IOT: TRANSFORMING THE APPAREL SUPPLY CHAIN MANAGEMENT WITH BLOCK CHAIN TECHNOLOGY

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Abstract - The Internet of Things has the potential to streamline various processes within the fashion supply chain, whether in a retailer, brand, specialist, or producer's ecosystem. In the future, these entities can collaborate seamlessly through the "Web of connected Computers," implemented at relatively low costs. With the emergence of the Internet of Things (IoT), machines can communicate with each other, facilitating real-time interaction with individuals for the exchange of crucial information and responsive actions. Several technologies currently available are shaping the future of Industry 4.0 in the clothing industry. In recent decades, there has been a notable shift toward decentralization as a new manufacturing paradigm in the apparel sector. Concurrently, advancements in data analytics offer deeper insights into clothing production lines, enhancing overall efficiency. This encourages more efficient operations and facilitates the shift from mass production to personalized manufacturing. This segment offers a concise overview of critical elements in service-oriented computing, information systems based on the Internet of Things (IoT), and introduces blockchain technology within the framework of the clothing industry.

Index Terms - IOT, Apparel Industry, Supply Chain, Their applicability

1 INTRODUCTION

Supply Chain Management (SCM) incorporates the entirety of management activities related to the movement of goods within an enterprise, beginning from the acquisition of raw materials to the delivery of the final product to the end customer, with the objective of cost minimization.

In spite of the extensive acknowledgment of the possible advantages of IoT, its utilization in supply chain management and operational excellence, notably in logistics, has been inadequately addressed. Existing literature predominantly focuses on technology, conceptualizing benefits, and simulating applications across various businesses. However, current research lacks sufficient demonstration of operational validity. Although a recent case study explores IoT usage in transportation, it does not specifically address its implications for supply chain applications. De Vass et al. (2018) discovered that supply chain integration (SCI) of IoT positively influences both supply chain and firm performance. Conversely, perceptual research based on surveys falls short in providing insights to the real-world implementation of IoT in logistics processes.

Supply chain operations incorporate a wide range of activities, spanning from product development to operations, including production and manufacturing, procurement, transportation, inventory, and warehouse management, as well as logistics. (1)

Nevertheless, organizations face numerous encounters in the realm of supply chain management today. Some of the encounters include:

- Absence of asset visibility
- Ineffective inventory management
- Mismanaged transportation or logistics
- Mishandling of data
- Inadequate supply chain risk management

IoT has emerged as a prime solution to address these challenges effectively. The Internet of Things refers to a network of interconnected electronic devices communicating wirelessly, accessible digitally from any location.

2 IOT IN SUPPLY CHAIN MANAGEMENT

One of the primary goals in implementing IoT in supply chain management is to achieve effective tracking and monitoring. This technology enables warehouse and fleet managers to oversee the movement and status of their cargo and inventory. However, the scope of the Internet of Things extends beyond its capabilities in asset management.

From a valuable perspective, blockchain essentially functions as a ledger. It meticulously records each transaction, storing the data across multiple servers in an encrypted format. The decentralized nature of the systems housing this data enhances adaptability, making it resilient to the unavailability of various servers. Furthermore, the encryption ensures that manipulating the information becomes a challenging task.

Limited research exists on the influence of IoT in Supply Chain Management (SCM) concerning working eco-friendly. The varied array of technologies, applications, and capabilities associated with IoT, coupled with the intricacies of Supply Chain Integration (SCI) within SCM, necessitate a comprehensive examination. Furthermore, even though literature exploring IoT-enabled supply chain sustainability in the setting of Industry 4.0 is in its nascent stages, a more profound understanding of the impacts of each of these technologies on supply chain activities is imperative.

In any case, what does this mean for real-world operations? Consider a scenario where a shipment is being transported from country

A to country M to evade duties in country U. If the shipment were equipped with GPS-enabled trackers, one could track its arrival in country M, making it more challenging (though not impossible) to conceal using counterfeit documentation since the information would be stored on multiple servers. With a legitimate IoT system, it would undoubtedly ensure that the correct goods were transported with precise provenance. While not foolproof, this approach is certainly more difficult for someone attempting to manipulate the system than traditional methods involving local bribery. Clearly, many other potential use cases can be envisioned. It is crucial to understand that the entire infrastructure is substantial to establish, and the set of guidelines is still evolving. (2) (3) (4).

