National College of Ireland

POTENTIAL APPLICATION OF BLOCKCHAINS IN FASHION/APPAREL SUPPLY CHAINS

Purpose: To study the benefits of applying Blockchains in Fashion/Apparel Supply Chains based on industry acceptance

A Thesis submitted in partial fulfilment of the requirements
for the degree of

MASTER OF SCIENCE IN INTERNATIONAL BUSINESS
By

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Under Supervision of

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I. Acknowledge

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NAME Naga Chandrika Muggulla

DATE Wednesday, 17 August 2022

SIGNATURE ……..

II. Glossary

Industry 4.0	Industry 4.0 is revolutionising how companies manufacture, improve and distribute their products.
Blockchain	The blockchain is a database that records all bitcoin and other cryptocurrency transactions. This data is stored across a system of interconnected computers.
Artificial intelligence	Artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems.
Robotics	Robotics is an interdisciplinary branch of computer science and engineering.
FiberCoin	FiberCoin is a coin, meaning it is a type of cryptocurrency with its own blockchain and works on its own.

Table 1: Glossary of Terms

III. Abbreviations

WEF	World Economic Forum
SCM	Supply Chain Management
RFID	Radio Frequency Identification Device
NFC	Near Field Communication
NFT	Non-fungible Tokens
BCTs	Blockchain Technologies
DLTs	Digital Ledger technologies

Table 2: Abbreviations

1. Abstract

Over the past ten years, researchers have looked into new ways to build trust in buyer-supplier relationships in supply chains. Several studies, such as (Saberi et al., 2019) (Bai & Sarkis, 2020; Klumpp & Loske, 2021; Stindt, 2017) have emphasized the need for industries to commit to Sustainability, Traceability, and transparency as their objectives. These objectives are frameworks by themselves and provide the ability for industries to demonstrate their commitment to being environmentally friendly. Transaction verifiability and traceability play a crucial part in building trust in today's globalized supply chains, where companies are spread out across the globe in a race to satisfy customers (Sahay, 2003; Shamah & Elsawaby, 2014). As a result of technological advancements, physical items can now be "***tokenized***" in the digital realm, allowing for a digital replication of the transactions that take place in the real world to be recorded in Blockchains implemented using ***Distributed ledger technologies*** (DLTs) (Ballandies et al., 2021; Kakavand et al., n.d.) for greater transparency.

"***Fast Fashion***" (Escalona Orcao & Ramos-Pérez, 2015; Lönnfält & Sandqvist, n.d.; Rese et al., 2019; Turker & Altuntas, 2014) is a term iconized by reputed fashion brands such as H&M, ZARA in recent times. These brands have not only put to use some efficient supply chain processes such as ***Just In Time*** inventory management (Franco & Rubha, 2017) but also embraced ***Blockchain Technologies*** (BCTs) to achieve Traceability, Sustainability, and Transparency objectives. An example of Blockchain implementation widely used in the fashion industry by some major brands has partnered with ***Textile Genesis*** .

Apparel manufacturers in countries like India and Bangladesh, and some other countries are the backbone of all big fashion brands. However, not a lot of research could be found into the application of blockchain technologies to the supply chains of these apparel manufacturers.

This paper attempts to review the suitability of BCTs for the supply chains of apparel manufacturers. The author hypothesises that integrating Blockchain Technology with ERP

systems at the manufacturing units will bring a new era of decentralization, facilitating better organizational operations within a single ecosystem. The author opines that blockchains in the fashion apparel manufacturing industry will enhance the traceability of materials and goods supply throughout various manufacturing phases, from initial raw materials to finished product management. Additionally, the transparency achieved by the Distributed Ledger Technologies (DLTs) is well researched. The author further hypotheses that BCTs can help manufacturers to achieve their sustainability targets.

The study is focused on the Indian context since the country is home to many large-scale apparel manufacturers. The author met with senior executives of some leading manufacturers and presented the case of BCTs to gather insights into sentiment for BCT adoption amongst apparel manufacturers.

The combination of an ERP system and Blockchain technology will be a potent instrument for enhancing supply chain operations, and yet, the evidence gathered from the interviews conducted with senior officials of some of the reputed apparel manufacturing companies does not present a strong case for the adoption of blockchain technologies largely due to the limited awareness of the use cases Blockchains technologies can solve for the apparel manufacturers.

Keywords: Sustainability, Traceability, Transparency, Supply Chain, Fast Fashion, Blockchain Technologies, Distributed Ledger Technologies

2. Introduction

Industry 4.0, or Digitization of Industry, is a new trend in Supply chain management (Schniederjans et al., 2020). Manufacturing firms today have access to better customer insights. Demand information is now being shared directly with manufacturers through data-centric Knowledge Management systems leading to shorter turnaround times and improved service offerings to clientele, all thanks to the digitized data available within the company and externally

(Feng and Shanthikumar, 2018). The 4th Industrial revolution is characterised by technologies such as Artificial Intelligence (AI) and Virtual Reality (VR) (Jin and Shin, 2021).

2.1. The Fashion (apparel) Industry

The apparel market was valued at 1.5 trillion U.S. dollars in 2021 and is expected to be $1.95 trillion in 2026. This is an increase of 1.26%, as shown in Figure 1 ("Revenue of the global apparel market 2013-2026 | Statista," n.d.).

India stands in the fifth position globally at $ 73.1 Bn, close to Japan at $ 75.8 Bn and UK at $ 76.3 Bn behind market leaders the US at $ 317.56 Bn and China at $ 303.34 Bn ("Global: apparel market revenue by country 2021 | Statista," n.d.) as shown in Figure 2 below.

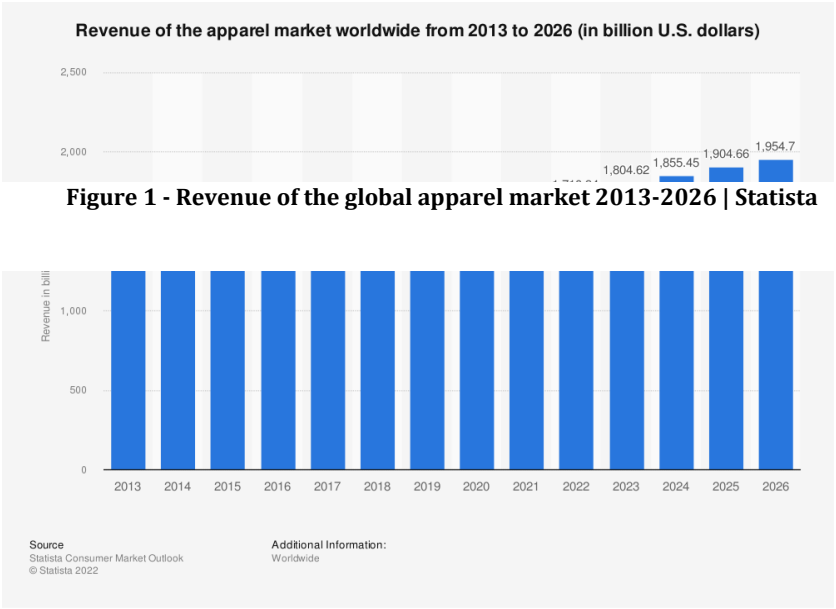

Figure 1 - Revenue of the global apparel market 2013-2026 | Statista

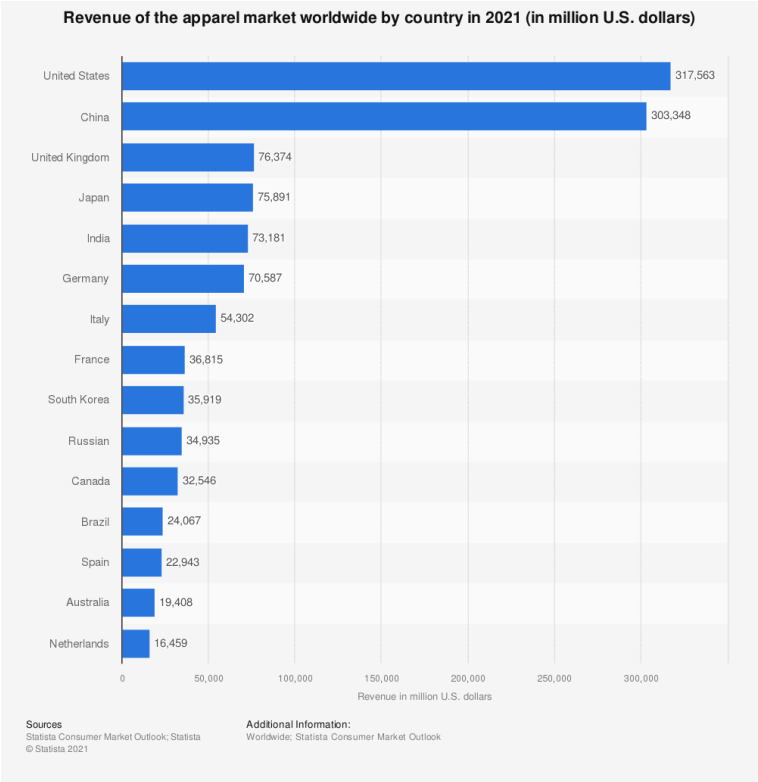

Figure 2 - Global: apparel market revenue by country 2021

France is the leading country for the fashion industry in the world, according to the Brands Countries IPX by IFDAQ. With more than 2,300 index points, France was ahead of Italy (2,205 points) and the U.S. (1,866 points) ("Fashion industry worldwide 2021: leading countries | Statista," n.d.).

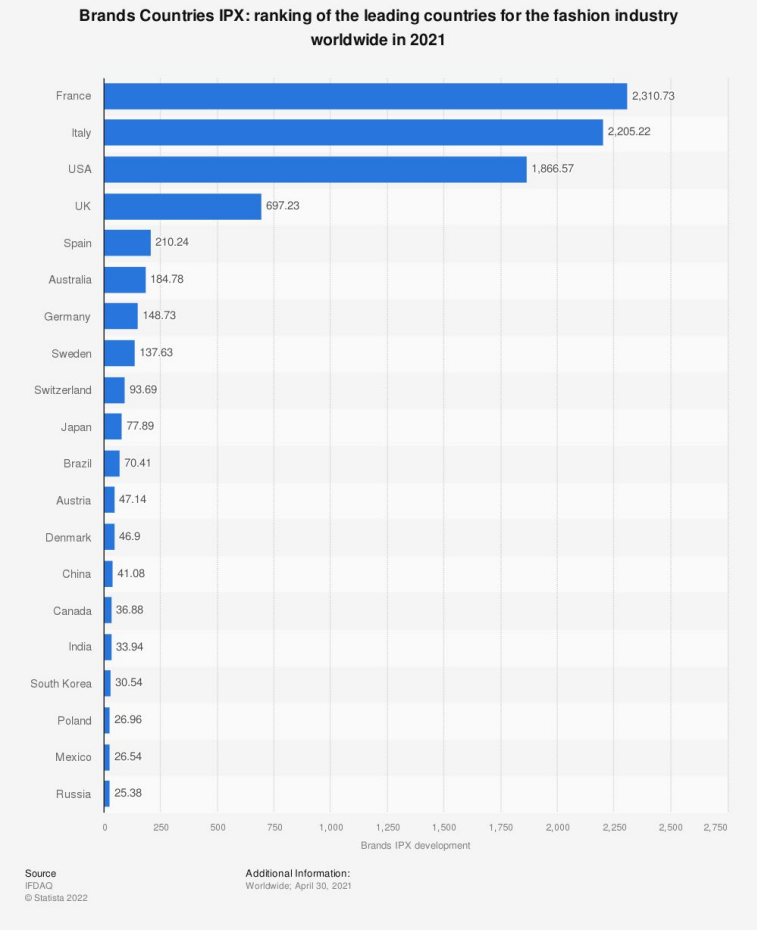

Figure 3 - Fashion industry worldwide 2021: leading countries | Statista

This ranking from McKinsey depicts the most prominent fashion companies worldwide by average economic profit in 2019 and 2020. Nike generated the highest yield among the public listed companies worldwide, with an estimated yield of 3.4 billion US dollars. ("Economic profit of leading fashion companies worldwide 2019/2020 | Statista," n.d.)

