly (Heim, 2022; Tapscott and Euchner, 2019). From a supply chain perspective, “trust” has been identified as the blockchain’s most significant advantage (Cottrill, 2018). A blockchain can eliminate the need for users to provide conventional forms of proof when exchanging information, which could lead to considerable efficiencies. Blockchain ensures that everyone has access to the same version of transactional ledgers, thereby preventing disputes (Ghobakhloo, 2018). Blockchain networks can store a variety of crucial data types and provide digital identities. Digital identities can be applied to products – known as Product Passports (Adisorn et al., 2021). Therefore, the digital identity can serve as the primary transparency mechanism for supply chain stakeholders (Mainelli, 2017).

Fashion companies are investigating these technologies because they believe them to have the potential to decentralise their software and reduce transaction costs as they become inherently more secure, transparent and in some cases faster and more economical. By compiling and verifying information, Web 3.0 technologies facilitate the straightforward implementation of transparency features between multiple parties. According to Ko et al. (2018), Web 3.0 technologies are a recommended tool for sustainability in the manufacturing sector, due to their real-time capabilities. In turn, this has prompted businesses to rethink traditional business practises, resulting in innovative blockchain-based business models. However, despite the growing number of applications and inventions, no universally accessible application exists to date. Platforms, such as Source Map, Open Apparel Registry (OAR), and the Provenance data capture framework (Provenance, 2021), provide the fashion industry with accessible and/ or affordable databases for supply chain information. Even though these are not yet blockchain-enabled, their data collection mechanisms position them well for eventual transfer to blockchain. This also demonstrates that the current SCT Web 3.0 technology landscape is currently a work in progress and seen as fractured – therefore fashion firms remain sceptical as to their utility. This study, therefore, focuses on a successful implementation as an exemplar of good practice in Web 3.0 adoption and derives implications for industry.

Industry Applications: A Contextual Review

The capabilities of Web 3.0 technologies sound ideal in theory, but there are currently only a small number of applicable scenarios. Those that do exist are found among large scale fashion enterprises conducted as beta pilot studies. For instance, the technology company VeChain collaborated with fashion brands such as H&M to develop pilots with digital tags that utilise blockchain technology to secure supply-chain tracking and assist customers in verifying manufacturing information and authenticity (Gates, 2019). Other pilots include the British-grown Alpaca wool for the Martine Jarlgaard label and the Swedish Asket shirt (Asket, 2021), where technology is used to verify idealistic marketing claims of sustainability, provenance and authenticity. Tech company FibreTrace is collaborating with Melbourne jeans manufacturer Nobody Denim to verify sustainable practice; tech company Labrys (Brisbane) is working with textile waste recovery firm BlockTexx to create a fibre token; TrusTrace (Sweden) is adding blockchain to QR codes on garment labels for the fashion brand Residus; LUKSO (Berlin) is developing a mobile application. IOTA, an Internet of Things technology provider, is collaborating with luxury brand Alyx to develop “Tangle”, an alternative protocol that can run multiple transactions simultaneously. Ethereum is the open-source platform that enables most supply chain protocols.

Zalando partnered with EON, a New York technology start-up that provides the digital foundation for identifying selected products throughout their lifecycle and enabling future resale, repair, reuse and recycling. Via an app named redeZIGN, each piece in the collection is fixed with a QR code that serves as a digital product passport (Heim et al., 2022). The dynamic code directs customers to a product website where they can obtain more information about the item’s origins and after-sales services. This includes information such as the manufacturing facility and the materials used. Customers can also find more detailed care instructions, including videos, and ways to prolong the life of their garments, such as returning them to the pre-owned section of Zalando (Zalando, 2021).

Web 3.0 technology adoption is hampered by entrenched interests and other technical factors such as scalability, significant energy consumption and trust. Investment in server infrastructure and the addition of specialised resources for development and governance discourages companies from adopting advanced technologies beyond the proof-of-concept stage. Given the “digital hesitancy” and combined barriers to adoption observed among firms (Heim et al., 2022), this study proposes two research questions:

RQ1: How can digital technologies that facilitate supply chain transparency be leveraged?

RQ2: How can supply chain transparency be facilitated at scale?