2.1 Present location-tracking

The IoT furnishes supervisors with a consistent flow of present data pertaining to the product's position and the transport atmosphere. Notifications would be triggered in case the product is dispatched in the incorrect place, enabling the monitoring of both finished goods and raw material deliveries.

Appreciations to environmental sensors, supervisors can monitor shipment situations and promptly react to any alterations. For instance, a prevalent IoT supply chain solution gathers data on vehicle temperature, pressure, humidity, and other factors that could jeopardize product integrity. This data prompts automatic adjustments to maintain optimal conditions. Managers utilize IoT devices and data analysis systems to enhance navigation quality and improve the accuracy of conveyance predictions. With present tracking, industries can verify the products throughout the shipment process, allowing them to predict deliveries more precisely and anticipate and mitigate risks associated with potential delays. (Impact of Internet of Things on SCM, 2021).

2.2 Locate products in the warehouse

The incorporation of IoT-based systems into SCM stands out as one of the primary trends in warehouse technology. This integration brings about a multitude of advantages, ranging from enhanced efficiency in warehouse processes to improved inventory supervision and heightened worker security. Due to environmental sensors, supervisors can track delivery situations and promptly react to variations. For example, a IoT supply chain solution collects data on factors such as vehicle inner temperature, pressure, humidity, and other variables which may affect the integrity of the product, initiating automatic adjustments to maintain its quality.

Thanks to continuous location trackers, such as those worn by employees on-site, locating goods and quickly navigating to the specific aisle for a particular item becomes effortless. In this scenario, the IoT facilitates a seamless workflow and efficiency which would be challenging to accomplish. Furthermore, when IoT joint with artificial intelligence, serves as a catalyst for complete warehouse mechanization, requiring minimal to no labour management. (Influence of IoT on Supply Chain Management, 2021) (5).

2.3 Improve contingency planning

IoT and data analytics perform a crucial part in helping supply chain managers plan routes by considering factors such as traffic, weather conditions, potential accidents, or other events that could cause delays along the way. The IoT consolidates all the necessary information to develop adaptable backup strategies and identify the root causes of prevailing interruptions. This technology gives real-time alerts to supply chain managers, facilitating prompt risk mitigation efforts. Managers leverage IoT devices and data analysis systems to enhance navigation quality and improve the precision of delivery estimates. Through continuous tracking, companies can monitor goods in transit, allowing for not only the anticipation of deliveries but also the forecasting and mitigation of risks associated with potential delays. (Influence of IoT on Supply Chain Management, 2021).

3 Applications of IoT in Textile and Fashion Industry

3.1 Manufacturing Sector:

The potential applications of IoT extend to the manufacturing sector, spanning from the initial fiber stage to the production of finished fabric. By leveraging AI to enhance the identification of fiber characteristics and employing IoT for data storage and processing, the result is a reduction in variations in the final product. In current times, IoT integration in spinning and winding machines is aiding in streamlining processes and significantly reducing defects. Analyzing the slower processes and automatically gathering data from the Blow space to the Ring Frame can lead to improvements in quality, time efficiency, labor requirements, paperwork reduction, and minimization of machine downtime, among other benefits.

3.2 Fashion and Designing and Product Sector:

The use of computerized testing tools in conjunction with the development of tests that closely resemble the finished products, executed through modern Computer-Aided Designs (CADs), has resulted in a significant reduction in fabric wastage. This approach also provides much greater flexibility to the system. In the current scenario, the development of an e-product is just a few clicks away. The abundance of cloud data, customer internet searches, and the easy availability of recent designs contribute to product and design development according to customer needs.

Looking ahead, the impact of 3D printing and 4D printing is anticipated to be substantial not only in the final product manufacturing sector but also in the design industry. Presently, digital weaving machines are preferred for their precision, reproducibility, time efficiency, and reduced human effort in creating intricate weaves and designs. With the use of Embroidery CAD, one can simply input designs, and the machines can produce the corresponding embroidered designs accordingly.

3.3 Marketing Sector:

The utilization of the IoT offers significant advantages, vast potential of the sales and marketing sector for textiles. A primary advantage lies in its ability to effectively handle large sets of data. By improving the management of big data, IoT facilitates a better understanding of the textile markets, their dynamics, and the needs and requirements of customers. This enhanced comprehension of the market and customer base contributes to more informed, swift, and accurate decision-making processes.