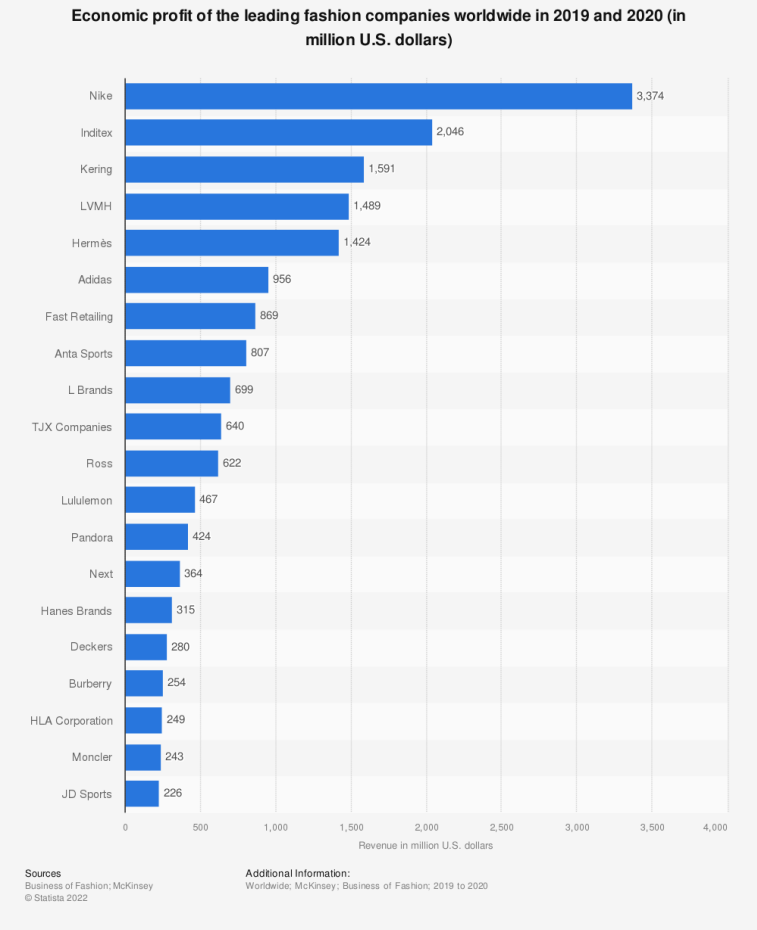

Figure 4 - Economic profit of leading fashion companies worldwide 2019/2020 | Statista

The estimated market value of the textile industry in India was worth 223 billion US dollars. when compared to the market value of the textile industry, it can be seen that the market value of the textile industry was approximately 140 million US dollars in 2018 across India ("India: textile industry market size | Statista," n.d.)

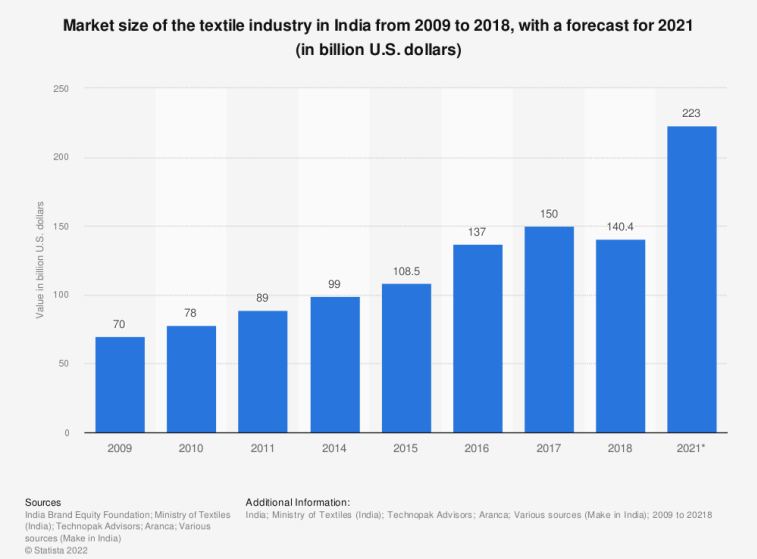

Figure 5 - India: textile industry market size | Statista

The value of imports to India of fabric was the highest, with a value of 1.7 billion U.S. dollars. With a growing organized apparel sector and rising income levels, India was the world's second-largest textile and clothing exporter, with a steady growth forecast in this market. By 2026 the import value is expected to nearly double ("India: textile and apparel import value by type 2026 | Statista," n.d.)

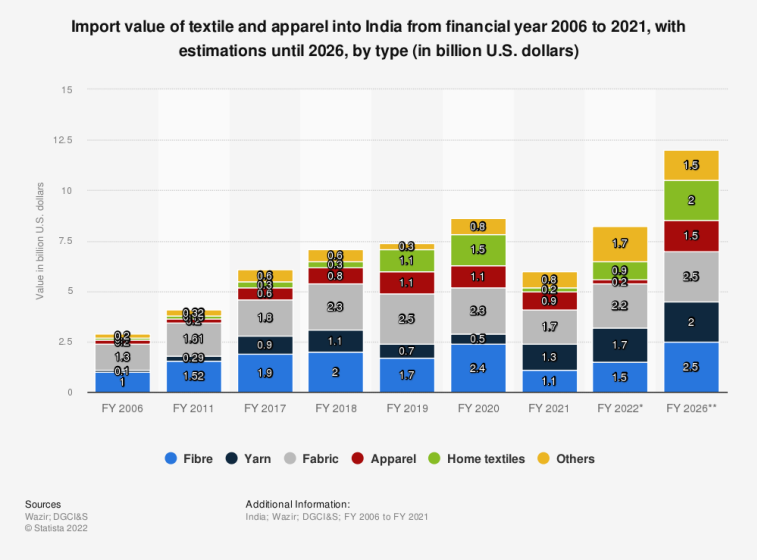

Figure 6 - India: textile and apparel import value by type 2026 | Statista

The export value of apparel from India in the financial year 2021 was the highest at 12 billion U.S. dollars, and this value was estimated to reach over 25 billion U.S. dollars by 2026. With a growing organized apparel sector and rising income levels, India was the world's second-largest textile and clothing exporter with a steady growth forecast in this market ("India: textile and apparel export value by type 2026 | Statista," n.d.)

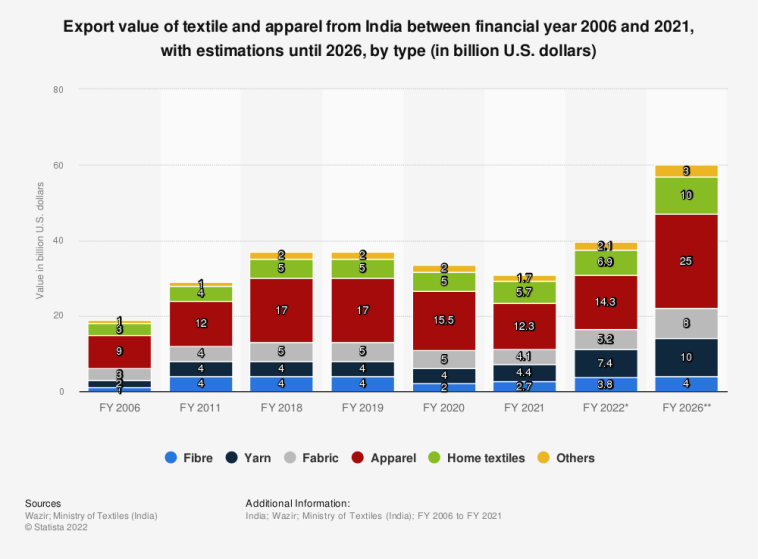

Figure 7 - India: textile and apparel export value by type 2026 | Statista

Technologies like artificial intelligence, robotics, and blockchain are performing an accelerated function in the global fashion sector. Regarding enhancement and growth, the fashion industry can greatly benefit from blockchain technology. Transaction and data security can set up efficient organizational performance and high-quality output (Caldarelli et al., 2021). Sustainable initiatives like reduced emissions, low waste generation, and a circular economy can all benefit from using blockchain technology in the fashion industry. It has been found from the report of Ro (2020) that the fashion industry contributes to approximately 8-10% of the carbon emissions globally. Hence, the fashion sector can take the help of blockchain to make its operation and supply chain sustainable.

The fashion or apparel industry of India is expected to be worth $59.3 billion in the current year, which will make it the 6th largest in the world (Amed et al., 2019). The worth of the Indian

fashion industry can be compared to that of Germany, which is $63.1 billion, and the United Kingdom (UK), $65 billion (Amed et al., 2019). It has been found that the utilisation of blockchain will help in promoting accountability and transparency in fast fashion in the landscape of India. It helps in providing end-to-end visibility in the chain of supplies that initiates transparency. For example, when raw materials for clothing leave the farm, documentation is done through paperwork, but blockchain will help in uploading the information in the block (Barot and Rathod, 2021). Therefore, anyone having access to that network will be able to check the information and its authenticity.

2.2. Apparel Manufacturing Process

2.2.1. The case of Ambattur Clothing Limited

Ambattur Clothing limited manufactures clothes for leading brands. They manufacture Women's tops & bottoms for Marks & Spencer, Women's bottoms for GAP, Women's tops for ZARA, and both Men's and Women's apparel for the BANANA REPUBLIC.

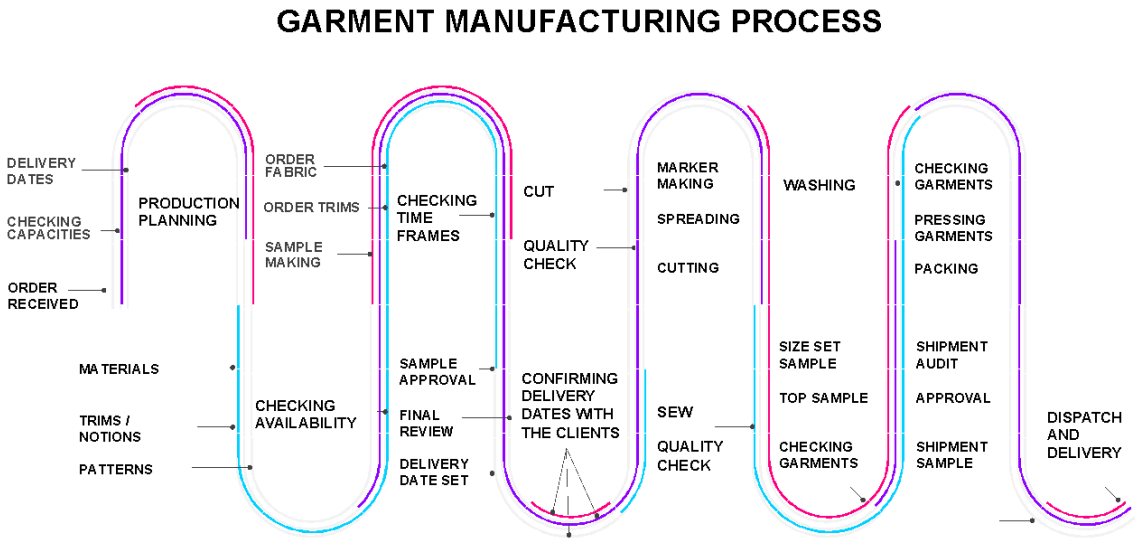

Figure 8 - End-to-end process of garment manufacturing at Ambattur Clothing Pvt Ltd.

As soon as orders are received from the client, the manufacturing plant's capacity is checked, and high-level delivery dates are estimated. The merchandiser, along with the Product Development department, in collaboration with the R&D and Production unit, jumps into action to assess product feasibility and generate high-level cost estimates. Samples of materials (fabric and trims/notions) are prepared, and inventory is checked for stock. As inventory checks are made, the R&D department works on creating a sample for the client to review and suggest changes and provide feedback. As sample creation is in the final stages, Merchandizer prepares to place orders for Fabric, Trims, and Notions.

Ordering materials and trims can happen in one of two ways. Most often, the clients already have a preferred vendor for material and trims. The company has no choice but to order from the client's preferred vendor [Margins, Sustainability, and trust are not aspects that the company gets to decide in the vendor selection process]. In some cases, clients allow the company to select the vendor. Once the material orders are in place, determining the feasible delivery dates begins while sample verification is in progress elsewhere. A final review of the sample is held with the client, and Target delivery dates are proposed. While the merchandizer confirms the proposed

delivery dates with the client, the Quality control team springs into action as the fabric cutting begins to ensure the specifications are adhered to during marking, spreading, and cutting of the fabric to minimize wastage. The cut fabric that passes quality control proceeds for sewing, followed by another quality check and finished garment check. The garments that pass the quality check are taken for washing. A quality check is once again conducted on the washed garments. The merchandiser engages with the Packing department to prepare shipments for delivery. The shipment is audited, and once approved, the sample is shipped to the client.

2.3. Supply Chain in the apparel industry

Low fixed capital investment, a variety of product designs and consequently input materials, unpredictable production volumes, significant competition, and frequently a high demand for product quality are all characteristics of the labour-intensive industry of apparel manufacturing. (Forza & Vinelli, 2000; Hassler, 2003; Scott, 2006). Although the manufacturing process is primarily linked to the creation of clothing and household linens, it is also employed in a wide range of other professions and businesses, including bookbinding, shoemaking, sail-making, upholstery, and the manufacture of various sporting products. Sewing is the underlying skill for a number of textile arts and crafts, such as tapestry, quilting, embroidery, appliqué, and patchwork. (Nayak & Padhye, 2015).

A finished item of clothing is made up of numerous parts. For instance, a man's casual shirt is made up of nonwoven interlining buttons or snap fasteners, woven or printed care labels, polyester embroidered brand labels, and cotton or cotton/polyester fabric. Due to the fact that each component is made by a distinct supplier, a delay in production may result from a component's late delivery. The largest garment companies typically handle between 2000 and 40,000 goods per year. (Ghemawat et al., 2006). ZARA, for example, handles more than 11,000 goods at any given moment. It takes an estimated 292 operations to complete one cycle of garment creation for each seasonal product. Design-change operations at apparel manufacturers

might therefore be anything between $7300 to $300,000, depending on the firm (i.e. products multiplied by activities). Due to worldwide outsourcing, longer lead times, and shorter seasons, the garment supply chain is extremely challenging. The supply chain is hampered by difficult-to-model limitations, costs, and lead times, making it impossible to foresee the shifting fashions. In the supply chain, responsible sourcing takes into account elements like sustainability, compliance, chemical safety, and the safety of the product. In today's fashion industry, greater attention is being placed on quality and supply chain intelligence and agility. Smaller stocks and quick responses to customer needs are the norms for retailers these days. Retailers always strive to keep retail prices from rising in tandem with input costs. As a result, profit margins are under more pressure than ever before. Internet or online sales are continuing to disrupt the apparel industry, putting pressure on stores. Internet sales may be harnessed by brick-and-mortar businesses, who are pondering ways to do so. Fierce competition will ensue as more Internet-based businesses spring up. Additional risks include poor fit, inappropriate colour, and wrong style when purchasing online. (Nayak & Padhye, 2015).