Methodology: Case Study

To answer the research questions, we adopted a single case-study methodology, a common approach when exploring real-life business settings (Yin, 2009). Indeed, prior research posits that a case-study approach should be employed when there is a need to acquire an in-depth appreciation of an issue and/ or phenomenon of interest in its real-life context (Yin, 2013; Yin, 1994; Crowe et al., 2011; Stake, 1995). Thus, this approach was deemed beneficial in the context of this study, which aims to investigate how Web 3.0 tools can be applied at scale to facilitate SCT (Ko et al., 2018). Moreover, case study methodologies have been widely adopted within supply chain literature, evidencing the provision of insights into real-life practices in particular industries, such as fashion (Shen and Chen, 2020; Ye and Lau, 2018). It is important to note that case-study approaches have received criticism relating to the lack of design structure (Meyer, 2001) and so, to alleviate this issue, our study adhered to Yin et al.’s (2013) procedure for employing a robust case study methodology; specifically, the selection of the case study, sampling strategy and selection of data collection procedures. A detailed outline of such an approach is delineated in the proceeding section.

Selection of Single Case Study

We have chosen a single case-study methodology because we aim to take a positivist approach. Based on case-study findings, testing and refining of theory are frequently emphasised (Crowe et al., 2011). This involves deciding in advance which variables to examine and determining whether they correspond with the findings (Shanks and Parr, 2003). Moreover, the application of single case-study approaches has been corroborated by prior supply chain studies (Genovese et al., 2014; Leigh and Li, 2015; Shen and Chen, 2020), signifying the usefulness of single case studies for enabling the researcher to question theoretical structures and explore a deeper understanding of the subject (Dyer Jr. & Wilkins, 1991). As already addressed and discussed within the literature review, the *a priori* variables we wish to examine and that have already been established in prior literature concerning digitalising the supply chain are:

Challenges, e.g., cost implications, scalability, lack of resources, lack of trust (Heim et al., 2022; Openlink, 2018; Fitzgerald, 2006; Von Hippel, 2005; Gartner, 2019; Kumar et al., 2017; Boiral and Gendron, 2011).

Solutions, e.g., proof of concept, technology enabled firms, connecting and collaborating (Heim, 2022; Garcia-Torres et al., 2021; Macchion et al., 2015; Gold et al., 2010).

Sampling Strategy

We have chosen the case of applications developer PaperTale as it is one of few firms that has successfully leveraged several aspects of advanced digital technologies at scale, creating a “product passport” application, allowing us to delve deeper and produce richer insights into this unique case. The firm is distinctive because it is both a tech company and fashion manufacturer. In the words of the founder, regarding the hype surrounding digital technologies for the supply chain:

The promise hasn't come true. So, we want to take the lead in that. And if we are able to, create a business model – which is not easy – we would like to address the challenges and share knowledge.

PaperTale provides behind-the-scenes information on fashion products to various stakeholders along the supply chain. The application achieves this through the implementation of a digital eco-system, built on a public blockchain to ensure complete supply chain transparency. Brands' customers can see that the workers involved in each “PaperTale'd” product are being fairly compensated, and that each product was made with limited environmental impact. The information provided is based on science and extensive research, guaranteeing verified information. The information is not owned by anyone – it is decentralised, meaning that once it has been entered and verified it cannot be altered.

Data Collection and Analysis

We conducted an in-depth, semi-structured interview with the CEO of PaperTale based on several prepared questions concerning the history of the company, motivation behind the app development, pilot studies, challenges experienced, solutions sought and the envisioned future of PaperTale. We then proceeded more informally, asking probing questions enabling the participant to elaborate on the answers provided. Probing questions further allowed the participant to inadvertently mention important topics that may have been missed. The interview took place online via MS Teams for convenience, as the participant resides in Sweden. The interview lasted two hours and was recorded (with the respondent's permission) and transcribed as soon as the interview was terminated. Thematic analysis was employed to analyse the data, adhering to the Template Analysis approach proposed by Brooks et al. (2015). Template Analysis uses hierarchical coding providing a high degree of structure when analysing the transcribed data while still preserving the flexibility to adapt it to the needs of the study (Brooks et al., 2015), thus data were coded according to key themes identified from the literature review.