When introducing a new product, IoT can play a crucial role in predicting customer reactions and reducing the product's shelf life. Advertising, a pivotal aspect of marketing, is significantly influenced by IoT. Google's local search ads exemplify this impact, as advertisements now target specific groups of people based on their searches. For instance, an individual frequently searching for clothing and textiles will receive related advertisements. This targeted approach enhances the effectiveness of advertising campaigns in reaching the intended audience.

4 SUPPLY CHAIN INTEGRATION AND PERFORMANCE

Organizational procedures need to be strategically planned, executed diligently, and seamlessly matched as a unified article to attain a superior modest benefit. Supply Chain Integration (SCI) envisions harmonizing business processes through both inter- and intra-organization of materials, resources, and data flow to deliver the maximum benefit to customers at the minimum cost and with the utmost rapidity. SCI enhances perceptibility, trackability, interoperability, and collaborative decision-making, aiming to maximize the performance of supply chain. Existing experimental indication supports the constructive influence of SCI on performance, as documented in the International Journal of Integrated Operations Research and Applications.

The multifaceted strategy of SCI has an important influence on performance. Inner incorporation breaks down practical silos, fostering association within an organization. For instance, supplier incorporation had shown to enhance association between organizations and their suppliers by handling cross-organization corporate procedures. Similarly, customer incorporation had found to reinforce downstream linkages, facilitating a deep synthesis and analysis of market expectations and valuable chances. Additionally, internal coordination helps as a foundation for outlining external association.

4.1 IOT AND SUPPLY CHAIN INTEGRATION

The Internet of Things (IoT) connects lakhs of products and devices, presenting valued openings for enterprises. The widespread adoption of IoT has greatly reshaped how humanities access, exchange data, and engage with their surroundings. The supply chain is also embracing IoT technologies. While the term IoT was originally coined for RFID, its idea has progressed to encompass embedded technology in any physical product, leading to extensive capabilities and diverse distribution. As a new genre of Information and Communication Technology (ICT), Internet of Things acts as an advanced bridge between the physical and digital realms.

Survey-based empirical generalization has faced criticism for oversimplifying reality, leading to an increasing demand for qualitative techniques. The complex and nuanced phenomena of process incorporation in an Internet of Things (IoT) atmosphere particularly call for qualitative inquiry involving open-ended questions to discover related issues. Though, qualitative narratives derived from interviews have provided limited insights into the IoT's role in Supply Chain Management (SCM).

A title search of peer-reviewed journal publications uncovered 7,537 academic articles on the 'Internet of Things,' with only 60 titles incorporating both 'Internet of Things' and 'supply chain.' While a recent single case study on the Internet of Things in logistics was found, it did not address the IoT's role in integrated processes within retail operations. On the other hand, deterministic hypotheses based on surveys have been criticized for distorting reality, leading to a surge in the popularity of qualitative approaches. Additionally, the complex nature of process incorporation in an IoT situation necessitates qualitative research that delves into open-ended inquiries. Despite the growing interest in supply chain sustainability, obtaining quantifiable data has been challenging. The literature lacks concrete evidence regarding the real-world impact of IoT implementation on retail sustainability. So this research aims on bridge this gap by conducting an experimental analysis to explore how IoT could connect internal and external operations in the retail industry, enhancing sustainability.

Additionally, the limitations of traditional Information and Communication Technology (ICT) have paved the way for a robust network of interconnected things (objects) possessing unique identities, ubiquity, sensing, automation, intelligence, and communication capabilities. Despite being in the starting level of development in various organization, the widespread availability of Internet of Things (IoT) devices is known to facilitate present monitoring across various segments of contemporary supply chains. This capability ensures a seamless flow of information and goods. Initially coined for tracking items along the supply chain, IoT has evolved to encompass various forms such as sensors, personal digital assistants (PDAs), and smartphones. These forms permit Supply Chain Integration, facilitating the conversation of information and the physical stream of goods.

