

INTRODUCING TRACEABILITY AND TRANSPARENCY IN THE TEXTILE VALUE CHAIN

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ABSTRACT

Traceability is defined as the capacity to monitor and trace data. The implementation of traceability within a supply chain can lead to increased transparency throughout the entire process. This text describes a traceable and open supply chain management system for textile manufacturing and retail, utilizing cutting-edge technology for the global context. The manufacturing chains employ multiple commonly available centralized solutions for ERP Systems, where multiple bottlenecks are encountered at various stages, resulting in a lack of traceability and transparency. Supply chains are prone to a variety of serious issues, such as data manipulation, Single point of failure, etc., which can lead to a lack of traceability, delays, and the inability to share information in real-time. Blockchain may offer a potential solution to these challenges due to its key features of decentralization, openness, and integrity. In this regard, blockchain could be used as a framework for the development of a new framework in order to provide traceability for textile supply chains. In the international scenarios, blockchain could serve as a platform for transparency and sharing of information for all members of the supply chain. By providing traceable and transparent information in the textile industry, customers can be more informed about the products and choices they make, the companies they support, and the companies they purchase from. This will help to improve the structure of the supply chain, increase efficiency, reduce risks & the costs of product recalls and unethical employment.

KEYWORDS

Enterprise Resource Planning, Supply Chain Management, Supply Chain Transparency, traceability, Blockchain.

1. INTRODUCTION

Traceability and Transparency are two distinct terms used interchangeably in supply chain management. While they may be related, they have diametrically opposed meanings. Transparency refers to the overall visibility of a supply chain; it is the degree to which all stakeholders have a common comprehension of the products and their manufacturing process, and are able to access the information they require without loss, disruption, delay or distortion. Traceability in this framework signifies the ability to access the granular level information about anything that remains as part of a supply chain. It can be about a particular inventory, process, or one of the associates of the supply chain such as a retailer or wholesaler. Several investigators have incorporated traceability in various supply chain scenarios in a direction to achieve transparency.

Supply chain traceability is the method of tracking the provenance and journey of products with the information of raw material and source, from the beginning of the supply chain through to the consumer. Brands across the textile and apparel sector are under great pressure to increase visibility and

transparency in their complex multi-tier supply chains and to share more information and evidence with their customers, partners, and stakeholders. Regulatory due diligence necessities, increased investor expectations, and increasing consumer prospects and technological advances have all raised the bar.

Supply chains are essentially a network of interconnected suppliers and customers of different manufacturing and processing facilities until the final product reaches the final customer. A successful supply chain system should possess a high level of traceability and openness. According to various literature, traceability can be defined in terms of the 'what', 'how', 'where', 'why', and 'when' of an underlying product in the supply chain. In addition to the oversight of comparable quality and safety, a successful traceable system also promotes the development of efficient and effective Supply Chain Management. The supply chain industry has been increasingly interested in blockchain technology in recent years, and few prominent stakeholders have suggested or expected that it could have a positive effect on traceability and transparency in supply chain management.

2. BACKGROUND

The application of blockchain-based traceability solutions can result in a better transparent supply chain through both tracking and tracing. The impression of the articles reported in the literature discloses that blockchain-oriented traceability solutions are acquainting popularity in supply chains used in all sectors irrespective of the type of manufacturing industry. In view of the literature considered, as of now, the majority of these systems are vastly used in food and pharmaceutical supply chains. Integrated and integration of Internet of Things (IoT) is drastically uplifting the applications of blockchain. But then again, blockchain cannot eliminate the existing technologies. In order to demonstrate the increased potential of blockchain-based traceability in improving supply chain transparency, a framework for coldchain management has been developed and a Proof of Concept was performed using Microsoft Azure Blockchain Workbench platform.

Though numerous applications are reported in the literature, almost all of them are conceptual in nature. Real-time implementations of blockchain traceability systems are very rare. Research efforts aiming for empirical evidence of the benefits of blockchain-based solutions are in high demand. Small-scale trials can be conducted to accentuate the need for blockchains in supply chains with evidence. The blockchain is still in its early stages of development and further research is required to nurture novel traceability applications.