2.3.1. Supply Chain Management & Technology

ERP is having the most obvious effect on the supply chain, improving operations and professionalizing practitioners of all the technologies. Numerous studies have demonstrated the beneficial effects of ERP on a company's supply chain efficiency. (Banerjee, 2015; Hwang, 2012; Ince et al., 2013). Today, almost all leading companies run computerized ERP and supply chain management software(Brody, 2017) (Banerjee, 2018). ERP systems (across organizations) result in fragmented information. The research by Koh et al. (Koh et al., 2011), Addo-Tenkorang and Helo (Addo-Tenkorang & Helo, 2012), and others emphasize the necessity of an open system to make information accessible to trading partners in the supply chain. This gap is a result of the fact that ERP predominantly enhances organizational operations on the inside, with little to no impact on operations outside of the companies. As a result, ERP is a software product that is always

changing, especially with cloud technologies and analytics, but it still lacks communication among its stakeholder outside of businesses.

Findings from an online survey Deloitte commissioned ("Creating a connected supply chain advantage | Deloitte Insights," n.d.). Suggests that the partners of the supply chain are eager to participate in platforms of data sharing where it was anticipated the data sharing value increase was across sales and marketing, Customer Relationship Management, Distribution Strategy, End-to-end visibility of assets and goods, Demand Planning, and Workforce and Asset utilization.

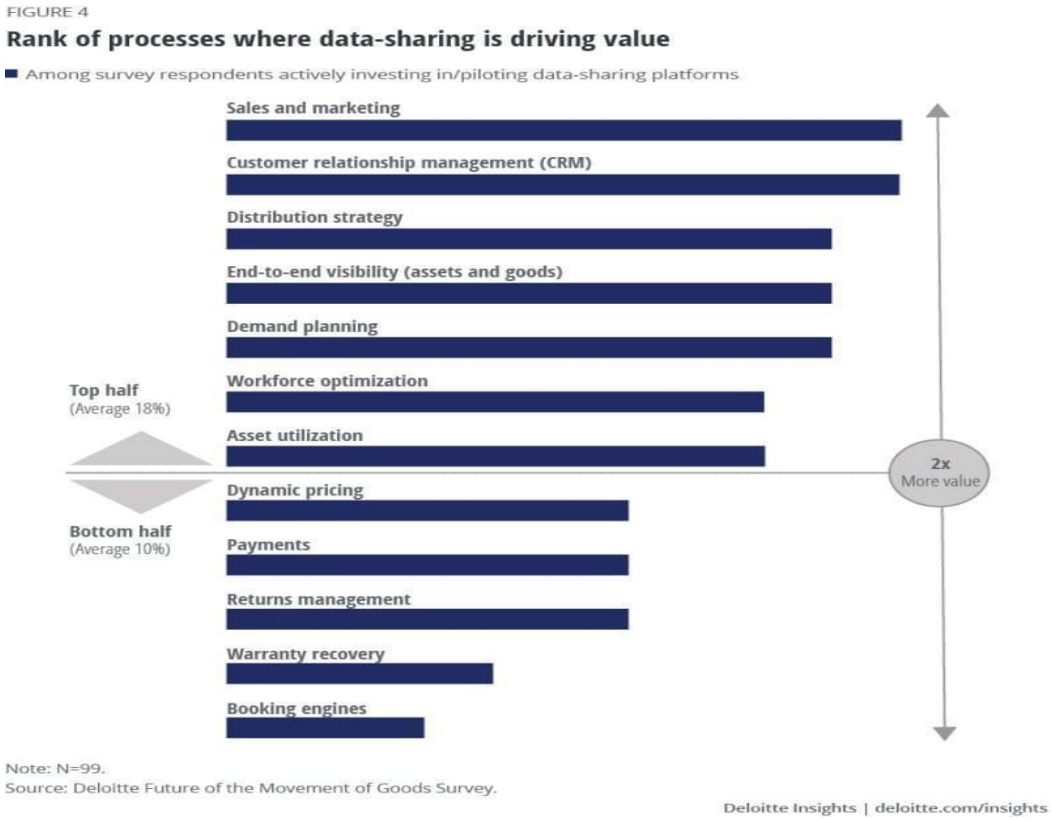

Figure 9 - Rank of processes where data sharing is driving value

Five steps to a more connected community ("Creating a connected supply chain advantage | Deloitte Insights," n.d.)

The following are the five steps that help in creating better associations with the community,

1. Develop and participate in new data-sharing platforms

2. Leverage cloud solutions to provide on-ramps to partner connectivity (e.g., cloud-based analytics platforms)
3. Participate in asset-sharing partnerships and flexible talent models
4. Collaborate and innovate with key partners to realize the full potential of advanced technologies
5. Automate physical work and digital processes/transactions at partner connection points

Proven frameworks already exist to capture information digitally (Feng & Shanthikumar, 2018; Schniederjans et al., 2020). It has been found that Covid 19 has adversely impacted every industry across the world. Hence, technology and digitisation have been considered to be important in this field to accomplish organisational goals despite the crisis. According to Rao (Rao et al., 2021), an adaptive supply chain and digitalisation technology are acting as support for the fashion industry to manage the post-pandemic business environment. Applying relevant technologies helps the supply chain of the fashion industry to efficiently conserve energy and water. The industry can choose to implement blockchain technology in its supply chain to initiate eco-friendly fashion goods for customers (Guo et al., 2020).

2.4. Blockchains

Blockchains have shown promise in these areas in many industries (Liang et al., 2021). The World Economic Forum ("5 ways traceability technologies can lead to a safer, more sustainable world | World Economic Forum," n.d.) observed that "every industry, every product, at every level, traceability is the driver of a smarter, safer, more efficient, entirely connected global supply chain – an intelligent supply chain. It is the key to a more sustainable world."

The two most common risks in information systems are to be analysed as the trust between all the entities in the supply chain (centralised and stand-alone) that current supply chains utilize. The most common issues faced due to the risks are errors, corruption, and hacking leading to wasted costs (Saberi et al., 2019).

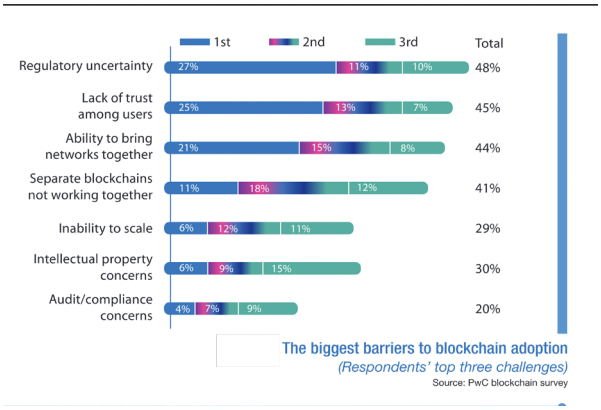

Figure 10 - Barriers to Blockchain Adoption (Itu-d, n.d.).

2.4.1. Blockchains in Textile Industry

In the textile and apparel industry, Textile Genesis (TextileGenesisTM, n.d.) is a blockchain platform adopting the global GS1 traceability standards to provide traceability solutions to participants in this supply chain network, right from fibre creation to retail. Fibercoins are digital tokens representing textile assets (non-monetary or crypto) on the TG platform. Only fibre producers can create Fibercoins in the blockchain. Other supply chain members in the blockchain represented as nodes can only transfer the Fibercoins. Tracking the movement of the Fibercoins in the shipment transaction provides traceability for all the nodes (Ahmed and Maccarthy, 2021a). The authors also looked at some other blockchains in the textile industry to solve sustainability concerns about practices utilized to source the raw materials and the environmental and social impacts of textile production, given increasing customer consciousness regarding a range of concerns such as the use of child labour in production, water consumption, pollution, and health and safety to name a few.

3. Literature Review

3.1. Apparel industry and Fast Fashion

The fast fashion industry is highly competitive and characterised by short life cycle products, volatile demand, unpredictability, and high level of impulse purchase' (Arrigo,2018, p. 1). In 2008, Sull and Turconi (2008, p. 6) introduced a definition of fast fashion: 'the retail strategy of adapting merchandise assortments to current and emerging trends as quickly and effectively as possible. Cachon and Swinney (2011, p. 778) highlighted the two constituent elements, namely, 'quick response techniques in terms of production and distribution and enhanced design techniques concerning the fashion product. Supply chain management is important, as the current trends and designs from the catwalk are expected to be brought to the market in the shortest possible time (Barnes & Lea-Greenwood, 2006; Zhenxiang & Lijie, 2011). In recent years, the product life cycle in the fashion industry has been shortened to one month or even less (Barnes & Lea-Greenwood, 2010). At the same time, the production costs are kept as low as possible to be able to offer highly fashionable products at an affordable price for a broad target audience (Zhenxiang & Lijie, 2011, p. 195). With the emergence of fast market processes, traditional managerial and marketing approaches, as well as business models, have become outdated (Amendola, Calabrese, & Caputo, 2018). In addition, marketing concepts for fast fashion concentrating on customer experience have not been explored in any detail' (Barnes & Lea-Greenwood,2010, p. 769). However, they are also important because customers get to decide on whether to shop in the physical store or the online shop or whether or not to purchase a product.

The concept of fast fashion became the popular first time in India when reputed brands like H&M, and Zara entered the apparel industry of the country. In future, engagement of India with fast fashion is expected to empower. With a swiftly developing middle-class population, India will transform from a sourcing centre for fast fashion to an effective market for clothing companies. The Indian Chamber of Commerce has estimated that every individual will spend Rs. 6,400 on buying clothes, by 2023 (Gowda, 2021). There can be seen a development in the level as in 2018 every person spent Rs.3900 on clothing. In a report published by McKinsey, it was stated that in the coming years approximately 300 international brands will expand in India (Gowda, 2021).

3.2. Supply Chain and Supply Chain Management Theories

The objective of developing the General Supply Chain Model is to provide a complete understanding of supply chains, in terms of both their management and their operation (Janvier-James, 2011; Caddy and H.1999). Supply chain models seem to focus on only one specific aspect of the supply chain: organization strategy, information technology and individual factors. While each of these aspects is considered important in its own right, each factor independently does not provide a comprehensive view of supply chain management. As the competition moves beyond a single firm into the supply chain, organizations began to realize that it is not enough if they only pay attention to improving performance throughout internal practices within their own company. According to Liet al. (2006), the development and implementation of supply chain management (SCM) practices can maximize customer value, gain competitive advantages in the marketplace, and get good profits as well. Thus, SCM becomes increasingly important (Quang et al., 2016). Combining the above-cited aspects result in the development of a general supply chain model, in which each of the aspects provides a disconnected as well as connected combined contribution. The general models represented below integrate into the model the interplay among the three aspects. Diverse effects are generated given the characteristics and level of interplay. Furthermore, the characteristics and level of interplay would be uncertain on organizational culture, the condition in which the organization operates, and the features of the supply chains used in the exchanges that happen among organizations. (Janvier-James, 2011)

An assessment of an important number of existing and representative models of supply chain management shows that a developed stage of development of a supply chain model has not been achieved as yet. There is a convergence to a commonly accepted normative model of supply chains and management (Caddy and H.1999). Essentially, it is considered suitable that another strategy is adopted to use the principles and theories of general theory to make sure whether a more fundamental supply chain framework can be created. Moreover, the problem here is whether the use of general theory in this field would provide supplementary awareness in terms

of the efficient management of supply chains. Ludwig von Bertalanffy (1969) developed an approach to systems. Systems with equivalent factors could still be distinct for the reason that a different adjustment of their factors often generates a different interplay between the factors. In most cases natural world all the systems were open systems. A crucial general systems concept has arisen from Ludwig von Bertalanffy (1969). Research is the theory of determinable boundary that divides a system from its environment. Yourdon E. (1989) declared that for a system to be recognized as a living system, it should include the following sub-systems: The duplicator; the boundary; the investor; the distributor; the producer; the matter-energy storage sub-system of various sorts of matter-energy; the extruder; the motor; the supporter; the input transducer; the internal transducer; the channel; the decoder; the associator; the decider; the encoder; the output translator. Yourdon E. (1989) adapted Miller, J.G. (1978)'s work to the information systems field. In the process, Yourdon E. (1989) improved this discipline in terms of a higher order of appreciation of what the concept "information system" signifies. It would be a fascinating exercise to re-adapt Yourdon E. (1989)'s research on supply chains to determine if these sub-systems exist and to assess the level of the contribution that each sub-system makes to the favourable development and management of a supply chain. In the case of the duplicator sub-system, even though the supply chain is an artificial construct, as such it does not reduplicate itself, supply chain lifetime is not inevitably ambiguous. As such, the following interrogations come to mind: What processes do corporates utilize to invigorate supply chains? What are the indexes that give information about supply chain obsolescence?