In the context of the supply chain, we define IoT by amalgamating the definitions provided by various authors. IoT, in this context, is characterized as an Internet-based platform comprising universal keen products capable of identification, sensing, processing, actuation, networking, and data sharing. Its purpose is to enable planning on time and connection of logistics procedures within an organization and among supply chain partners. Current empirical evidence, gathered through surveys, highlights the positive and significant impact of IoT capabilities on internal, customer, and supplier integration for performance improvements. Though, review-based observational speculation has faced criticism for distorting reality, leading to an increasing demand for qualitative methods. Moreover, the diverse, intricate, and mysterious aspects of process incorporation in an IoT situation require qualitative research, involving open-ended inquiries to discover applicable topics. Despite this, there is limited awareness of the role of IoT in SCM through interview-based qualitative descriptions.

The lack of concrete evidence regarding the real-world benefits of IoT deployment in various industries has led to uncertainty. Although supply chain sustainability has gained attention, quantifying sustainability has historically been challenging. While the IoT presents a viable solution, there is insufficient real-world evidence of its impact on retail sustainability in the literature. Thus, this study aims to represent the gap by conducting an investigation into how IoT can enhance both internal and external processes with suppliers and customers to enhance the sustainability.

Despite the promises of IoT, several barriers hinder its widespread adoption and use. Many businesses hesitate to embrace IoT due to a lack of awareness regarding its capabilities. The difficulty in predicting the impact of digitalization on businesses arises from its pervasive effects, especially as technologies become more discreet, widespread, and omnipresent. While the cost of IoT hardware, such as RFID tags and readers, had decreased, hesitation to invest in IoT persists due to social, financial, and technical concerns. Barriers such as the integration of logistical activities across supply chains with diverse technology and data services, along with considerations related to security, ethics, privacy, and standardization, continue to impede adoption (Borgia 2014).

5 IoT and Block Chain Technology in Apparel supply chain

In supply chain, raw materials are sourced from vendors, and the production process takes place at same or different production sites. Subsequently, the finished products are transported to intermediate storage facilities, including physical warehouses and transit warehouses and shipment to customers. This garment manufacturing supply chain involves various business entities such as suppliers, manufacturers, distributors, retailers, and customers.

Supply chains in manufacturing and logistics, particularly in industries like textiles and clothing, are grappling with heightened difficulty and the necessity for increased suppleness to meet unique client necessities. In the garment sector, there is a notable emphasis on providing both products and services. The contemporary nature of fast-paced fashion necessitates a high degree of flexibility and adaptability to stay abreast of ever-changing fashion trends. (6).

Moreover, the existing complexity within the apparel manufacturing network is further compounded by the locational dispersion of suppliers and manufacturers. Additionally, an effective data-sharing mechanism among business partners operating in the global supply chain adds to this intricate structure. Handling the sharing, storage, and processing of data within the garment supply chain in such a scenario requires a secure information systems architecture.
Analyzing data from the apparel manufacturing supply network can identify problematic areas, enabling logistics management teams to issue appropriate operational instructions. Modern Information and Communication Technologies (ICTs) are regularly acknowledged for enhancing the capabilities of information exchange within the supply chain. Connectivity serves as the cornerstone for sharing information across textile production networks. (6)

The foundation for information exchange within textile manufacturing systems is the linkage of unique identifications of items by RFID or barcodes technologies in supply chain database management systems. This process is primarily facilitated by the Electronic Product Code Information Services (EPCIS), recognized as the greatest standard in industry. The garment industry is currently leveraging the potential of the Internet of Things (IoT), which includes RFID tags, sensor technology, and appropriate data communication networking services. The perception of the Internet of Things (IoT) seamlessly integrates the digital realm of information technology with the physical world of tangible objects. In the clothing manufacturing industry, contemporary computers and data communication devices contribute to making the physical world more accessible. (6).

Over the past few decades, IoT technology has significantly enhanced various aspects of the garment supply chain, including inventory management, warehousing, product transportation, automatic object monitoring, and supply chain management. Operational managers within the garment supply chain can conduct near-real-time analysis and make informed strategic decisions when they have access to accurate data.

6 Block chain Technology

Blockchain technology initially gained attention as the underlying foundation for cryptocurrencies like Bitcoin. While cryptocurrencies may or may not emerge as the future of currency, blockchain-oriented technologies are highly appealing for a variety of business applications. Regarded as a novel form of information technology, blockchain has the capacity to disrupt various industries and business practices.