3. THE NEED FOR TRANSPARANCY AND TRACEABILITY

The textile industry is renowned for its long history and traditional production methods, and is a major contributor to the global economy, with an annual value of USD 842.7 billion in 2015, which has increased by more than \$1500 billion by 2021 and be expected to grow more than \$1950 billion by 2026. What makes traceability indispensable in textile and apparel industry is that there are billions of garments being manufactured every day, through the complex supply chains that cross seas and continents, from the origin of resources to the final customer. Analyzing the current scenario, Fast Fashion is identified as a prominent and powerful trend in most developed countries and in some developing nations.

In the current fashion trends, the term "fast fashion" has become associated with well-known fashion brands, including H&M and ZARA. These fashion brands have implemented a range of supply chain developments, such as just in time inventory management, and have incorporated Blockchain Technologies into their supply chains in order to promote traceability, openness, and environmental sustainability. An example of a Supply Chain Management application is Textile Genesis, which is widely used by a number of prominent fashion brands. In the fashion industry, apparel manufacturers in

Asia, particularly in India, Bangladesh and other countries in the region, form the core of all major fashion brands. Unfortunately, there is limited evidence on the use of blockchain technologies in these apparel manufacturers' supply chains.

Textile corporations have developed cutting-edge technology to design, manufacture and ship products to customers in a timely manner. However, the textile manufacturing processes present significant risks to the environment and sustainability, which can have a significant impact on a brand's financial performance, profitability, credibility and operational capacity. Furthermore, the end consumer is only provided with information on the origin, when and where of the textile product and is passed on to the next stage of value addition. It is worth noting that the majority of textile corporations have moved their manufacturing facilities overseas by outsourcing to local apparel manufacturers in developing countries. As a result, the traditional textile supply chain has become much more vulnerable, and has also grown in size as manufacturing has expanded into Asia, Africa and other developing countries. Before arriving at the end consumer, the textile material or product passes through a vast network, which includes retailers, distributors and transporters as well as processors and storage facilities. In many cases, the textile passes through an opaque and unreliable network. Even if databases exist, the information is typically fragmented and does not provide visibility on the product's origin.

In order to address the increasing textile challenges, several IoT technologies, including RFID, wireless sensor network, and hardware, can be employed to improve supply chain traceability. However, one major issue that has not yet been addressed is the reliability and trust worthiness of the information that textile supply chain members share in centralized systems. Such centralized systems are highly powerful in terms of controlling data, which can lead to information asymmetries between industrial/commercial entities and individuals. Furthermore, it can be a potential source of illegal and unethical practices, such as data manipulation, and if the administrator is able to manipulate the information, it can lead to the loss of trustworthiness of the entire system. These limitations highlight the need for multiple reconsiderations and the need for an automated method of information sharing between all stakeholders to improve and enable traceability of information related to textile and apparel manufacturing.

As a promising and efficient modern technology, blockchain has drawn more and more attention from market research and industrial implantability areas. Blockchain refers to a distributed ledger offering an unalterable digital record of communications and connections. The decentralized and undisputable nature of this networking technology enables the creation of a non-editable digital record of data and real-time information sharing among various networkers, which could remove the dependence on a central entity system. Instead of storing data in an opaque network system, with blockchain, all the information of the textile and apparel products can be stored in a shared and transparent system for all the members along the manufacturing chain. As an emerging technology, blockchain also has its inherent shortcomings as claimed in various research, with the increasing applications, scalability has become a primary and urgent concern which also has to be emphasized.

3.1 Structure of Textile Supply Chain (TSC)

In predominant and advanced manufacturing industries like automotive, electronics, and food manufacturing, which have long product lifecycle and require highly sophisticated and modern manufacturing procedures to function in an extremely structured atmosphere. Considering the agri-food sector, applicable regulations like labelling, compliance with the standards, and audits make traceability a main goal. In the pharmaceuticals supply chain, very strict and rigorous rules are being followed stringently and appropriate transparency level is maintained along with the trust among all the stakeholders of the supply chain for delivering the product in time and with expected quality.