The General Supply Chain Model indicates that supply chains change with time. With the actual condition of new information technology, nowadays supply chains are performed distinctively to the way they have performed some time ago. Furthermore, the nature of the connections among organizations within the supply chain would also be expected to improve over time. Yourdon E. (1989) also debated the use of the following general systems theory principles in the discipline of information systems: First principle: The more complex a system is the less compatible it is with changing environments. Second principle: The larger the system, the

more resources are necessitated to support that system. Third principle: Systems generally include other systems and are in themselves factors of larger systems. Fourth principle: Systems develop, with apparent implications for the second principle. (Janvier-James, 2011)

3.3. Just in Time (JIT)

As a manufacturing practice and mindset, the "Just in time" philosophy requires that necessary materials are made available right when they are needed (Franco and Rubha, 2017). Toyota, Dell, and Harley Davidson have successfully leveraged JIT principles in their inventory management and manufacturing processes. The benefits of JIT are preventing overproduction, and avoid waiting times, unnecessary transportation, maintaining unnecessary stock etc.

In the apparel industry, Zara epitomizes "fast fashion" by owning its supply chain and being able to bring items to market extraordinarily quickly leveraging JIT manufacturing principle. The brand believes that **inventory = death**. It commits six months in advance to only 15 to 25 per cent of a season's line. And it only locks in 50% to 60% of its line by the start of the season, meaning that up to 50% of its clothes are designed and manufactured right in the middle of the season. If a certain style or design suddenly becomes popular, Zara reacts quickly by designing new styles and getting them into stores while the trend is still peaking, satisfying seasonal demand and exploiting changing customer preferences (QuickBooks Commerce, n.d.).

3.4. Traceability

The market for sustainable fibres is set to reach $100 Bn by 2025 as it expands three times. This may be partly because the top 100 fashion brands have set a target to utilize only sustainable fibres in their products by 2025. (“Blockchain: What are its 3 distinct features? - YouTube,” n.d.)

The traceability Model based on the Internet of things (IoT) has six stages for digital data Textile and Clothing Value Chains. Creation, Reading, Communicating, Aggregating, Consulting/Tracing, and Analyzing (Alves et al., 2022).

(Bullón Pérez et al., n.d.) as mentioned in Section 2, in the supply chain industry the approach that makes more sense is to use a private and open blockchain, where the nodes allowed to add blocks to the data chain would be the actors involved in the manufacturing process. A registry of agents participating in the textile production chain must then be created. Each of the registered agents is consequently assigned a unique identification code. Every agent participating in the production, marketing, distribution, and commercialization chain must provide the following information when registering each textile unit in the traceability system: 1. Unique identification code for textile agents and their role within the production chain, marketing, distribution, and sale of the textile unit to be registered. 2. Location of the establishment where the textile unit is located at the time of registration.3.Unique code and batch number of the textile unit.

Louvain community detection algorithm was used by (Etemadi et al., 2021) to study a large network of research papers by mapping groups of papers into smaller sub-units. They found eight significant Louvain Communities from their analysis of major studies' citation networks. Disruption Risk Management by Blockchain, Shared and Trusted Information by Blockchain Technology, A Digital Record of Every Transaction and Interaction, integration of Blockchain with IoT to Solve Privacy and security Vulnerabilities, Transparency and Traceability in Information Exchange blockchain Technology, Anti-Counterfeiting by Blockchain, Information Privacy by Blockchain, Safety and Security Aspects of the Blockchain.

(Liang et al., 2021) observed, functional and symbolic benefits positively impacted managements' assessment of task-technology fit. Additionally, viability is a key criterion in adopting blockchain technology. Their work is based on a model with Partial Least Squares (PLS) on findings from earlier studies on Fit-Viability, Task-Technology Fit models, and the Unified Theory of Acceptance and Use of Technology (UTAUT).

(Teodorescu & Korchagina, 2021), states that there include five propositions for Blockchain adoption in Supply chains. **Company size**; **Form of ownership**; **Collaboration with other parties**; **Scale of blockchain implementation**; **Place in the supply chain.** Blockchain is the main technology used in ecosystems with innovative technical capabilities using open innovation. Five forms of open innovation in supply chains are identified by Yun and Yigitcanlar. **User open innovation; customer open innovation; common profit community; together growth community; and inner open innovation**.

(Yiu and Zareravasan, 2021) observed concerns created by the supply chains implemented with architectures relying on a centralized authority to combat potential attacks anti-counterfeit and traceability systems.

Tracing each lot of raw materials, each lot of intermediate products like yarn or fabric, and each lot or item of manufactured garments is essential for understanding the full environmental impact of the entire value chain. A traceability system is crucial for this purpose. As a decentralized database for tracking amongst business partners, blockchain technology (BCT) is already in use. Transparency, durability, and process integration are just some of the benefits that can be realized in supply chains thanks to blockchain technology, which records transactions chronologically and makes them permanent and tamper-proof (Alves et al., 2022). Every piece of information needed to track an item can be found in its digital twin on a traceability platform. Every trackable object needs a way to communicate with its digital twin (the data in the platform), and IoT makes this possible.

3.5. Sustainability

Sustainable materials and resources are concerns that have become topics of many board room discussions in the labour intensive apparel manufacturing industry. Reputed fashion brands have embarked on their own journeys to achieve sustainability, transparency, and traceability objectives. Reputed brands have started investing in sustainability solutions and embraced efficient manufacturing processes such as Just in Time production which require maintaining minimal stock of products which in turn results in a demand for efficiency on the part of apparel manufacturers. The Higg Index to assess the sustainability performance of organizations (*The SAC - Sustainable Apparel Coalition*, n.d.). The Hot Button ranking system from the Canopy Planet Organization to assess the sustainability of fiber producers (*Hot Button Report – Detailed Matrix of Viscose Producer Performance (2021 Edition)*, n.d.) and the Textile Exchange which is an industry-wide non-profit organization that works on developing standards for the industry and provides industry insights on developments for sustainability in the sector (*Home - Textile Exchange*, n.d.) are examples of some frameworks and solutions fashion brands are partnering with to ensure their sustainability objectives are achieved.

3.6. Blockchains

3.6.1. Current Affairs

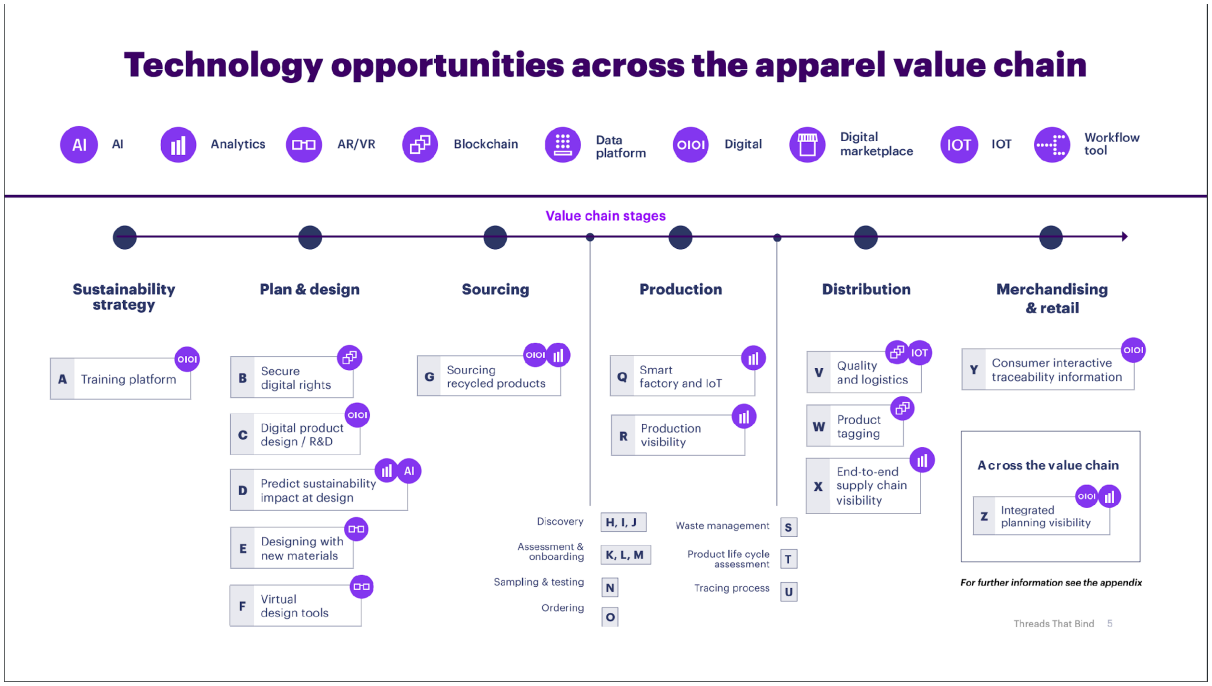

Figure 11 - Technology Opportunities across the apparel value chain (Accenture, n.d.)

Blockchain technologies have lately been used in many use cases other than the most familiar Cryptocurrencies. Blocks in a blockchain represent transactions that are cryptographically linked together in chronological order, creating a distributed ledger that can be accessed from multiple computers simultaneously (Destefanis et al., 2018). This makes it so that past transactions can't be changed or removed without fundamentally altering the blockchain itself. Self-enforcing agreements, or "smart contracts," are at the heart of blockchain technology. These contracts are written as code and executed digitally (Lansky, 2018). Distributed ledger technology, or blockchain, relies on shared databases and digital contracts to facilitate reliable business transactions. Even though blockchain was originally developed to support bitcoin's decentralized ledger system, its potential to revolutionize other industries has become rapidly apparent (Crosby et al., 2016)(Chawla, 2020).

(Ballandies et al., 2021), describe the four main functional components of any blockchain implemented using *Distributed Ledger Technology* (DLT). ***Action component*** – An action performed in the real world is digitized to enter the blockchain as claims. ***Consensus component***

– The claim is broadcasted to all the nodes in the chain and written to a Distributed ledger (DL) creating a transaction. ***Distributed ledger component*** – is where the transactions are stored. ***Token Component*** – This is where a transaction is assigned a value in the Blockchain, and this is the medium of exchange or accounting unit.

A user can propose a new state of ownership of a token through a transaction at any time using the blockchain technology, which typically consists of users and miners. At a minimum, a transaction will include details about the accounts involved, the amount of tokens being transferred, a timestamp, and a sender's signature. Miners submit proposals for new Ledger states after they have solved a cryptographic puzzle. Miners proposed new legislators by compiling user transactions into blocks and proposing them all at once. This was done so that only the first person to solve the puzzle could propose a new state of the Ledger. Since the previous block's unique identifier is included in the newly proposed block, a chain of blocks is created, hence the name blockchain. (Koens & Poll, 2019) studied scenarios where blockchain might be useful and examined the various blockchain decision models that have been proposed because we believe that such a scenario exists. A good example of this kind of model is the Decision Tree, which takes into account factors like storage state, writer count, and throughput per minute (Trusted Third Party), There are four potential outcomes, including are all writers known, are all writers trusted, and the state can be publicly verified. Avoid using blockchain unless it's a permissioned network.

Property	Blockchain Governance		
	Public	Consortium	Private
Governance Type	Consensus is public	Consensus is managed by a set of participants	Consensus is managed by a single owner
Transactions Validation	Anynode (or miner)	A list of authorized nodes (or validators)	
Consensus Algorithm	Without permission (PoW, PoS, PoET, etc.)	With permission (PBFT, Tendermint, PoA, etc.)	
Transactions Reading	Any node	Any node (without permission) or A list of predefined nodes (with permission)	
Data Immutability	Yes, blockchain rollback is almost impossible	Yes, but blockchain rollback is possible	
Transactions Throughput	Low (a few dozen of transactions validated per second)	High (a few hundred/thousand transactions validated per second)	
Network scalability	High	Low to medium (a few dozen/hundred of nodes)	
Infrastructure	Highly-Decentralized	Decentralized	Distributed
Features	Censorship resistance Unregulated and cross-borders Support of native assets Anonymous identities Scalable network architecture	Applicable to highly regulated business (known identities, legal standards, etc.) Efficient transactions throughput Transactions without fees Infrastructure rules are easier to manage Better protection against external disturbances	
Examples of technologies	Bitcoin, Ethereum, Ripple, etc.	MultiChain, Quorum, HyperLedger, Ethermint, Tendermint, etc.	

Table 3 - Blockchain Classification (Dib et al., 2018)**.**

Company	Platform	Consensus Algorithm	Smart Contracts	Private Transactions	Popularity ♠	Activity (Github) ♠
Coin Sciences Ltd	MultiChain	DiversityMining	No	No	Low	Medium
Quorum	Quorum	pluggable: IstanbulBFT ①, Raft	EVM	Yes	High	Medium
IBM	Hyperledger Fabric	pluggable ②: Kafka	Chaincode	Yes ③	High	High
R3	Corda	pluggable: Raft, BFT-SMaRt	JVM	Yes	Medium	High
SWIRLDS	Hashgraph	Hashgraph	No ④	No	Low	N/A
Stellar	Stellar	SCP	No	No	High	Medium
ParityTech	Parity	pluggable: Ethereum, Aura ⑤, Tendermint	EVM	No	High	High
Intel	Hyperledger Sawtooth	PoET	EVM	No	Low	High
Monax, Intel	Hyperledger Burrow	Tendermint core	EVM	No	Medium	Medium
All In Bits Inc.	Ethermint	Tendermint core	EVM	No	Medium	Medium

♠ Rough estimation based on GitHub metrics and online presence (*e.g.,* download count, community hubs activity, *etc.*)
① IstanbulBFT is an adaption of PBFT for blockchains
② Other consensus to be added, or unofficial: PBFT, BFT-SMaRT, HoneyBadgerBFT
③ Stand alone private transactions are not possible, but participants can set up private channels
④ Hashgraph let the transactions semantics be implemented by the application, but they will not be checked during consensus
⑤ Aura is a simple consensus engine developed by ParityTech, but it is not well specified and there is no assessment of its soundness

Table 4 - Benchmarking of Enterprise Blockchain platforms and Technologies (Dib et al., 2018)

Consortium Ledgers: Consortium blockchain networks consist of entities with common business purposes. The trust model developed by (Chen et al., 2020) by investigating data model, consensus, and security reveals that access to data is a fundamental problem that is yet to be fully solved. **Private Ledgers:** Only the nodes with specific permissions can access the DLT. **Public Ledgers:** Permissionless network implementation in which anyone can read from or write to the DLT. **Smart Contracts:** Technology to automatically evaluate and execute contract clauses is known as a *Smart Contract*.