Essentially, blockchain is a decentralized data structure consisting of a chain of blocks. It acts as a distributed database or a global ledger, recording all transactions within a blockchain network. These transactions are timestamped and organized into blocks, each block uniquely identified by its cryptographic hash. The blocks constitute a sequential chain, with each block referencing the hash of the preceding one, thus forming the 'blockchain.' This blockchain is managed by a network of nodes, with each node executing and recording identical transactions. The blockchain is duplicated across all nodes in the network, enabling any node to access and review the transactions.

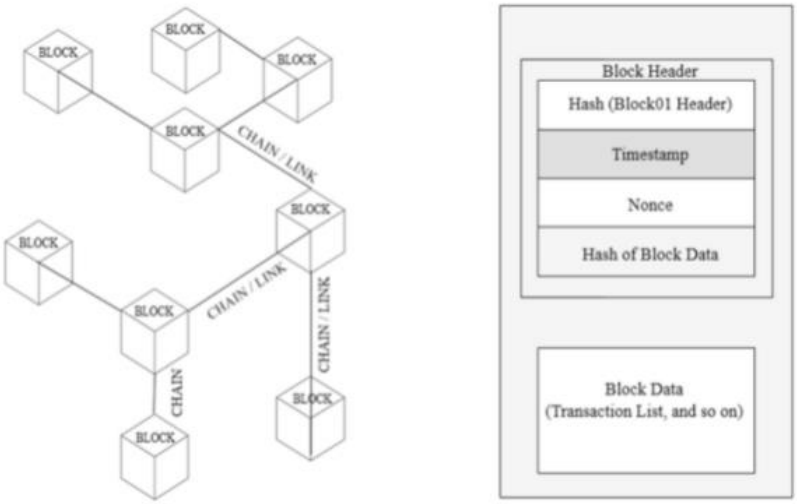

Fig.1 Structural parts of a block chain, Ref. (6)

At its essence, blockchain technology revolves around an unchangeable distributed ledger within a dispersed network, fortified by cryptographic security measures. The structure of blockchain enables participants to distribute a ledger via peer-to-peer replication, updating it with each consensus on a block of transactions before submission. Consequently, blockchain technology holds promise in lowering operational expenses and barriers, establishing unalterable change logs, and facilitating clear ledgers with nearly instant updates. Moreover, it could profoundly influence the structuring of workflows and organizational procedures, paving the way for fresh avenues of innovation and expansion.

In the upcoming decades, both Service-Oriented Computing (SOC) and Internet of Things applications are poised to play pivotal roles and exert a substantial influence on garment manufacturing supply chain management. This part outlines the ways in which SOC technology will be enhance efficiencies, generate fresh business prospects, meet regulatory standards, and promote transparency and visibility in the global textile manufacturing sector. Furthermore, IoT technologies enable the present capture of manufacturing business process data from the operational environment at the plant level.

The diagram below showcases the enterprise architecture employed in this study for the distributed garment manufacturing supply network. The architecture consists of the following layers:

(i) IoT-based services,
(ii) blockchain-based data control, and
(iii) data storage and processing.

The advancement of the IoT has resulted in the development of a plethora of devices, such as sensors and networked interoperable devices, specifically engineered for the collection and sharing of data. The data generated by IoT plays a crucial role in enhancing the convenience of garment manufacturing, enabling diverse decision-making processes across all levels and segments of the apparel business. Figure 2 illustrates the architecture of an enterprise information system tailored for the garment industry.