In response to the increasing textile challenges, several new technologies are being employed to ensure traceability and transparency in the supply chain. However, a fundamental issue has yet to be addressed, namely the trustworthiness and reliability of the data shared by textile suppliers in centralised systems. These systems are highly powerful in terms of controlling data, which can lead to an asymmetry of information between industrial and commercial establishments and between individuals. Furthermore, it can be a potential target for unlawful and unethical practices, such as data manipulation, if the administrator is induced to tamper with the information, and the credibility of the entire system will be compromised. These limitations highlight the need for multiple reconsiderations and the need for an automated method of information sharing between all stakeholders to improve and enable traceability of data related to the textile manufacturing industry. The supply chain is a series of steps that lead to the production of finished goods and their distribution to retailers. There are numerous players involved in the supply chain, and typically multiple processes are carried out by each of them. This results in the creation of significant amounts of information and data at each stage of the supply chain. Information is a vital and essential element of the supply chain, so it is essential for each supply chain player to control the flow and safeguard valuable information. Figure 1 illustrates the various components and operations of the textile supply chain. The chain begins with the production of raw materials, and progresses through the various stages of production until the product is produced in accordance with the customer's requirements. This product will then be sold through various types of trade, ultimately reaching customers.

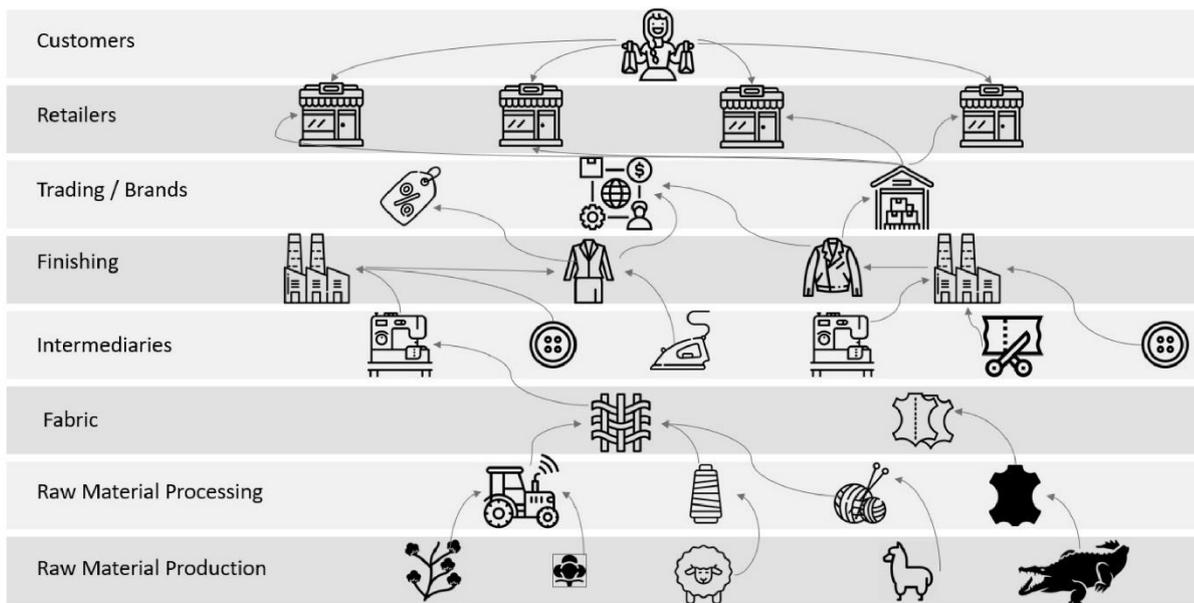


Figure 1. Structure of textile supply chain

The digitized information is of great value throughout the value chain in the industry through the proper implementation of blockchains. Major fashion brands such as Hugo Boss, H&M and Zara have adopted BCT to achieve their traceability objectives and sustainability goals. However, commercially available traceability solutions which are based on centralized systems are not very effective due to the likelihood of data manipulation. It is challenging to achieve traceability within a centralized environment. A centralized traceability system lacks transparency and confidence due to the fear of information that may be manipulated. Various literature refers to the centralized traceability systems as monopolistic, asymmetrical, and opaque information systems. It can lead to issues such as the exploitation and fabrication of information. Additionally, issues such as the single point of failure (PoD) can immediately disrupt the functions of centralized systems.