Hence, the following procedural steps were followed: 1. identification of a priori themes (identified challenges and solutions concerning SCT established in existing literature); 2. familiarisation of the dataset; 3. preliminary coding of the data; 4. emerging themes placed into meaningful clusters; 5. finalise the template and apply it to the data set (King, 2012; Brooks et al., 2015). Template Analysis was chosen to analyse the case-study findings as it allowed the researchers to establish a priori themes already established in SCT literature, enabling us to focus on key areas potentially relevant to the study and advance existing theory concerning how digital technology can help facilitate SCT.

Theoretical Lens

Organisational culture theory has proven to be a key influencing framework in studies focusing on supply chain management and innovative information systems adoption (Gong et al., 2022), yet its application for investigating the ability of blockchain to facilitate SCT at scale is lacking. Organisational culture consists of the unwritten rules that influence individual and group behaviour and attitudes, as well as the way an organisation conducts its business. The organisational structure, the system and processes by which work is performed, the behaviour and attitudes of employees, the organisation’s values and traditions, and the management and leadership styles adopted can all influence organisational culture. According to Caldarelli et al. (2021), “the type and culture of the company play a determinant role”.

Organisational culture theory consists of a collection of shared assumptions, values and beliefs that are reflected in organisational practises and goals and help members understand organisational functioning (Black, 2003; Deshpande et al., 2017; Khazanchi et al., 2007). It influences the way the firm responds to external events and makes strategic decisions (Deshpandé and Farley, 2004; Zammuto and O’Connor, 1992). In the extant literature, scholars have proposed various alternative ways to classify organisational culture, including relation- and transaction-oriented culture (e.g., McAfee, 2002) and flexibility-control orientation (e.g., McDermott and Stock, 1999; Khazanchi et al., 2007; Boyer and Lewis, 2002). In this study, we adopt the framework of flexibility-control orientation from Quinn and Rohrbaugh’s Competing Values Model (CVM) (1983), and the Competing Values Framework developed by Cameron and Quinn (2011). The framework posits that there are four classifications of organisational cultures:

1. **Adhocracy** – highly flexible and externally focused. Managers are forward-thinking, innovative and risk-taking.
2. **Market-orientated** – highly controlled and externally focused. Managers are focused on winning, and employees are goal focused. Higher market share remains the utmost priority.

3. **Bureaucracy** – internally focused and inflexible.
4. **Clan** – highly flexible and internally focused. Clan culture is posited to resemble a group of like-minded people. Managers are viewed as mentors.

Using the Organisational Culture Assessment Instrument (OCAI), a method for assessing organisational culture, the Competing Values Framework is populated with evaluations of the company's present and future state. Considering this theoretical framework, we propose that to facilitate SCT at scale, there needs to be an organisational culture shift towards an adhocracy culture, which focuses on flexibility, innovation and experimentation, all of which are valued deeply by management as well as employees (Gong, Jiang, and Liang, 2022). Indeed, this organisational culture is a direct challenge to current bureaucracy and market-oriented culture, which are viewed as barriers to innovation and collaboration.

Findings and Discussions

PaperTale is a Swedish tech company founded by Bilal Bhatti, the now CEO of PaperTale, in 2019. When questioned about the motivation behind the company, Bhatti detailed his first-hand experience of the corruption, inequalities and forged certifications that occurred in fashion factories. Before discussing PaperTale's solutions to current challenges facing SCT, it is important to note that PaperTale investigates sustainability from two aspects, social performance and environmental performance:

In terms of environmental sustainability, consumers can view each step of the process [which is] based on the consumptions of the materials. The system calculates the amount of CO2 and water used to produce the product.

Now the social aspect [. . .] the app connects the people with the product. We want to make sure the technology is creating red lines, like no slavery. Our systems verify workers age, gender, and wage type [. . .] and if it's above the minimum wage.

This points to the values driven rather than market driven organisational culture of the business.

The proceeding section analyses the challenges and proposed solutions concerning digital technologies facilitating SCT through the theoretical lens of organisational culture as outlined above. The three main themes found were: cost implications, scalability and competition.

Cost Implications: The Challenge

The cost implications associated with investing in Web 3.0 technology to help facilitate supply chain transparency have been well documented in prior academic literature. Indeed, research has revealed that the predominant reluctance for mass adoption pertains to the high investment costs and complications associated with reaching full global traceability (Boiral and Gendron, 2011; Garcia-Torres et al., 2021; Kumar et al., 2017; Macchion et al., 2015). Currently, the majority of fashion brands adopt a market-orientated organisational culture, aiming to purely sell to customers in pursuit of profit (Gong, Jiang, and Liang, 2022). Unsurprisingly, it was apparent from the interview that cost implications for firms wishing to adopt the technology were found to be an inhibiting factor for PaperTale in achieving mass adoption:

There has to be a cost, and nobody's willing to pay that cost. That's the challenge.