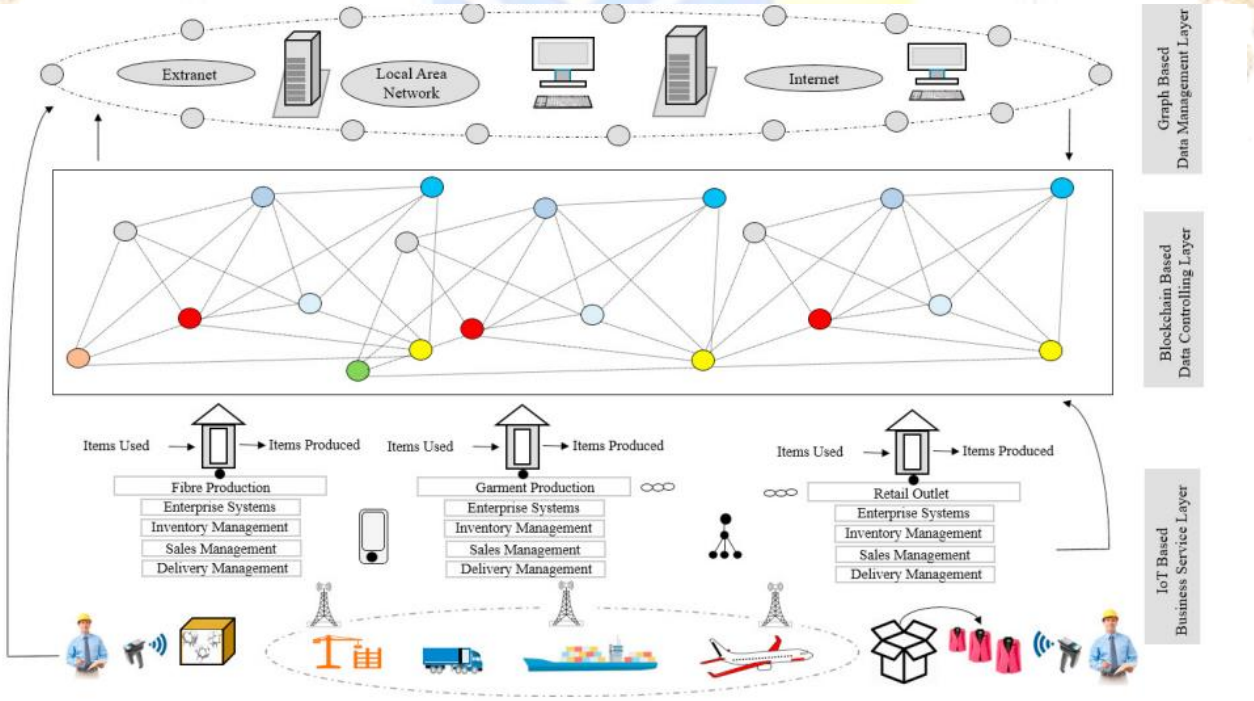

Fig.2 Enterprise information system architecture for apparel business, Ref. (6)

6.1 DATA CONTROL ON THE BLOCK CHAIN

The controlling component based on blockchain is a decentralized database that records transactions in blocks, interconnected through cryptographic hashes over time. The credibility of this framework is solidified through the consensus approval of the mainstream of nodes functioning within the system. This consensus mechanism thwarts data tampering by a single node or a small group of nodes, ensuring that only authentic transactions are documented.

6.2 DATA PROCESSING AND STORAGE

In the blockchain system, nodes within the apparel manufacturing and distribution chain enroll as semantic-enabled agents. The data storage and processing facility, structured on a graph-based approach and utilizing blockchain, logs tagged items as assets.

6.3 EMERGING ISSUES IN THE DEPLOYMENT OF BLOCK CHAIN-BASED APPLICATIONS

The integration of IoT-based technical solutions, combined with the use of the Electronic Product Code (EPC) world-wide network for present data collection, object tracking, and diverse business services, has resulted in a significant enhancement in the accuracy of supply chain operations management.

Blockchain-based solutions enable the decentralized aggregation of extensive data produced by IoT devices, guaranteeing a fairer distribution of benefits among participants in supply chain transactions. Table 1 underscores several research topics, including scalability, security, and IoT data management. Blockchain facilitates machine-to-machine communication, synchronizing sensors and IoT devices with machinery, thereby enhancing flexibility and collaboration with exchange partners. The significance of this capability lies in the secure communication, privacy, and veracity of exchange transactions. Users can directly engage in on-demand manufacturing services with registered machines, securely sending transactions to the machine.

Smart contracts integrated into blockchain-based distributed ledgers enable the incorporation of business logic for various purposes, encompassing payment conditions, product acceptance, intelligent inventory replenishment, predictive maintenance, and repairs.