Blockchain is an ingenious intervention that might enable an immutable, distributed, transparent, secure, and auditable ledger. Blockchain is distributed and decentralized by virtue and has unbelievable opportunities in supply chain management. Actions ongoing within a supply chain network can be appended to the chronologically arranged blocks of a blockchain in the form of transactions. In general, transactions performed by any one of the supply chain participants can be seen and verified by the other participants which ensures and guarantees transparency in the whole network. Blockchain has the potential to create transparency and act as a one-stop-shop for supply chain actors, as outlined by Tapscott, Tapscott et al. (2016). All blocks in a blockchain are digitally and chronologically linked, eliminating the risk of data manipulation, which is more prevalent in centralized systems, and can reduce a variety of supply chain risks, such as information infrastructure failure, information latency, lack of transparency, and interoperability between digitalized platforms. The introduction of IoT has further increased the adoption of traceability through blockchain.

3.2 Functionalities of a Textile Manufacturing Chain

Upon receipt of the orders from the customer, the manufacturing plant capacity is verified and the high-level delivery date is estimated by the Merchandiser assigned by the organization. The Merchandiser, in conjunction with the product development department and the designing department and production unit, evaluates the product feasibility and generates cost estimates. Sample materials such as fabric, trims and accessories are arranged and inventory is examined. While inventory analysis is being conducted, the designing department is preparing a sample prototype to be used by the client to evaluate the merchandise and provide comments and suggestions for alterations, as necessary. As sample creation is in its final stages, the Merchandiser is preparing to place purchase orders from vendors and suppliers for fabric, trim and accessories.

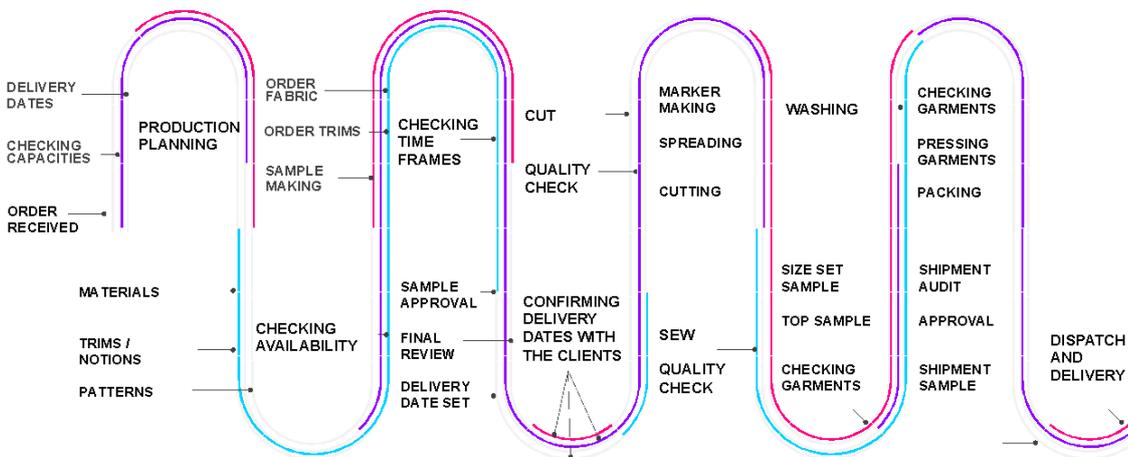


Figure 2. Garment manufacturing process

Raw material sourcing and procurement of trims can be done by either of the two common methods, followed in the industry. More often, the client has an empanelled or nominated vendor/supplier (vendors in some cases) for material and trims. In this case, the manufacturer has no other choice than to source it through the client's empanelled or nominated vendor only. Alternatively, clients allow the manufacturer to select the vendors in the lateral case. In the former case margins, sustainability, assurance, and trust are not responsible aspects that the manufacturer has to decide as this will have been already inspected and ensured by the buyer or by the buyer's nominated agent. In the latter case, the manufacturer will have to shoulder the responsibility to assure the client's requirements on sustainability tag, quality, specific requirements, and other trust issues besides the margin and other variable factors. It is important for the