3.6.2. Textile Genesis

In the textile and apparel industry, Textile Genesis ("TextileGenesisTM," n.d.) is an award-winning blockchain platform adopting the global GS1 traceability standards to provide traceability solutions to participants in this supply chain network right from fibre creation to retail. *Fibercoins* are digital tokens representing textile assets (non-monetary or crypto) on the TG platform. Only the fibre producers can create Fibercoins in the blockchain. Other supply chain members in the blockchain represented as nodes can only transfer the Fibercoins. Tracking the movement of the Fibercoins in the shipment transaction provides traceability for all the nodes (Ahmed & Maccarthy, 2021). The authors also looked at some other blockchains in the textile industry to solve sustainability concerns about practices utilized to source the raw materials and the environmental and social impacts of textile production given increasing customer consciousness regarding a range of concerns such as the use of child labour in production, water consumption, pollution, and health and safety to name a few. The *AURA Consortium* and the *Arianee consortium* and HUGO BOSS in collaboration with ASTRATUM are examples of fighting fraud and ensuring product authenticity using blockchain implementation in the luxury goods space.

Fighting fraud and ensuring product authenticity have been significant drivers for many blockchain pilots, especially but not exclusively for luxury brands with high-value end-products. In most of these pilots, the traceability solution starts from the point of final product creation. Some of the high-sustainability fibre producers also use the technology to authenticate their fibre and fight counterfeiting. Examples of such blockchain pilot projects in the supply chains of specific organizations include Hugo Boss (Hackling, 2019), Chargeurs Luxury Materials [52], and Lenzing [53]. Examples of blockchain projects undertaken by consortia include the AURA Consortium, developed by LVMH [54,55], and the Arianee Consortium, which use blockchain to enable the digital certification of luxury goods [56].

3.6.3. The AURA Consortium:

AURA Consortium blockchain strive to provide tools to assist in creating transparency and trust for all customers and stakeholders. Their aim is to improve the buying, owning, selling, reselling, and recycling experience of luxury goods. Founding members LVMH, Mercedes-Benx, OTB, PRADA Group, RICHEMONT.

are examples of fighting fraud and ensuring product authenticity using blockchain implementation in the luxury goods space.

Other examples include blockchain for supply chain, sustainable logistics and mulitsourcing. Blockchain helps the fashion retailers with a real time data flow and substitutes fragmented data with immutable and single one which is clearly visible for every authorised party. Incorporation of eco-friendly logistical solutions can help towards establishing a sustainable supply chain leading to become carbon neutral (Ilgar, 2021). In this respect, adoption of open logistics ecosystem may help the fashion industry to monitor its transport mechanism in real-time and also recognising the best alternatives as well. Multisource performs a crucial role as it helps the companies to formulate credit terms down the way (Farrell, 2007).

4. Research Question

This paper begins with an introduction to the fashion industry and outlining the end to end apparel manufacturing process. Supply chains supporting the apparel manufacturing is briefly introduced. The first section of this paper provides context for the rest by explaining the complete cycle of garment production. The garment industry's supply chains are briefly discussed.

The author proposes that a new era of decentralization will usher in by combining ERP systems in factories with Blockchain technology, making it easier for businesses to function within a shared environment. Blockchains, in the author's opinion, will improve traceability of materials and goods supply in the fashion apparel manufacturing industry across all stages of

production, from the management of raw materials to the administration of finished goods. Distributed ledger technologies (DLTs) have also been studied extensively for the transparency they provide. Further, the author speculates that BCTs can aid producers in meeting their sustainability objectives.

Due to the abundance of large-scale apparel manufacturers in India, the study is concentrated there. To better understand how the apparel industry feels about adopting BCTs, the author met with senior executives from a number of prominent companies and presented the case for BCTs.

There have been a number of studies that highlight the importance of industries committing to Sustainability, Traceability, and transparency. Research into BCTs as potential means of accomplishing these goals has been the subject of numerous other studies. Some of the biggest names in fashion have joined forces with Textile Genesis, a Blockchain platform that has proven particularly successful in the apparel industry.

Integrating an enterprise resource planning (ERP) system with Blockchain technology will yield powerful new tools for optimizing supply chain management.
In this chapter, we explore how the synergy between these two technologies will improve the su pply chain in every conceivable way, cutting costs and increasing efficiency.

4.1. Research Aims

The research aims to investigate the awareness about the utility of blockchain among the reputed garment manufacturing companies in India. It also intends to find out the need, suitability, readiness and challenges Indian garment manufacturing organisations face while adopting blockchain technology. The research would like to find out the strategic actions that the clothing manufacturing companies incorporates for value creation within their garments and other apparel production.

4.2. Hypothesis Development

Proving or disproving these hypotheses also form the sub-objectives for this research study. These sub-objectives will provide a better view of the likely hood of Blockchain technologies being used to solve problems in the supply chains of apparel manufacturing companies.

The questions to be answered through this research study includes the following.

- How can blockchain technology address problems and/or opportunities in the supply chain space for the fashion industry?
- What is the role that is played by the blockchains in the industry of fashion or apparel in India?
- How is blockchain awareness formulated in the fashion or apparel sector of India?
- How the changes related to the adoption of blockchain in managed within the selected industry of India?
- What are the processes by which blockchain helps in the process of tracing the activities of the supply chain in the apparel or fashion industry of India?
- What types of adaptability challenges does the fashion sector of India fare because of adopting blockchain technology?
- How value is created within the sector by resolving the challenges?

In answering the questions above, the author wishes to explore if the following two hypothesis hold.

- H1 – Apparel manufacturers have significant gaps in the supply chains
- H2 – Apparel manufacturers see blockchain technologies as solution to their supply chain issues

4.3. Systems and Processes

1. Procurement of raw materials (Ordering process, Delivery delays, Unforeseen damages, etc)
2. Inventory Management (Inaccurate information, Warehouse efficiency, Limited visibility with regards to Quantity received Vs Physical checks).
3. Production issues (Quality problem, Manpower issues and violation, Cost impact, Output problem).

5. Methodology

This paper begins with an introduction to the market demographics of the Fashion industry and then Apparel focused garment manufacturing process at Ambattur clothing private limited (ACPL) which has manufacturing units in India, Jordan, and Bangladesh. The company manufactures apparel for some well-known international brands such as Mark & Spencers, GAP, ZARA, and the BANANA REPUBLIC.

In the Literature Review section, we present some key observations about the latest processes. The literature review also shows us that top fashion brands are already embracing blockchains to ensure traceability of all raw materials used in their products to achieve their sustainability targets. The goal is to understand how the apparel manufacturing companies in India enable the fast fashion trends that these brands can deliver. It is known that with increased gaps exist in the value chains of a selected few apparel manufacturing companies in India that are the backbone of enabling the fast fashion through

The Research Question is formed upon investigating the value chains of the apparel manufacturing companies based in India. Many of these companies manufacture apparel to fulfil bulk orders placed by well-established, globally recognised fashion brands such as ZARA and H&M. In analysing the value chains of the manufacturers who are smaller in size than the brands they manufacture for, The author brings out some interesting elements that influence supply chains of these companies. The interviews conducted by (Caldarelli et al., 2021) were very useful[1] in framing the study in the context of apparel manufacturing companies in India.

Thematic analysis has been chosen here because this methodology is efficient in data interpretation with huge flexibility and also enables to make extensive themes from large data sets. According to Nowell et al. (2017), it is very much appropriate when it comes to analyse large qualitative data sets. Here thematic analysis was chosen as it was beneficial for understanding the influence blockchain has on the fashion industry of India. Further, it has also been chosen because rigorous and proper thematic analysis can help in facilitating insightful and trustworthy findings and also generating unanticipated insights (Nowell et al., 2017). In this research, the chosen analysis technique has been beneficial in summarising the essential features of a large set of data comprising detailed information of blockchain and fashion industry. It also helped in enforcing the study to establish a well-structured perspective in terms of data handling that led to present an organised and clear finding based on the utility of blockchain for the Indian fashion industry.

5.1. Research Philosophy

[1] I would like to personally thank the authors (Caldarelli et al., 2021) as the interviews they conducted were influential for my project.

5.1.1. Construct

(Smith & Shaw, 2019) postulate a framework to identify similarities between Problem Structuring Methods (PSMs). The underlying assumptions are categorized into four pillars. Methodological, ***Axiological*** - The study of the nature of value and valuation, and of the kinds of things that are valuable: one of the central questions in axiology is this: what elements can contribute to the intrinsic value of a state of affairs?, ***Epistemological*** - the theory of knowledge, especially with regard to its methods, validity, and scope, and the distinction between justified belief and opinion, and ***Ontological*** - the theory of knowledge, especially with regard to its methods, validity, and scope, and the distinction between justified belief and opinion.

Epistemological knowledge is the ability to analyse and interpret data, test hypotheses, and probe beyond the surface level (Lawrence Neuman, 2014). Evaluations of such metrics can be qualitative, quantitative, or a hybrid of the two in published papers. Quantitative research involves analysing data and drawing conclusions based on numerical or statistical findings. However, qualitative research involves surveying people for their thoughts and feelings about a subject through in-depth interviews and questionnaires. Combining qualitative and quantitative techniques, as in a mixed approach.

Quantitative studies attempt to precisely represent a dataset through numerical expression, as stated by (Lawrence Neuman, 2014). To find statistical inferences hidden in large datasets in a short amount of time is a major benefit of this method. Due to its conversational methodology, the qualitative approach under consideration would yield a limited number of thematic findings.

While qualitative research would likely yield insightful results, it would be less likely to lend itself to replication and quantifiable analysis than a quantitative study. When compared to using either approach alone, a combination of the two would result in a more thorough comprehension of the topic at hand. In light of the limited data available, the author has made this decision.

5.1.2. Philosophical Framework

An Interpreter philosophical framework is adopted for the purpose of this research.

The perspective and positioning of research are strengthened by a philosophical framework (Quinlan et al., 2018). According to this literature, a research methodology may be based on three epistemological frameworks; (i) positivism, (ii) constructionism and (iii) interpretivism. Interpretivism is based on interactions and experiences and assumes a subjective reality. Constructionism is based on socially constructed realities while are multiple in nature. Lastly, positivism has data related to only a single reality (Quinlan et al., 2018). Five errors in research Overgeneralization Selective observation Premature closure Halo effect False consensus (Lawrence Neuman, 2014)

The author adopts a positivism framework to meet the objectives of this study. As Newman (2006) states, since the positivism approach does not look towards finding an explanation about its discovers, it makes it more reliable to be used in quantitative studies.

For thematic analysis, interpretivism research philosophy has been chosen because themes include qualitative data. This particular philosophy according to Chowdhury (2014), helps in focusing more on multiple realties and promoting the significance of qualitative data in terms of knowledge. In this research study, interpretivism research philosophy has helped in locating the uniqueness of the research area by identifying the integration between the usefulness of blockchain and Indian fashion industry. This in turn also helped in making contribution towards underlying pursuit of theoretical depth.

5.2. Research Design

When researchers intervene in the inherent flow of an experiment by controlling a specific variable to study the effects of the relationship of the dependent and independent variable, is known to be an experimental research design (Newman, 2006).

5.2.1. Purpose

Newman (2006) states that a study is conducted for either explanatory, exploratory or descriptive purposes. A descriptive approach was adopted by the author for this research study with an aim to create a picture of the topic at hand and consequently enable the author to ascertain how a problem occurs and what it looks like. By taking up a descriptive purpose the author opted to utilise a survey or questionnaire since the outlined objectives would not be satisfied by a case-study approach. On the other hand, an observational approach would prove to be inefficient as the authors presence might skew the behaviour and responses of the respondent. A descriptive approach also allowed effective distribution and collection of data through online mediums.

5.2.2. Instrument

The research instrument is referred to as a tool that is utilized to collect, measure, and evaluate the information data concerned with the research topic and objectives. The research instrument is ultimately connected with the methodology selected for conducting the study.

The objective of this study is to gain insights from senior management in Indian apparel manufacturing companies whose day to day involves decision making concerning Supply Chain and those who would use the ERP or alternative Information Systems (MIS) that are in place. This criteria to select potential respondents for the questionnaire was crucial as these are the individuals who would be in a position to understand the challenges they face in the daily operations and the limitations of their ERP systems.