It's not our cost that's the problem here because we are probably gonna add maybe -3% of the production cost on the product level [. . .] but brands don't want to absorb this cost themselves.

Within an adhocracy organisational culture, costs are secondary yet require absorption. However, it is apparent from the interview that presently stakeholders (i.e., manufacture, brand, and consumer) are all reluctant to absorb the cost.

Cost Implications: The Solution

When questioned about which stakeholder should absorb this cost and whether PaperTale could provide a solution for clients who express this concern, the founder detailed PaperTale's regenerative business model, or “what we [PaperTale] call a digital eco-system”. The founder emphasised the various value propositions that stem from this new regenerative model for all three stakeholder groups (consumers, factories and brands). It was apparent from the interview that the development of a new regenerative business model emerged in response to the well-documented hidden frauds experienced in the supply chain, including unfounded claims made by factories and exploitation of workers:

The current [conventional] business model is fractured and based on fake claims [. . .] traditional certificates are very easy to buy and sell and so, [factories] could buy them so that they don't need to do much on ground and can still get a very nice grade.

PaperTale proposes a new Regenerative Business Model, which is built on the principles of transparency and incentives within the supply chain. The more transparent a business is, the more money it should make.

PaperTale has developed a digital ecosystem focusing on four aspects: factory facing, brand facing, consumer facing and product facing. Their cloud-based platform veri-

fies factories that are compliant with current and future economic, sustainability and governance (ESG) laws and regulations, making them more desirable to brands who, via this mechanism, can confirm assets and environmental performance resulting in the optimisation of resources. This solution thus provides an answer to Research Question 1. Consumers can also derive value from the app by scanning a unique NFC tag developed by PaperTale and view the journey of a product from where each step is verified automatically on a public blockchain. It is to be noted here that the app only traces the product from manufacturer to consumer at this point. Developments are still required upstream (to fibre origin) and downstream to waste management. It is for this reason that the founder calls for a digital eco-system. The founder outlined the benefits for each stakeholder in accessing and using a digital ecosystem, justifying an increase in overall production costs:

Factories can charge brands more as our technology helps factories with being compliant with ESG laws and regulations. Factories can also use the ecosystem as a channel for direct interaction with the end customer.

By using PaperTale, brands can charge consumers more for products as it allows them to map out and control their material assets and supply chains, making compliance with current and future ESG laws and regulations easier.

PaperTale empowers the consumers to make informed buying decisions through radical transparency [. . .] the data shows consumers now want to pay more for sustainable products.

Hence, it is apparent from the above discourse that PaperTale's current digital ecosystem offers value to all stakeholders (factories, brands, and consumers), providing an incentive for brands to invest and innovate their current business models. Interestingly this demonstrates how a firm with an adhocracy culture can influence a market-driven company – and is demonstrated in PaperTale's pilot with a Swedish fast fashion company (see “Scalability” section below). At the same time this finding also responds to the call for urgent research into how companies can encourage stakeholders within the supply chain to adopt blockchain (Cole et al., 2019). To answer the pervasive question of “who will pay”, we suggest that the client is incentivised to pay ultimately for sustainable production and the technology company (e.g., PaperTale) for developing the appropriate technology, with the brand sharing some of both these cost positions. This finding suggests that by implementing technologies, such as AI and blockchain, a company can transform its cost structure by optimising logistical streams and shortening the supply chain. Our findings suggest that to facilitate SCT at scale, cultural shifts are required at the organisational level by demonstrating the advantages of adopting a digital ecosystem mindset, whereby fashion and tech companies work collaboratively.

PaperTale do hope to recoup their costs, but currently that seems secondary – and another adhocracy trait. In the case of PaperTale, blockchain technology acts as a “value-add” component of their business model – whereby manufacturing and selling

garments is still the profit-making core of the business. In this way the case demonstrates a twofold benefit to the company: first, it is possible to see tech as a value-add addition whereby the costs of R&D are absorbed and second, this can be achieved through mutual arrangements within a robust digital ecosystem in which players are offering mutually beneficial contributions to developing solutions. The finding that organisations are willing to go beyond their usual market approach to find reciprocally constructive synergies extends the literature on the Competing Values Framework in the context of fashion supply chains and technology.