manufacturers to have the flexibility to collaborate with their preferred suppliers and with the suppliers nominated by the clients.

Once the procurement for the materials and trims are placed and finalized, determining the final feasible delivery dates commences while sample verification is parallelly carried out by the client further on the approval of the internal quality assurance team. Following a final examination of the sample, the merchandiser proposes the final delivery dates to the client. The quality control team enters the process of fabric cutting to ensure that the specifications are met during spreading, marking and cutting in order to guarantee the quality of the product. The cut fabric passes the quality control and is sewn, followed by another quality control and the finished garment is inspected again. Garments that pass all quality checks are carried out for washing. An intermediate quality inspection is carried out on the washed garments, and the merchandiser includes the Packing department in order to prepare the shipments for delivery. Finally, the shipment is audited by an external inspection source and the complete lot is shipped to the client using the preferred mode of delivery. If the lot does not meet the Acceptance Quality Limits, the manufacturer must rework the shipment to eliminate any faults and the inspection process is initiated again and the shipment is shipped.

All the separated processes in the above supply chain should be integrated into the prospective model to make it progressive, effectively working, and executable in terms of efficiency and transparency with traceability. In contrast, the primary focus has been to introduce traceability and the advantages to counter the issues faced by the textile industry with consideration of the mechanisms for information sharing and operation that lead to the development of ERP systems. The impact of Enterprise Resource Planning (ERP) on supply chain operations is the most visible, as it improves and professionalizes operations at all stages of production and processes. Currently, the majority of the world's leading companies operate a computerized Enterprise Resource Planning and Supply Chain Management (ERP) system. Different ERP systems within different organizations lead to a lack of consistent and unstructured information, which in turn increases the likelihood of traceability, thus compromising transparency. This discrepancy is due to the fact that the majority of ERP systems enhance intra-organization operations with very little to no effect on interorganizational operations. This is due to the lack of communication between the ERP system used by the stakeholders, clients and suppliers, which highlights the need for an open system that allows information to be made available to trading partners within the supply chain.

4. METHODS OF ADAPTING TRANSPARANCY

At the World Economic Forum, it was asserted that traceability is at the core of any industry, any product, at any level, and is the driving force behind a more intelligent, safer, and more efficient global supply chain. This is the foundation of a more sustainable global economy. There are already established frameworks to capture information digitally, where technology and digitalization must be taken into account in order to achieve organizational objectives in the midst of the pandemic. In practical terms, a flexible supply chain and digitization technology will provide the fashion industry with the necessary support to successfully navigate the post-crisis business landscape. Furthermore, the industry can opt to incorporate blockchain technology into its supply chain in order to achieve environmentally friendly and sustainable fashion products.

Deloitte US commissioned a survey to explore the concept of "Connected Supply Chain Advantage" and identified five steps for enterprise solutions that can be used to foster stronger connections with the manufacturing eco system. The results of the survey, "Deloitte Insight", summarized as 5 key points.

1. *Create and engage in new data sharing platforms*
2. *Utilize cloud solutions to support partner connectivity, such as cloud analytics platforms Partner in asset sharing and flexible talent model*
3. *Partner in innovation and collaboration with key stakeholders*
4. *Utilize advanced technologies to reach full potential*
5. *Automate in-person and digital workflows and transactions at partner touch points*

A Blockchain is a collection of interconnected blocks, each containing a specific transaction. Every block in the blockchain contains its unique hash value and one of the previous blocks. Hence, each block is connected to its predecessor, which creates a chain when considering all the previous blocks. The blockchain is a compilation of a public, shared ledger containing details on each transaction made within a peer-to-peer system. It is made up of a linked block with specific time-stamped transactions that are encrypted by a public key and can be validated by the network participants. Once a transaction is added to the blockchain, it cannot be edited, which makes this technology immutable.