The author compiled some Informational videos listed in Appendix 2 from YouTube. These videos provide the potential respondents with a background to Blockchain and some areas where they are applied in the fashion and agriculture industries. Respondents were given sufficient time to watch and understand the context of the research correctly.

Personal semi-structured interviews were designed as these are known to yield the most honest responses (Bloggs 1993; Murphy 1994) and the author has significant work experience in the field of garment manufacturing. It was anticipated that getting time with senior managers for any form of interviews or discussion was likely to be a challenge, they may also be reluctant to answer some sensitive questions Malhotra (1994) the interviews were also presented to the respondents as questionnaires.

The questionnaire was prepared using Google forms. The link to the questionnaire is in section 11.2 below. The questionnaire has three sections to it as described in the tables below. Questionnaire was sent to the respondents via email, and the responses were automatically captured into a Google Sheet securely hosted on Google Drive with two-factor authentication activated.

5.2.3. Data Collection and Sampling

The data was collected by using the convenience sampling method. Convenience sampling is a research strategy where researchers collect market research data from an easily accessible pool of respondents. This sampling technique is known to be used frequently as it is cost-effective, quick, and simple. Often, people are inclined toward participating in the research. It may be the only method of data collection in some circumstances. For data collection for this study, a questionnaire was prepared and then presented to the respondents with the probability to get it filled and submitted to the researcher within the prescribed time limit.

Sampling Questions

Question	Type	Options	Responses
Name of the Company	Short Text		
Your designation	Short Text		
Are you a decision-maker in the company for your department?	Multiple Choice	● Yes ● No	
Do you manage partners in the Supply chain on a day-to-day basis?	Multiple Choice	● Yes ● No	
Following are the Major Categories of Suppliers or Partners you source raw materials or obtain services from the following,	Check Boxes	Fabric, Trims, Accessories, Dyes, Machinery, Transportation, Skilled/Unskilled manpower, Other	
What kind of Supply Chain Management processes are in place?	Long Text		
What kind of Supply Chain Management tools are in place?	Long Text		
How many Supply channels are involved in producing the final product?	Multiple Choice	● 1 to 10 ● More than 10	
What qualifications or certifications do you seek in your partners?	Long Text		
Main Nature of your business	Multiple Choice	1. Only Manufacture for Fashion brands (Not involved in any other form of distribution/sales) 2. Manufacturing and Some Sales 3. Manufacture in house to Sell 4. Other (Option to add text)	All 10 respondents were Manufacturers for fashion brands

Table 5 – *Questionnaire Section 1: Sampling questions*

Value Chain Questionnaire

Questions are based on the template for Value chain analysis from Hubspot's website.

Question	Type
Firm Infrastructure	Long Text
HR Management	Long Text
Tech Development	Long Text
Procurement	Long Text
Inbound Logistics	Long Text
Operations	Long Text
Outbound Logistics	Long Text
Marketing & Sales	Long Text
Services	Long Text
Margin	Long Text

Table 6 - Value Chain Questionnaire

Questions for Thematic Analysis

	Question	Type	Options
1	Traceability of materials is a concern for the company	Multiple Choice	Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree
2	Sustainability is a Goal for the company	Multiple Choice	Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree
3	Trust and Conflict resolution is a concern for the company and its supply chain partners	Multiple Choice	Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree
4	Gaps are known to exist in the company's operations	Multiple Choice	Yes, No, Maybe
5	Pain points are known to exist in the company's supply chain	Multiple Choice	Yes, No, Maybe
6	The company has some level of familiarity with Blockchain technologies and their applications.	Multiple Choice	Yes, No, Maybe
7	The videos were informative	Multiple Choice	Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree
8	In your opinion, are Blockchain technologies (BCT) relevant in solving the pain points in the supply chains?	Multiple Choice	Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree
9	The company has the necessary digital infrastructure in place to integrate with Blockchain technologies (BCT).	Multiple Choice	Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree
10	The company supports supply chain partners with abilities to digitally integrate	Multiple Choice	Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree

Table 7 – *Questionnaire for Qualitative Analysis*

5.3. Validity

Malhotra and Birks (2007) explain that there are two forms of validity in research: (i) external and (ii) internal. In respect of internal validity, this research study used pre-validated questions from previous studies or used pre-validated questions as a basis to create suitable questions, to create the research instrument for this research.

The scales for each construct were developed from earlier studies conducted by a variety of writers. T. Erdem and J. Swait (2004)'s work on attitude toward the New technology was referred to and derived from, in which they inscribed a 0.89 Cronbach's Alpha for the scale. B. Yoo, N. Donthu, and S. Lee (2000) reported composite reliability of 0.93 for their scale, which has been modified for the readiness and awareness of adopting BCT. The measure was taken from R.

Algesheimer, U. Dholakia, and A. Herrmann's (2005) research, which revealed composite reliability of 0.9.R. Ahluwalia (2000) reported a Cronbach's alpha of 0.62, which was used to adjust the scale for readiness to commitment. The emotional connection to the blockchain awareness scale was taken from J. Rossiter and S. Bellman's study (2012). The alphas for the scale were not reported by the authors. The scale employed in their study was delivered in a 'check any of the following' manner, with participants being asked to pick or tick the adjectives that they believed applied to the challenges in their minds. The participants did not rank them on a scale of one to nine but instead determined based on the fact that their decision was absolute. In this study, however, the scale was changed to a 7-point Likert-type answer scale. Lastly, the scale for acceptance intention was developed from E. Lepkowska-White, T. Brashear, and M. Weinberger (2003), who used the scale in both English and Polish and reported Cronbach's alpha values of 0.9 and 0.89 for the two languages, respectively.

5.4. Data Analysis

The author directly combined the sheets after downloading them directly from the source without tampering with the data. The author had no impact or influence on the responses and the sheets represented the true answers by the respondents of the survey. The volume of data was low but is considered to be of quality since it is obtained with individuals that are decision makers in their respective companies and handle Supply Chain operations on a daily basis.

A Qualitative analysis approach has been taken as responses to Value Chain questions provide good qualitative data for theme analysis, whereas the responses to opinion polls can be used to prove the hypothesis.

5.4.1. Qualitative Analysis (NVIVO)

The six stages that has been uses here to generate and analyse themes include familiarisation, coding, searching, reviewing, defining, and finally naming the themes. In the first step,

familiarisation with the concepts of blockchain, fashion industry and their integration were initiated so that relevant information could be obtained. After getting proper articles, coding was used for sematic and conceptual reading of the data. Next, searching was done on Google Scholar and approximately 40 articles were identified. However, based on the review in terms of presence of the DOI number, name of the author, and publication date. Based on this review, around 20 articles were chosen and finally themes were generated by naming and defining them properly. NVIVO software was used to perform theme analysis on the value chain-based questions. These are discussed in detail in the next chapter.

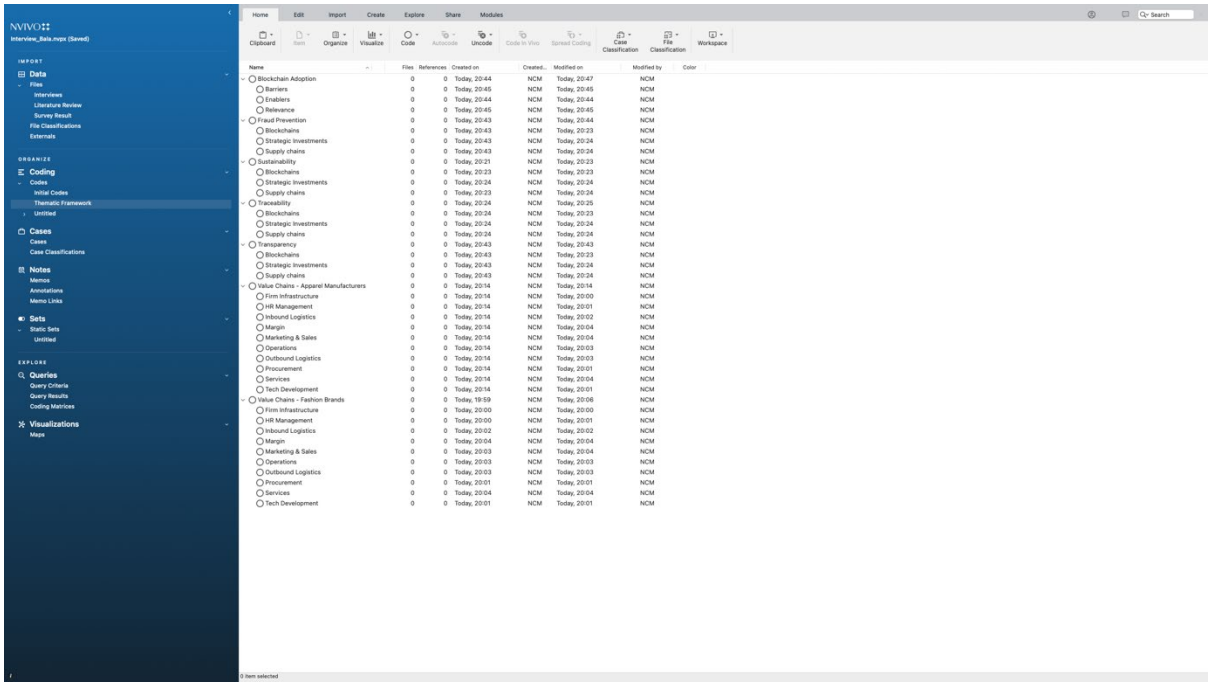

Figure 12 - Codes that make up the thematic framework (NVIVO)

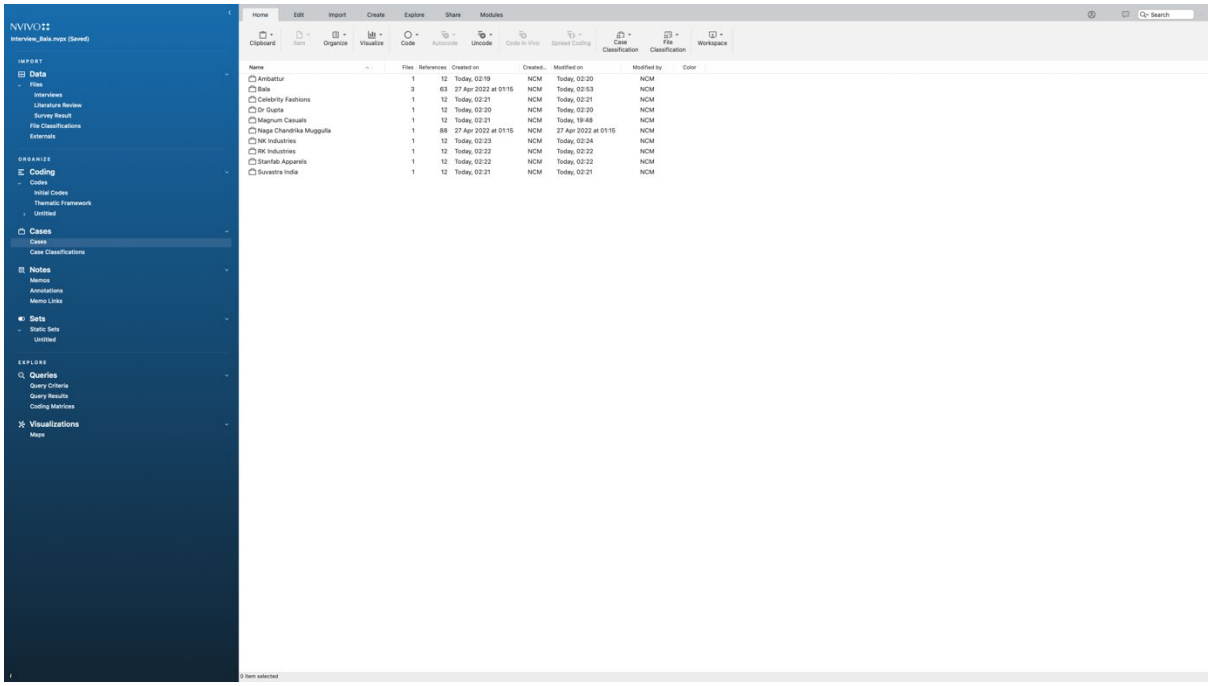

Figure 13 - Cases that make up the thematic framework (NVIVO)

6. Discussion

Literature provides many evidences that Blockchain technologies have helped major fashion brands achieve Sustainability, Traceability, and Transparency objectives through the use of Digital Ledger technologies and global information sharing frameworks such as GS1 (*GS1 Global Traceability Standard | GS1*, n.d.; MHL, 2017).

There is very little research into the application of blockchains to the supply chains of apparel manufacturing process and identifying tangible and economically viable benefits through the use of Blockchains. Representatives of most manufacturers that were interviewed pointed that the choice of suppliers who would provide the materials such as fabric, trims and accessories is decided by the client (brands such as H&M or ZARA) in majority of the orders they receive. Their own choice of supplier is limited to only a small portion of their bulk orders. This indicates the following. Firstly, manufacturers need to be flexible to work with either the suppliers of their choosing or with the suppliers the clients nominate. Secondly, Sustainability, Traceability, and Transparency objectives for the apparel manufacturers are largely derived from the requirements stipulated by their clientele.