Table 1: Research issues of internet of things with block chain technology

Internet of things	Block chain Technology
Extensibility	The pursuit of scalable transaction throughput remains a persistent challenge in blockchain technology. Certain blockchain-based information systems utilize a computationally expensive consensus technique, deliberately designed to require solving a cryptographic challenge. Conversely, permissioned blockchains, involving known participants, employ consensus methods grounded in Byzantine fault-tolerant state machines. These methods have been selected for their high transaction throughput and minimal consensus time. Evaluating early adoption and performance is a significant research challenge in assessing the utility and scalability of IoT-based blockchain technology.
Safety	With the ongoing expansion of global partnerships in the apparel business, the textile and clothing industries encounter the challenge of protecting their data, information, and the integrity of physical products from theft and illegitimate trade, which includes diversion and counterfeiting. Furthermore, blockchain-based information systems have the potential to redefine the benefits of IoT by bridging the gap between device and data interoperability, all while ensuring security and privacy.
Data management and Internet of Things	Research is currently underway to address design considerations for IoT data streams, storage, and processing applications. A crucial aspect is comprehending the data in connection with reference data and a business lexicon. Technical challenges include the identification of reference data entities, automated understanding, and the effective management of reference information from external sources.

7 INDUSTRY 4.0 WITH IOT EMBEDDED SUPPLY CHAIN

The Industrial Internet of Things (IIoT) is regarded as the latest revolution in the realm of the Internet. Objects and devices have become smarter, making themselves noticeable and acquiring intelligence by making decisions based on their predefined processes. This is primarily attributed to their ability to communicate with each other using a mutual communication protocol. These objects and devices can either access information collected by physical objects, devices, and sensors, or they can function as integral components within a sophisticated network of services.

This transformation is made possible by the rise of cloud computing capabilities and the shift of the Internet to the IPv6 protocol, which boasts nearly limitless addressing capacity, addressing a constraint of IPv4. The Internet of Things presents solutions through the integration of diverse information technologies, spanning both hardware and software for data storage, retrieval, and processing, as well as communication technology involving electronic systems facilitating communication between individuals or groups of devices. The swift advancement and convergence of information and communication technologies are unfolding across three tiers of technological progress: the cloud, data and communication pipelines/networks, and devices.

The IoT is recognized as a catalyst for the evolving Industry 4.0 period, characterized by automation and digitalization. Expanding upon the three previous industrial revolutions marked by mechanical power (Industry 1.0), mass production (Industry 2.0), and the digital revolution (Industry 3.0), Industry 4.0 brings forth intelligent products, smart machines, and advanced services, including quality-controlled production, scheduled operations, and maintenance. Since its initiation by Germany in 2011 under the Industry 4.0 initiative, which gained significant attention on the 2016 World Economic Forum's agenda, the role of IoT has emerged as one of the

most influential technologies in the forefront.

While Industry 4.0 aims to elevate company's manufacturing to the next stage, its genuine vision can become a realism if supply chains become more digital, self-assisted, and data-driven. Therefore, the incorporation of supply chain processes with Internet-connected technology is vital for Industry 4.0. Moreover, the IoT platform integrates supply chain processes with external business partners such as suppliers and customers, yielding important recital advantages. In initial context of Industry 4.0, IoT applications can aid in present asset tracking, monitoring material directions, managing transportation of logistics, and implementing precise risk management. The envisioned potential is a self-sustained supply chain platform through complete automation with less or no labour involvement (Tharaka de Vass, 2021).
In the context of Industry 4.0, the term represents the next industrial revolution and signifies a new level of control and connectivity across various supply chain industries, with a focus on meeting individualized customer needs more efficiently. The processes encompass the entire product life cycle, starting from ideation, demand generation, development, and manufacturing, to final delivery for the end consumer.

Moreover, Industry 4.0 encompasses recycling and all post-delivery services. The objective of the fourth industrial revolution is to ensure real-time information availability by integrating and connecting all stakeholders involved in the value chain. In Industry 4.0, deriving the optimal value-added flow concurrently is crucial.
The interaction among individuals, objects, and diverse organizational systems generates a dynamic, interconnected, optimized, and value-enhancing flow across all elements in the supply chain in real-time. The figure below illustrates the progression and specific key stages of industrial automation evolution.

8 FUTURE INDUSTRY CONCEPT WITH IOT

Ongoing developments and the transformation of industries, manufacturing will undergo significant changes. Humans and machines will become highly interconnected and interact with one another. In future industries, individuals have need to navigate a intricate environment of processes, networks, machines, sensors, robotics, and devices. It will necessitate diverse operating concepts for improved man-machine interaction.