The perception of the integration of blockchains into the apparel manufacturing supply chains and the ability to identify tangible and cost-effective advantages through the implementation of blockchains is limited. To address sustainability concerns, few blockchain applications are being implemented in the textile sector to provide traceability and transparency, with a particular focus on the practices used to source raw materials and sustainability objectives, the environmental impact of the raw material, and the subsequent production of the textile using the raw material. This raises heightened customer awareness of a variety of issues, including the exploitation of child labour, large-scale water consumption, contamination, health, and safety concerns.

Several researchers have incorporated a vision of traceability in various supply chain circumstances to alleviate transparency and introduce a novel system for a transparent textile supply chain like *Tex Genesis* and *AURA*. These systems facilitate several options for the customers to check and intercept the history of an apparel commercially available in the market. Suppliers and other players of the supply chain can track and trace the journey of material throughout the value chain and even Government bodies can monitor the quality of the product and origin of the material. *GPS LAB*, a traceability system enabled by the Global Positioning System, has been initiated to provide traceability and tracking services in the context of global supply chain management and production planning.

The potential of blockchain-based traceability in bringing transparency to various supply chain scenarios is explored through several literature. The supply chain scenario with blockchain traceability solutions is also examined in the distribution network design. There are 6 major distribution network designs in which the level of order visibility is one of the key features to consider in the design of the distribution network. The order visibility is a measure of the visibility of information across the supply chain network. When the order visibility is high, the supply chain is generally more transparency. The standard order visibility in the six distribution network designs is presented in Table 1.

Table 1. Order visibility in different distribution network designs.

Type of distribution network design	Order visibility
Manufacturer’s storage and direct shipping (drop shipping)	Very important for a customer service perspective and is more difficult to achieve
Manufacturer’s storage – Direct shipping and in-transit merge	Similar to drop-shipping
Storage by the distributor and delivery by the carrier	Easier than manufacturer storage

Storage by the distributor by means of last-mile delivery	Less of an issue and easier to implement than manufacturer storage or distributor storage with package carrier delivery
Storage by manufacturer/ distributor and pickup by customer directly	Order of visibility is very less and difficult, but essential
Storage by retailer and pickup by customer directly	Trivial for in-store orders. Difficult, but essential, for online and phone orders

4.1 Commercially available Block chain technology based SCM solutions

Blockchain traceability solutions are widely accepted and acknowledged in textile supply chains. With the recent literature, it is apparent that the introduction of a novel framework for the traceability of textile production and process was prototyped on Ethereum public blockchain. The framework aims to bring transparency in a supply chain consisting of a seed company, farmer, manufacturer, processor, distributor, retailer, and customer with multiple elevator levels as and when required. With the implementation of the proposed framework, tracking and tracing of fibers is conceivable and any sort of quality issues can be easily resolved by identifying the source of the problem. Inter Planetary File System (IPFS) and standardized identifiers like Global Trade Identification Numbers (GTIN) are essential parts of the proposed framework. While retailers purchase products as batches, the use of standard identifiers increases the effectiveness in tracking products, processes, and transaction-related details among the supply chain participants. Participants of the supply chain have to interact with a smart contract arrayed in the blockchain to add the information as and when required.

In order to guarantee safety, Bigchain-DB was familiarized with the concept and provided an accessible traceability solution based on Hazard Analysis and Critical Control Points (HACCP), blockchain, and the Internet of Things (IoT). HACCP, in turn, is a systematic approach to eliminate risks associated with textile safety, taking into account Global Organic Textiles Standards (GOTS), as well as other standards such as Azo-free. Similar to this, by addressing the limitations of centralized traceability solutions, the literature explains how to combine blockchain with IoT and HACCP to have transparency in an internationally connected supply chain. HACCP syndicates with azo-free, GOTS, and Öko tex regulations and laws can be integrated with blockchain technology. This can reduce the risk of entering azo or other harmful items into the market. The azo-free supply chain considered in this international scenario embraces farmers or cultivators, spinners, weavers/knitters, wet-processors, garment manufacturers, wholesalers, distributors, retailers, and final consumers as supply chain actors. Blockchain-based traceability system for textile supply chain enables the target final customers to trace the whole history and provenance of the products of their choice.