It has been observed that the blockchain plays an important role in the fashion industry which is associated with the chain management process Value chains also help in increasing the efficiency of the business organisations in the fashion industry in India to make sure that the business can deliver the valuable products for the customers at the low prices. According to Piboonrungroj and Simatupang (2017), fashion is also emerging as the dominant part in India because of which the utilisation of the block chains creates a major impact on the sustainability level. The implementation of the technology of blockchains seems to help for collaborating with developed brand value as well as the manufacturing departments of the fashion industry in India. It has also been found that because of the relevance in the blockchain in the apparel industry of India the efficiency has increased effectively. The technology has also led to the development of transparency in the organisation due to the tracking ability as well as the attribution.

6.1. Value Chains – Apparel Manufacturing

As opined by Kano and Yeung (2020), the value chain is considered as the step-by-step process for making the business model to transform the products or services from ideology to reality.

Apparel manufacturers are the key contributors to the ecosystem of the Fashion industry. In order to deliver value, these companies work with a plethora of suppliers to source the materials such as fabric, threads, trims and accessories. It is evident from the data collected, the supply chains of these manufacturing companies are quite complex in nature. The manufacturers need to work towards very tight timelines to enable Just In Time inventory management for their clientele. Often times the manufacturers need to accommodate changes to designs and appropriately manage their own inventories of the materials involved in the apparel creation process.

6.2. Digitisation

According to Vaska et al (2021), digitisation is important for the growth of the business because of the integration of the technology which helps in transforming the way through which the organisations can operate across various areas, channels, and services along with the customers as well as stakeholders. It has been observed that the famous and reputable fashion designers in India are effectively taking the initiatives in order to be the part of including digitisation in the Indian fashion industry. The fashion industry has evolved in this modern era because of the utilisation of the blockchain technology which includes the three-dimensional designs in the products, virtual understanding of the size as well as fittings have helped the industry to grow rapidly. As opined by Verhoef et al (2021), the Indian retailers along with the designers tend to make their collection according to the needs or the preferences of the customers

in order to make sure that the customer centric approach is maintained effectively. The change management in terms of the garment manufacturing industry in the country India has utilised the blockchain technology. The change management has also brought the scope for the garment industry in the future for the growth as well as development.

6.3. Integration with Blockchains

According to Alves et al (2022), blockchain also has the ability to be more transparent and accurate tracking end-to-end in the supply chain management. The organisations can also digitise the physical assets as well as creating the decentralised record of each and every transaction that also helps in making it possible for tracking the assets from the production to the delivery or use through the end user. Blockchains also help the fashion industry in the country India because it helps in facilitating the voting, reducing the occurrence of frauds as well as improving the functions of back office which includes purchasing. As opined by Dutta et al (2020), the business transactions in the future, management of the data and the ways through which the decisions are taken in the organisations and the business, need to keep the track of the manners in the organisation works. It has also been found that changes are occurring in the fashion industry and has been accelerating in the country India through the utilisation of blockchain technology to maintain transparency. Transparency is an extremely important step for achieving success in the organisation.

6.4. Sterling Styles: A case study

Gone are the days when we are not involved in knowing what is happening after we ship the garment according to Bala, Senior Manager at Sterling apparels. We are going into a pattern of these scorecards which are given by the buyers. So we naturally know what is the product, how is the product and what is the performance in sales also. So you know that is one of our key

performances. So we keep ourselves updated on what is happening to the government that is going on the floor in the.

And what will be the tails and what will be the outcome of the business, OK? And that reflects in our next season. So that is how we generate business and we, you know, take the next set of replenishment of orders or the new cells that come into our, you know production and the next season because there are some reorders, there can be replenishments, there can be you know new sales, all these depends on what we supply and how we perform and how we deliver or in what quality and how.

You all these factors come into play, so its blockchain is going to involve influence all these things, then definitely we will have you know we can consider that on the long run. Already there is a system in place where we get the, we get all the information. So, in addition, if this is going to help, fair enough, we will look into it.

(Koens and Poll, 2019) the authors argued that Blockchain does not seem to be a viable solution in certain scenarios when only technical technological scenarios are taken into account. In their analysis, the authors studied the cryptocurrency bitcoin the identity management solution or port and the supply chain scenario for agriculture products called table grapes they noted these three adoptions of blockchains employed different scenarios. Bitcoin for example was purely a technological scenario, you put on the other hand demonstrated network scenarios while table groups implementation of Blockchain primarily employed economic incentives scenario. The authors employed a generic description of Blockchain technology and introduces the decision model (Wüst & Gervais, 2018).

7. Findings and analysis

The following chapter presents the author's observations and tries to establish themes and associations with the literature review based on the responses received to the questionnaires

described in Section 5.2.3 from the senior managers at some reputed apparel manufacturing companies in India. Questions in Table-5 were designed to gain insights into the data sample. The questions in Table-6 attempt to capture information related to value chains of the companies that were surveyed based on Porters framework and questions in Table-7 themselves can be largely construed as themes at a high level, and these questions were designed to understand commonalities between the thought processes amongst these companies.

The study has evaluated the understanding of the apparel manufacturing industry in the Indian context. In the research, there has been information related to the secondary qualitative thematic analysis which relate the role of blockchain in the Indian fashion industry. Moreover, the study also helps in understanding the awareness of blockchain technology in the organisations of the garment industry of India. Change Management and the challenges of adaptability also being measured in the study. Apart from these, there has been constructive information about the traceability of supply chain management through the blockchain system in the apparel manufacturing industry of India respectively.

7.1. Data Sample

Nine companies responded to the online questionnaire. The data sample is quite small for this study but the study sets stage for further research into the Blockchain adoption by apparel manufacturers. All respondents could make the connection with Blockchain Technologies based on the videos presented to them 2 mong the 9 companies Strongly agreed that the material was informative.

7.2. Value Chain

All the nine companies who responded to the questionnaire were apparel manufacturers who produced in bulk for reputed fashion brands. They were not involved in any form of Distribution or Sales activities. Infrastructures of all companies largely resemble one another due to the nature

of the end product they produce. Celebrity Fashions Pvt ltd expressed pride in their focus on continuous infrastructure and process improvements. Human Resources division in all nine companies are focused on the welfare of its people. Ambattur Clothing Private Limited and Suvastra India have Transparency and Sustainability objectives under their HR and operations policies. Dr Gupta & Co, RK Industries, and Sterling Styles have explicitly mentioned the use of ERP systems whereas NK Industries utilize SAP in all manufacturing processes. Details forecasting and study of trends, “Fast Fashion” sourcing techniques, GOTS stands for Global Organic Textile Standard find mention in the procurement processes the companies have adapted to ensure the pace of production is at par with the demand and rely on trusted partners they have worked with in order to ensure the materials needed for production are in constant supply at the right time. Logistics are mainly outsourced, but Ambattur clothing private limited utilise their warehouses as well.

Based on the value chain analysis conducted for the Apparel manufacturing units in India, it is apparent that most of the Traceability and sustainability objectives are inherited from the client requirements, and in majority cases such as Sterling Group, it is client who suggests trusted partners for both procurement and final product distribution. The company's involvement is limited to manufacturing operations.

In Sterling Group's perspective, operational data such as number of machines, and machine throughput can be digitised and made available in a BCT so that the company's real time production capacity is known to other partners in the Supply chain who have also subscribed to the BCT.

It can be observed that enrolling to BCT might have indirect benefits for the manufacturing unit, as they can be assured that the supply chain partners would adhere to relevant quality requirements. However, quantifying the benefits will need more study.

7.3. Theme analysis

In Table-8 below, the author has filtered out the questions that are most relevant from theme analysis perspective.

Q. NO	QUESTION
1	Traceability of materials is a concern for the company
2	Sustainability is Goal for the company
3	Trust and Conflict resolution is a concern for the company and its supply chain partners
4	In your opinion, are Blockchain technologies (BCT) relevant in solving the paint points in the supply chains?
5	The company has the necessary digital infrastructure in place to integrate with Blockchain technologies (BCT).
6	The company supports supply chain partners with abilities to digitally integrate

Table 8 - Key Questions for Theme Analysis with Serial Numbers

Table-9 below shows a heat map of the responses received from the senior managers of the nine companies who responded to the questionnaire. The responses were captured as multiple choices on a five point scale ranging from Strongly agree to Strongly disagree.

		Q. No					
	Name of the Company	1	2	3	4	5	6
1	*Ambattur clothing private limited*						
2	*Dr Gupta & Co*						
3	*Magnum Casuals*						
4	*Suvastra India*						
5	*Celebrity Fashions Pvt Ltd.*						
6	*Stanfab apparels*						
7	*RK Industries*						
8	*Sterling Styles*						
9	*NK Industries*						

Table 9 - Heat Map of Codified responses to Key Questions

Legend

Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree

Q. No	Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Traceability of materials is a concern for the company	0%	67%	22%	11%	0%
2	Sustainability is Goal for the company	56%	44%	0%	0%	0%
3	Trust and Conflict resolution is a concern for the company and its supply chain partners	0%	22%	67%	11%	0%
4	In your opinion, are Blockchain technologies (BCT) relevant in solving the paint points in the supply chains?	0%	22%	78%	0%	0%
5	The company has the necessary digital infrastructure in place to integrate with Blockchain technologies (BCT).	0%	33%	67%	0%	0%
6	The company supports supply chain partners with abilities to digitally integrate	0%	22%	78%	0%	0%

Table 10 - Aggregation of responses for sentiment analysis

Table-10 summarizes responses to the ten question into aggregate percentage. The data collected shows that 67% of the nine companies Agree that ***Traceability*** is a concern to their organization whereas 22% were neutral and 11% disagreed. Value chain analysis for the 11% companies that disagreed indicate they have good ERPs in place and have some sort of process in place to address traceability objectives. ***Sustainability*** appears to be a strong objective for all the companies with 56% in strongly agreement and the remaining 44% also in agreement. ***Trust and Conflict resolution*** remains a concern for 22% of the nine companies whereas 67% companies admitted that the concern exists but they are dealing with it using bespoke processes they have in place. Out of the nine companies, Dr. Gupta & Co and Celebrity fashions were the two companies that opined Blockchains are relevant to solve the issue they have in their supply chains based on the information presented to them. Three companies said they have the necessary technology infrastructure in place to integrate with BCTs. Finally, Two companies out of nine said they would like to work with partners or suppliers who had technology capabilities to integrate with them digitally.

The section has analysed all the findings on the basis of the research topic like blockchain system relation and effects on the supply chain and change management of the Indian fashion industry and it has been found that it has a huge impact on that. Therefore, it has also been found and evaluated in the following section that blockchain application has some adaptability issues like mechanism related and others which can affect the pattern of work in the Indian fashion industry in a certain manner.

7.4. Secondary qualitative thematic analysis

7.4.1. Role of Blockchain in the Indian fashion industry

In India. As blockchain is a large and distributed digital database which helps in storing the record of the fashion industry. Thus, sustainability has been labelled by blockchain through product validation that can provide the supply chain transparency to the customer.

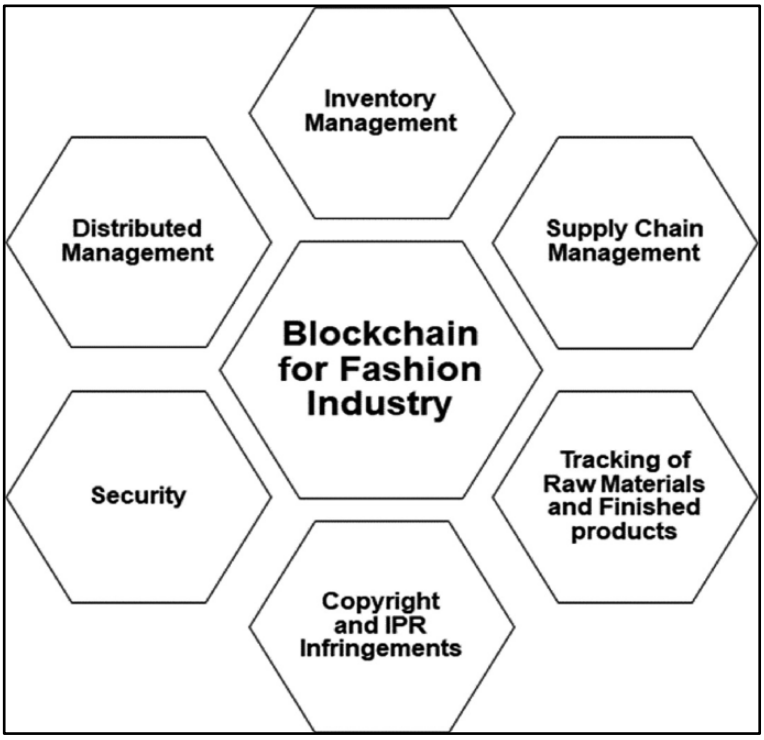

Figure 14 - Blockchain technology in the fashion industry (Source: Tripathi et al., 2021)

The above figure (12) depicts the role of blockchain technology in the apparel industry. Tripathi et al. (2021) opined that the role of blockchain provides potential solutions to the existing challenges and issues that have been faced by the apparel industry. Fashion is a most dominant part of India and the use of blockchain impacts the sustainability level. The very first implementation of blockchain technology helps in collaborating with the developed brand value and manufacturing departments for the fashion industry of India.

Furthermore, Chowdhary (2019) determined that the relevance of blockchain in the apparel industry of India helps in gaining customers and solving the complex network of fragmented and

global supply chains. Blockchain technology also decentralised the storage solutions and provided accurate information in the apparel industry of India and globally.