In the future, rapid, bright, and self-adaptive production processes will be the measure of accomplishment and a modest advantage. Currently, the maximum production facilities are designing systems that will make devices and machines adaptive, fully collaborative, analytical, and more efficiently operate in a manner like humans.

Through the interaction between humans, objects, and various other system elements, it is conceivable that the value chain can progress to be continuous, assisting in achieving various business objectives such as cost reduction, optimizing resource utilization, and ensuring maximum availability. Manufacturers, laborers, and customers need to know and embrace the future supply chain as an progressively complex entity, incorporating various processes, machinery, and components that operate in a coordinated manner. This necessitates adopting diverse operating concepts to streamline and foster synergy between humans and machines, thereby enhancing efficiency and reducing time-to-market. Such measures ensure that manufacturers compete in a manner that minimizes operational costs and maximizes resource utilization.

9 CONCLUSION

The Internet of Things offers an enormous array of applications in supply chain management. It enables the tracking and monitoring of goods, promotes transparency in communication processes, and improves planning accuracy. Implementing an IoT-based platform can be a valuable speculation for both small businesses and large corporations, provided there is a clear objective for what the technology is expected to achieve. Additionally, assembling a skilled crew for the design and development phase is vital. In the dynamic operational landscape, today's textile and garment manufacturing enterprises face significant challenges, including volatility, ambiguity, and difficulty. Adaptability to changing consumer behaviors and fulfillment models, such as a demand for lesser prices, improved service levels, and mobile commerce, is essential.

These challenges exert pressure on the supply chains of clothing manufacturers, necessitating a reevaluation of supply chain design strategies. This involves implementing the right information systems to support supply chain execution, with enterprise information systems structure playing a critical level in addressing these situations. This research outlines a hybrid enterprise information systems structure that integrates IoT applications with a blockchain-based distributed ledger to provide transaction services within a multi-party global apparel industry network. The Internet of Things represents a clever, interconnected world network of items capable of communication and collaboration with each other and their business partners, utilizing unique addressing systems to achieve mutual aims. The information obtained from IoT solutions, when combined with clothing business processes, can significantly streamline operational decision-making. Conversely, standalone IoT application systems encounter security and privacy concerns. (8) (9) (10) (11).

10 REFERENCES

[1] Himanshu Shee, Shan Jahan Miah, "IOT in supply chain Management : opportunities and challenges for business in early industry", 2020.
[2] M.Aabid A Majeed, Thashika D Rupasinghe, "IOT Embedded Future supply chain for Industry 4.0", 2017, pp. 26-28.
[3] Tharaka De vass, Shah Jahan Miah, "IoT in supply chain management: a narrative on retail sector sustainability", 2020, pp.9-12.
[4] Rupasinghe, Thashika D, "IOT embeded future supply chain for industry 4.0 an assessment from an ERP based fashion aapparel and footwear Industry", 2017.
[5] H.S.birekel, E Hartmann, "IOT-future of managing supply chai risks", 2020, pp. 535-548.
[6] Kamalendu Pal, Ansar -Ul- Haque Yasar, "IoT and block chain technology in apparel manufacturing supply chain data management", 2020.
[7] Sneha S Kothari, Simarn V Jain, prof Abhishek Venkteshwa, "The Impact of IoT in scm", 2018.
[8] L.ardito, A.M petruzzeli, "Towards 4.0 industry mapping digital technology for scm", 2019, pp. 323-346.
[9] M.Ben-Daya, E.Hassini, Z Bahroun, "IOT and SCM a literature review", 2019, pp. 15-16.
[10] A.Aryal, Y.liao ,P.Nattuthurai, "The emerging big data analytics and IoT in scm ;a systematic review", 2018.
[11] Hofmann, E & Rüsch, M, "Industry 4.0 and the current status as well as future prospects", 2017, pp. 23-34.
[12] Steve Simke, Karim Rejeb,Horst Treblmaier ,Suhaiza Zailani, "IOT research in supply chain Management and logistics", 2020.
[13] Tharaka de Vasss, Shah Jahan Miah , himanshu Shee, "IOT in supply chain management : a narrative on retail sector", 2020.
[14] Rupansinghe, Thashika D, "IoT embedded future supply chain for industry 4.0", 2017.