4.2 Limitation of Existing Textile SCMs and shortfalls in new technology adaption

The most frequent risk identified in the information-sharing systems to be analysed is the lack of trust between all the actors in the supply chain, both centralised and stand-alone, that current supply chains use. The most frequent issues associated with these risks are errors, misuse, and hacking resulting in misused costs. Improved technology, more efficient and responsive route planning, and closer ERP integration are essential in the current manufacturing business environment. Blockchain may not provide these features, but it can certainly increase transparency, reduce or remove reliance on intermediaries, enhance inventory visibility across the entire supply chain, and enhance tracking and communication capabilities. These capabilities have the potential to significantly enhance the overall performance of each department. However, only three of ten organizations have a general awareness of BCTs, and very little

enthusiasm for embracing Blockchain. This may be due to the fact that BCTs may not be the solution to all the issues associated with the internationally interconnected apparel manufacturing industry and associated trade and logistics. Most textile manufacturing organizations are mainly interested in the insights related to the demand generated by the current arrangements. All apparel manufacturing industries are concerned with the issue of inventory costs. Procurement, material receipt, supplier invoice, and payment are all essential components of the procure to pay or source to settle process. Finance departments, warehousing departments, logistics departments, and legal departments all contribute to the procure to pay process. Omnichannel distribution has increased the complexity of product marketing, sales and distribution beyond what was anticipated, including a large number of business associates and partners. Consequently, supply visibility is restricted.

With the rapid growth of online and digitalized technologies and centralized information-sharing mechanisms, many emerging technologies have been applied in traceability systems of the textile manufacturing supply chain for the confirmation and coordination of updated information concerning process status such as EDI, ERP, and RFID systems. However, to date, almost all these systems are centralized which are monopolistic, asymmetric, and opaque which could result in the trust problem such as fraud, exploitation, tampering, and falsifying information. The partners and consumers must rely on a single information point to store, transact and broadcast the traceability data. As a result, it becomes difficult for customers and partners to obtain full transaction information and track the products from their origin. In order to ensure the quality and authenticity of products, customers and stakeholders in the textile supply chain must be kept up to date on the product life cycle. Besides, a centralized system is vulnerable to failure since a single point of breakdown will lead the entire system to be crashed. Moreover, enterprises with small resources still highly rely on manual operations or phone calls, e-mail communication, and internet-based service to achieve maximum efficiency which remains unproductive to achieve synchronization among supply chain participants about traceability and tracking. Reports various incidents impacting the textile supply chain which are nothing but a result of complex supply chain structure with large geographical distance among stakeholders which has made the textile sector one of the most opaque and vulnerable networks. Although all supply chain partners are linked to the network, they do not have all the required information about their supply chain and products.

Table 2. Devastating incidents of the textile manufacturing industry

Type	Issues	Incidents
Social	Safety and health of employees	Rand Plaza collapse-Bangladesh
	Human trafficking	Exploitation of migrant worker - Turkey
	Lower than minimum wage	Most of the developing countries
	Child labour	
Environmenta I	Uncontrolled release of toxic chemicals into groundwater and bodies of water.	Independent water pollution analysis of textile-producing factories in India, China, and Indonesia.
	Higher water consumption to produce cotton fabric	The desertification of Aral Sea
Quality	Spurious or Inferior raw materials	When a big U.S. retailer was questioned on the usage of Indian cotton instead of Egyptian cotton.
	Incidence of harmful chemicals	Substantial levels of cadmium are found in jewellery of major U.S. fashion chain retailers.
		A Fast Fashion retailer in the UK has recalled thousands of its flip-flops after finding a toxic chemical used for color-changing.