7.4.2. Awareness of Blockchain technology in the organisations of the apparel or garment industry of India

According to Nast (2021), the blockchain technology has emerged in the Indian fashion statement in terms of bringing transparency with the tracking ability and attribution. Based on that, blockchain technology has allowed the supply chain process to be effectively accommodated with the flow of real time data. In the Indian fashion industry, the fragmented data are being removed or more likely to be replaced with single usage. In addition to that, the data added that the welfare of factory employees and workers are being tracked as well followed by their authentication and contribution. Nast (2021) has included an intense usage and application of blockchain in the Indian apparel industry followed by Radio Frequency Identification Device (RFID) and Near Field Communication (NFC). These technological aspects have allowed the products to be verified based on its brands, tags, quality and efficacy as per to provide an authentic and accurate service.

Furthermore, recently the famous fashion designers of India are taking initiatives for being a part of the association in order to include digitalisation in the fashion industry. according to the identification of Laghate (2022), the Indian fashion designers, such as; Manish Malhotra, Anamika Khanna, Raghuvendra Rathore and more are embracing the essential aspect of blockchain technology with the participation in NFT (Non-fungible Tokens). it has been accumulated for a credible source of their earning that they can contribute with their fashion collection. In terms of the source of Dash (2022), Indian fashion and its future is on the way of being digitised. The source has mentioned that the blockchain transformation in terms of 3D design, 3D garments, virtual fitting and such attributes have been making the industry evolve through every aspect of fashion and style. Hence, the Indian retailers and designers are in the trend to make their

collection and supply chain process more customer centric in terms of providing more reliable, trustworthy and authentic materials.

7.5. Change management in the garment manufacturing industry of India with the use of Blockchain

According to Radocchia (2018), the emergence, and conveniences of blockchain technology has brought changes in the management of the garment industry at different levels. The change management has been incorporated using the incorporation of blockchain in manufacturing, and in the supply chain. In the garment industry, change management has been initiated with recognition of the need for change, as technological sufficiency has the potential to bring agility in manufacturing activities (Errida and Lotfi, 2021). The change management has brought the potential scope of more manufacturing, less wastage in time and manpower and more productivity by investing the same amount is the target of many garment manufacturers. As per Agrawal et al. (2021), need for change through blockchain technology in the garment industry has emerged with the effectiveness of high scope of traceability, synchronisation of information, product quality monitoring and control, and real-time data accumulation and maintaining transparency in the entire process. The manufacturing process of the garment industry across the globe is now inclined to adapt changes of blockchain technology in business activities for having higher control over operations.

According to Dutta et al. (2020), changes in the garment industry have been accelerated in India, by the adaptation of blockchain technology to maintain transparency. In businesses, transparency is regarded as a step to success, and blockchain-led control in manufacturing units of the Indian garment sector, and in the supply chain, the industrial operations have witnessed huge shifts towards tech-sufficiency. Moreover, India being a developing nation, and several developed nations and new age investors have become curious about the potential of blockchain in the changing arena of manufacturing and are eager to invest in creating blockchain

infrastructure in the entire industry. The change management has been proposed in garment sector using Technology Acceptance Model, Planned Behaviour theory for manufacturers and Technology Readiness Index (Dutta et al., 2020). These models and theory can bring effective change management in Indian garment manufacturing activities using blockchain technology adaptation for a technology sustainable business world.

7.5.1. Traceability of supply chain through the application of Blockchain in the garment manufacturing industry of India

According to Tandon et al (2021), blockchain has the ability to address the challenges of traceability. Tracking as well as tracing functionality solutions which are implemented with the blockchain helps the whole supply chain networks to document the updates to the single ledger that provides the total data along with the particular source of truth. As opined by Javaid et al., (2021), block chain can be used in the supply chain management because it enables more accurate as well as transparent end to end tracking of the supply chain such as the companies can digitise the physical assets and it also helps in creating the decentralised record of each and every transactions that helps in making it possible for tracking the assets from the production to the delivery by the end user. Blockchain can be used in the process of manufacturing from the sourcing of the raw materials which are delivering the finished services or the products. The blockchain can also increase the rate of transparency along with the trust at each and every stage of the value chain of the industries. Based on the effectiveness of blockchain it can be stated that the technology will play a beneficial role for the Indian garment manufacturing organisations.

7.5.2. Adaptability challenges of the implementation of Blockchain in the Indian garment or apparel manufacturing industry

According to Agrawal et al (2021), blockchain is referred to as the technology along with the combination of the features which includes the decentralised structure, mechanism of storage, distributed notes, consensus algorithms as well as asymmetric encryption in order to ensure

transparency as well as visibility. As per Ahmed and MacCarthy (2021), blockchain has the potential for transforming the functions of supply chains from the business process to the enhancement of security. Block chain also allows the warehouses, suppliers, manufacturers as well as the production sites for connecting with each other through the permanent record of each and every transaction which takes place.

7.5.3. Creation of value through the application of Blockchain in the Indian apparel industry to enhance productivity for the big fashion brands

The most important feature of the blockchain is the transparency in the pathway of service development. Therefore, the use of blockchain can enable value creation for the apparel industry of India. The revolutionary concept of tracing down garment origin can be an important leap using the blockchain technology in the industry. The manufacturer and consumer relation can be improved through implementation of the technology (Agrawal et al., 2021). Along with the information on the garment the customer can also gain insight on the purchase history of the material. The feature of blockchain that promotes accessibility to the information gathering process is another factor that has significant business implications (Alves et al., 2022). Scanning a tag, a customer will be able to gather information on the aspects that comply with their purchase expectations. The stakeholders are an important part of businesses and therefore the value added to the garment quality can be assessed by them. This can influence the interest of investors using blockchain technology. The changes made are centralised in case of blockchain technology and security is prioritised. Therefore, it can be said that blockchain technology can promote sustainability to the Indian apparel business enhancing productivity and customer support.

The application of blockchain in the apparel industry can promote the growth of small and large businesses (Sharma and Gupta, 2021). However, the main issue associated with the application is the inefficiency of technology design to track down the error in case of issues in the system. The effectiveness of blockchain in large scale organisations is still questionable and the

therefore implementation in the Indian apparel industry can be challenging. The implementation cost of block chain is high which might not be appropriate for all scales of business to support. Therefore, it can be said that implementation of blockchain requires to be assessed based on the values it can provide and the efficacy of the implementation.

7.6. Summary

Internet of things has enabled the digitization of supply chains through various devices such as Sensors, tags etc and leveraging global frameworks such as LoRaWaN. The digitized information is valuable across the value chain of the industry through the appropriate use of Blockchains such as Textile Genesis, AURA etc. Top fashion brands such as HUGO BOSS, H&M and Zara have already embraced BCT to achieve their traceability and sustainability targets. The founder of Textile Genesis claims only 95% of the top 100 fashion brands have 100% traceability across their supply chain. This is termed a “95% traceability gap”.

It has been found that the value chain represents the chain of the activities which the organisation generally manages to deliver the valuable products or services to the customers as well as for the market. The effective distribution network also helps in providing the competitive advantage to the apparel industry in India. The supply chains which are connected with each other because of several advancements in the technologies also require the integrative as well as structural problems in order to solve different types of issues. The manufacturing process of the fashion industry all over the world is basically inclined to the adaptation of the changes of the blockchain technology in the activities of the business in order to have the control on the operations. It has also been observed that the blockchain has the ability for addressing the challenges in terms of the traceability. Tracking and the tracing solutions that are implemented along with the blockchains helps the supply chain networks in order to document the updates which provide total data in addition with specific sources of truth. Blockchains can also be utilised

in process of the manufacturing from sourcing of the raw materials that helps in delivering the beetle services or the products to the customers.

As per the data analysis, it has been found that block chain plays a huge role in the fashion industry of India, and it is interrelated with the chain management system as well. It helps in generating transparency in the supply chain management system for which the Indian fashion industry is growing stronger day by day. Sustainability has been labelled by the block chain through product validation. It has the potential to provide supply chain transparency to the customers which enhances the customer dependency base as well. In the Indian fashion industry block chain technology implementation has become one of the most prominent steps that assist the industry in collaborating with the developed brand value and makes the production more effective. Indian famous fashion designers have focused on 3D design and garments which make the pathways more impactful in the competitive fashion industry. With the help of application of blockchain value the Indian garment industry is enhancing their value chain and eventually it would bring up the high productivity and influence the international big fashion brands at the same time. Therefore, some adaptability challenges like enhancing security, mechanism of storage have the intention to reduce the strong base of the Indian fashion industry.

8. Conclusion

Apparel companies are applying 3 key levers to support the transformation.

1. Optimization of current processes, such as central cross-functional merchandising teams, fewer approval iterations, and greater engagement with suppliers.
2. Digitization of processes throughout the fashion cycle, from intelligent consumer insights to virtual design and prototyping, as well as integrated vendor management tools and digital sell-in.
3. Rethinking inbound logistics, with the goal of striking a good balance between air and sea freight, as well as establishing extremely efficient warehousing systems.

Most companies have the necessary systems and processes in place to manage their supply chains. Companies utilize proven methodologies such as JIT, and Lean to manage not only the production but also Supply chains. Only 3 out of 10 companies have general awareness about BCTs. Little excitement about adopting Blockchain. This could be because BCTs are not the silver bullet to solve all the issues concerning the apparel manufacturing industry in India. The majority of the companies are content with the insights related to demand generated by the existing systems.

Survey clearly states that there is gap existing between the ERP systems which is consistent with the resulting in fragmented information (Banerjee, 2018).

All Apparel manufacturing industries are concerned about inventory costs. Purchasing, receiving, supplier invoicing, and payments are all part of the procure-to-pay or source-to-settle process. Finance, warehouse, and legal departments are all involved in this process, which goes beyond procurement. With the introduction of omnichannel distribution, product marketing, sales, and distribution have grown much more complicated, including a larger number of business partners and associates. As a result, supply visibility is limited.

Better technology, more efficient route planning, and tighter ERP integration are all necessities in today's Business. While blockchain cannot deliver these features, it can increase transparency, reduce or eliminate reliance on middlemen, improve inventory visibility across the supply chain, and improve tracking and communication. These talents have the potential to considerably improve performance of every department.

From a managerial outlook, this is a hot topic. This paper can be a good starting point for a debate about the viability of a blockchain initiative. This study provides useful and unique insights for manufacturers considering the drivers and challenges to new blockchain initiatives, as well as real questions that managers may use to determine whether blockchain technology satisfies the needs of their specific production context (Moretto and Macchion, 2063).

Blockchain have revolutionised how fashion industry can utilize the real time flow of information within the supply chains of the big brands in the Fashion industry in India and globally leading to improved transparency, reduced costs and ensure a sustainable business which can be coined as important feature delivered by the blockchain technologies. The impact of the value is considered as important in every industry because it includes the welfare of the employees in the fashion-based firms that is important for the growth of the organisation.

Blockchain can be considered as the technology leveraging unique features such as the consensus algorithms, storage mechanism and the asymmetric encryption would enable the apparel manufacturers provide services to big fashion brands in a way that has not been seen so far. At the offset, integrating ERP systems with the blockchain technologies such as Textile Genesis appears to be the most natural course of systems evolution in the fashion industry since doing so would help in promoting the growth as well as development for the small and large business organisation.

Based on the evidences discussed in this paper, it can be concluded that embracing blockchain technologies (BCTs) and integrating them with existing ERP systems can be beneficial to the apparel manufacturing industry since BCTs have the ability to increase the rate of transparency in addition to the trust, loyalty at each and every stage of the value chain analysis in the fashion industries in the country India.

This paper does not articulate the material benefits that can be realised through integrating the ERP systems with Blockchains. However, this work can be used to further research into identifying material benefits for the apparel manufacturers and also look into how embracing BCTs at manufacturing stage will bring about more efficiencies in the entire fashion industry ecosystem including subjects such as recycling.

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10. Appendix 2 - Informational Videos

- Blockchain: What are its 3 distinct features? - https://www.youtube.com/watch?v=TflwdPtPE2E
- Trust Your Supply Chain, How Technology pioneers Transparency and Traceability (Lenzing Group) - https://www.youtube.com/watch?v=DPyvfniIjTc&t=128s
- Textile Genesis, H&M Foundation - https://www.youtube.com/watch?v=_9qSiPRnk9E
- Blockchain tracks manufacturing of high-end textiles from sheep to shop (IBM) - https://www.youtube.com/watch?v=jIR1FC5Hqzw

11. Appendix 3 - Data Collection

11.1. Link to Questionnaire

https://docs.google.com/forms/d/1R2GUliB3mpoHxstZQkm2W6ivgNpdqpLE6Xhh39EAFeQ/edit

https://forms.gle/yNcCbgwt1ocehUoe8

11.2. Responses to the Questionnaire

https://docs.google.com/spreadsheets/d/1Hu0yx9qIwN7JZReWM2VViI1o9vSZ716tqiB94dnMGHE/edit?usp=sharing

11.3. Appendix 3 – Interview Participants

1. Karthik - MD, Suvastra India
2. Vasu – VP Operations, Shahi Exports
3. Revathy – VP Marrketing, Ambattur Clothing Pvt Ltd (ACPL)
4. Bala Chandran – GM, Sterling Group

5. Senthil – VP Marketing, NK Industries
6. Narmada – Manager operations, Magnum Casuals
7. Dinesh – GM, Stanfab
8. Venu gopal – GM, Gupta and company
9. DMM – Celebrity Fashions Pvt Ltd
10. Prabu – GM, RK Industries