Scalability: The Challenge

Despite the potential of blockchain being widely acknowledged, scaling Web 3.0 technologies remains an abstruse issue amongst industry practitioners and scholars alike (Caldarelli et al., 2021), with some describing the battle for overcoming the issue of the “blockchain’s moon race” (Kenny, 2019) – the start-up phenomenon of aiming to be first-in-market. While scalability lacks a clear definition within literature, Khan et al. (2021) note that the scalability issue surfaces due to the increasing number of nodes and transactions in the blockchain and as a result public blockchains demand a vast amount of computational power, high bandwidth internet connectivity and a vast amount of storage space. Specifically, Schatsky et al. (2018) claim that the main hindrance to adopting blockchain technology was due to its slow transaction processing speed, limiting its utility in the context of large-scale applications.

Scalability: The Solution

From the case-study findings, it is apparent that PaperTale has already developed and successfully tested the app with SMEs, including Swedish companies Gina Tricot and Sail Racing (arguably market-oriented organisations), providing proof of concept:

We had one pilot with Swedish brand Gina Tricot [. . .] which is like a fast fashion business but is quite a young brand [. . .] we made a collection with them here in Sweden. The Government factory was in Sweden and the supply chain was dispersed from Cotton Australia to mainly in Pakistan [. . .] that was a very successful project where they were able to raise the prices and sell it instantly and they [Gina Tricot] were super happy with that. They became our first test case where [we realised] the system can work actually.

The founder further detailed the successful collaboration with another Swedish brand, Sail Racing, in producing over “9,000 pieces with mixed materials”. On the Sail Racing website, consumers can download the PaperTale app and scan the NFC tag provided on the label to see the garment’s entire product journey and the total impact

of the product (PaperTale, 2022). Given the aforementioned success stories, the participant stated that PaperTale is now at the point of scalability, whereby they have partnered up with a large fashion corporation, Levi's denim manufacture in Pakistan:

[This partnership] will showcase that our technology can be implemented from a smaller supply chain to a bigger supply chain.

To our surprise from our first stage of analysis, we figured out that application is a lot easier to implement in a bigger supply chain than a smaller supply chain and so, we are currently building some things to integrate with companies' ERP systems, so the plug & play part, that's exactly what we are building now.

This partnership with Levi's shows PaperTale's ability to provide a promising solution to facilitate transparency on a large scale, directly challenging the barriers outlined by Schatsky et al. (2018). Yet, it is important to note that this advancement in scalability is only possible in a fashion supply chain that is willing to share data, has a more balanced power structure and is more collaborative than the current norm (Jordan and Rasmussen, 2018; Heim, 2022). Indeed, as noted by the founder:

Technology is not the challenge here. We have already built the base [. . .] we are now dependent on the vehicles [brands] to launch it to the market. We need some participation from forward thinking brands.

Needing participation from "forward thinking brands" shows that PaperTale recognises its own (adhocracy style) organisational culture – and is seeking "like-minded" organisational cultures. This finding also addresses Research Question 2. It is apparent that SCT can be facilitated and achieved at scale but for now, while the technology is still in development, only through collaborating with like-minded business partners. Indeed, based on the data, we recommend that fashion companies need to be open to the prospect of working and collaborating with tech companies as opposed to seeing technology as a "last-minute solution" to issues surrounding SCT. The current lack of technological resources in fashion companies was further alluded to by the interviewee:

Even very big brands don't have an in-house tech team and even if they have some members, it's all about the web shops, you know like basic levels. The good thing that our team has, we are a bunch of three types of people, textile engineers, tech[nology] engineers and researchers.

While this section highlights the significant progress that has been made by PaperTale, the success to date may be a result of the company's unique position as both a tech company and a fashion manufacturer. Indeed, prior literature has evidenced fashion brands' current lack of infrastructure and organisational culture required to effectively implement Web 3.0 technology.