4.3 The impact of counterfeiting on the textile supply chain

Technically the term “counterfeiting” is used in specific cases of trademark transgression. However, in the field of fashion and textile industry, the term denotes any manufacturing of a product that imitates the appearance of an item of another producer, to dupe a customer that it is the authentic item. Counterfeiting is perceived as an important issue that is increasing rapidly in recent times. The amount of market share of counterfeiting world wide is estimated to be 5–7 percent of world trade. There are no substantial aggregated data to support this, but the figures are now accepted and used to illustrate the extent of the counterfeiting problem. Counterfeiting in the textile industry is highly widespread in Europe and North American countries. The most correlated way to profit from the free movement of counterfeited goods across borders is to import the unbranded textile product and affix the branding by labels, etc, in one member country and then sell the products in the retail market of another nearby member country. International trade loses big amounts due to counterfeiting activities. These losses not only involve the owners of the original products but they also influence social costs to a great extent. The eventual victims of counterfeiting are indeed the costumers because they end up buying poor-quality items at an expensive price which exposes them to various risks including health and safety dangers too and governments are also impacted by losing out on unpaid taxes.

5. CONCLUSION

Nowadays, traceability has become a primordial focus in the context of complicated supply chain networks and management. A representative textile manufacturing and supply chain is made up of several players who are scattered all over the globe and have varied specialties with different rules, regulations, and standards governed by local systems and government. As a result, it becomes highly difficult and sometimes impossible to collaborate with the suppliers of the fabrics and raw materials if the data are not properly and completely recorded in the system through the entire supply chain links. In this context, the importance of blockchain-integrated data framework for improving supply chain traceability and information sharing in the textile sector has been described. The apparel industry's sustainability, traceability and transparency objectives are largely based on clientele requirements. Blockchain has revolutionized the fashion industry's ability to analyze and leverage real-time supply data within the fashion industry's supply chains in India and globally, resulting in increased transparency, decreased manufacturing costs, and the establishment of a sustainable business, which can be described as an important feature delivered by blockchain technologies. The value chain is considered to be of utmost importance in any industry, as it encompasses the well-being of the employees, particularly in fashion-based companies, which is essential for the development of the organization.

This article examines the challenges associated with the scaling and implementation of blockchain technology in the context of the new approach of shared traceability systems. This traceability system is designed to provide real-time data to all members of the supply chain regarding the state of textile production. It is expected to significantly reduce the risks associated with centralized information systems, as well as increase transparency in collaborative systems, which will be safeguarded with the necessary distributed channels. Furthermore, the evaluation of this framework has revealed its positive effect on the margins of manufacturers, retailers, and brand owners in the textile sector. Furthermore, the traceability framework has revealed that brand owners can gain more insight into their supply chains, and that in the event of quality issues or recalls, the data can be quickly retrieved and used to trace back the involved parties to address the issue. Nevertheless, this article presents a framework to address the situation associated with traceability and tracing in the textiles supply chain.

The following are identified key leverages that can sustain the transformation. In order to optimize current processes, such as the centralization of merchandising cross-functional teams, the reduction of approval iterations and the increased involvement of suppliers, the fashion cycle should be digitized, including trend forecasting, intelligent consumer insights, virtual design, and prototyping. Additionally, inbound logistics should be re-evaluated to ensure a good equilibrium between air and maritime freight, and warehousing solutions should be developed to be highly efficient.

The future outlook should be to study the costs of implementation in a real-time supply chain of the textile industry with real time industrial and commercial requirements, that can provide a lot better understanding to the involved financial part and that will contribute to refining the framework. Subsequently, future research may further focus on different aspects of this model like 1. volume, velocity & variety of exchanged information: the size, the type, and time of transmitting and receiving information within the chain. 2. Outcome of information sharing: in the same supply chain, the total number of shared information against the total number information available. 3. Extend of traceability: specific to a node of the supply chain, the volume of access to the strategic information that is available within the process chain.

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