Fashion companies often rely on sourcing a tech consultancy company to help implement digital technology. The findings from this case study also revealed that blockchain technology should not replace current systems – including legacy enterprise management (ERP) systems – but instead be integrated with existing systems. Thus, to

achieve SCT at scale, PaperTale suggests fashion companies develop a digital ecosystem mindset, enabling fashion and tech companies to work hand in hand in a mutually beneficial relationship. The findings further allude to the prospect that, as Venkatraman (2017) suggests, fashion companies of the future should equally be tech companies if they are to be successful.

Increased Competition: The Challenge

Findings from the data also demonstrated that, as there is still no universally accepted standard on blockchain implementation to date (Caldarelli et al., 2021), competition between various tech companies offering to provide traceability solutions is mounting. Indeed, providing universal access to this hard-won tech has become a race to be first-in-market for tech companies. This increased competition has led to a new phenomenon known as tech-washing – the practice of placing a current buzzword on pseudo-tech solutions:

[. . .] before there was an era of green washing based on [unverifiable] certificates and now I see another era of tech-washing coupled with green washing because there are now a lot of solution-based tech companies now. They're just starting to use the traceability solutions and use words such as blockchain and AI just to sound more techie but, in reality they don't have implementations.

So, what is happening is digital green washing – you're putting exactly the same information that you used to do before and just including keywords e.g., traceability and transparency and launching it to consumers.

Gong, Jiang and Liang (2022) revealed that when organisations with a market-orientated culture attempt to transform towards a less market-outcome-focused organisation to pursue an environmentally friendly mission, this change is often met with scrutiny given the cultural history of the company. This does not appear to be the case with PaperTale. The company demonstrates its adhocracy organisational culture in which innovation is key; constant innovation is necessary to maintain market presence. Team members are encouraged to strive for innovation and use their creativity to generate new ideas in a work environment that is dynamic, entrepreneurial and creative (Cameron and Quinn, 2011). In addition to being innovators, managers are also risk-takers. These organisations aspire to be market leaders and/or innovators of new products and/or services. Therefore, they encourage individual initiative and provide the freedom to choose which tasks to complete.

Increased Competition: The Solution

The findings suggest that a more collaborative approach is called for within the industry. Indeed, the participant acknowledged that although PaperTale has been open to collaborating with others to facilitate SCT on a global scale, other parties are reluctant to engage due to concerns relating to Intellectual Property (IP):

We have not explored it [collaboration] much to be honest [. . .] even if we are open, we don't see that other parties are open. I've been in some conversations, but I don't see the real intention because there is a challenge of IP here.

So, until we solve this problem of collaborating properly everybody will be out. We have to find a solution to collaborate [. . .] if we can find a way of respecting each other's IP, then we should be able to. For example, we try to find like-minded people and who add [value] so we don't need to invent the wheel on every aspect.

Therefore, although there is an appetite for SCT, stakeholders are presently operating in silos due to IP concerns, evidencing current bureaucracy and market-orientated organisational cultures which are highly controlled, inflexible and resistant to collaborative change (Gong, Jiang, and Liang, 2022; Cameron and Quinn, 2011). Wang et al. (2010) found that when organisational readiness for new technology is high, management and staff are more likely to initiate change, exhibit greater commitment and engage in collaborative behaviour. Hence, to facilitate SCT at scale, culture must change both at the inter- and intra-organisational level to embrace innovation and flexibility. Consequently, we propose that as PaperTale have already designed, developed, tested and successfully implemented blockchain technology on both small and large supply chains, this should incentivise other parties to adopt a digital ecosystem and follow suit.

Summary and Future Considerations

This chapter adopted a single case-study methodology to answer pressing research questions addressing the leveraging of digital technologies that facilitate supply chain transparency at scale. The authors of this chapter suggest that if fashion companies wish to partake in achieving SCT authentically, then the entire culture of the organisation needs to transform from a market-orientated culture towards a more adhocracy-orientated culture, focusing on innovation – or at least collaborate flexibly with such an organisation. Organisations not only need to connect with “like-minded” business partners – but more importantly with tech companies i.e., non-fashion firms that share the same values and best practice to achieve sustainability goals. It seems to us that both tech and fashion firms are willing to undertake research and development – for their individual benefit – as well as for the greater good. The findings show that significant progress has been made by one company, PaperTale, who have developed

a digital ecosystem that has four aspects: factory facing, brand facing, consumer facing and product facing.

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