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An Integrated Approach to understand Supply Chain Optimization through the Lens of Technology

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Abstract

Supply chain management and optimisation is a crucial aspect of modern organisations and a successful research area. As an important problem for efficient capacity utilization and difficult infrastructure choices, the presence of uncertainty within supply chains is addressed. Organizations are continually refining processes by implementing business process improvement solutions to deliver better business outcomes, even in times of disruption. A lack of transaction and inventory visibility may be one of the important problems at the moment. With the assistance of intelligent workflows, technology can help develop supply chain processes to eliminate operational silos, respond to market disruptions, minimize risk and sustain business continuity. The paper discusses on how use of embedded AI capabilities in supply chain will provide real-time intelligence and actionable recommendations. Data-driven insights help increase efficiencies and reduce costs. Technologies such as Blockchain, IoT, Analytics, Software Process Improvement and many more can impact the supply chain immensely. The paper mentions about various technology including blockchain and how it improves the supply chain by improving traceability, auditability, accountability, actionability and visibility. The right technology helps the business to make the supply chain more accessible, gain more leverage over the inventory, reduce operational costs, and eventually outpace competition.

Keywords: Supply Chain Optimization, Technology, Cycle time, Blockchain, IoT, Software Process Improvement

Introduction

Optimization of the supply chain means running a supply chain at optimum productivity. This is focused on main performance metrics, including overall operating costs and gross margin return on invested inventory. The aim is to produce goods at the lowest average cost and the highest amount of benefit to consumers. In order to meet these goals, organisations must balance the costs of manufacturing, inventory, transportation, fulfilment and customer service expectations. The configuration of the supply chain that is currently the best mix of cost and service may alter over time. This may be due to material cost fluctuations, shifts in the carrier, and demographics of consumers or other factors requiring constant monitoring.

Usually, the process for optimizing the supply chain begins with a detailed review based on predicted demand, accompanied by the implementation of a production and inventory plan to fulfil the forecast. Inbound raw materials or parts, production, transportation and distribution are included in the analysis. In order to help navigate the optimization process and incorporate technical and operational improvements to ensure the outcomes that can thrive in the real world, and businesses typically collaborate with consultants and their service providers. To increase quality and performance in a supply network, supply chain optimization allows the best use of technology and tools such as block chain, AI and IoT. A high-performance supply chain allows business reliability and responsiveness, because consumers get what they want, when and where they want it, in a manner that is both efficient for the company and contributes to the sustainability of the supply chain. Blockchain is a strong technology, and its strength is dynamically strengthened when used in combination with AI and IoT. The relationship begins with the blockchain, which migrates from a traditional business network and puts high quality data partners together. AI takes data from the blockchain, extracts from it a concrete context and creates powerful insights into potential benefits. IoT serves as an interface or sensor that works to transform the real into the virtual at the edges.

Cycle Time Optimization (CTO) is an operational principle that optimizes sub-optimal value-added operations' efficiency while minimizing non-value-added operations and time for optimal performance, cost and responsiveness to customer needs. Cycle time optimization can do wonders as it is visible that the shorter the cycle time, the shorter the lead time to market, and the company will thus launch goods much faster. For example, with new enhanced features, a smartphone market is very demanding, resulting in the launch of new models every week, which demonstrates that the production cycle time is reduced. The cycle time here is of primary importance as this will directly impact on the product's revenue. Lower cycle time means greater efficiency; lower costs and time spent are lower, rising profitability and ROI. As the goods are shipped before their scheduled delivery period, customer satisfaction would be high. Productivity grows as time in the cycle decreases. It can also be expected that the process is simplified, resulting in higher morale for employees. By reducing the time spent on non-value-added operations, cycle time reduction is achieved.

Literature Review

(Tsang, Choy, Wu, Ho, & Lam, 2019) Discuss how food traceability, for enhancing the areas of anti-counterfeiting and quality assurance, has become one of the emerging blockchain applications in recent years. Blockchain tech is committed to creating a new ontology for supply chain traceability. In their paper, a food traceability framework based on blockchain and IoT is proposed to combine the latest implementation of blockchain, IoT technology, and fuzzy logic into a shelf-life management system of complete traceability for the management of perishable food. Lightweight and vaporized characteristics are implemented in the blockchain to meet the needs for food traceability, while an integrated consensus mechanism is developed that considers shipment transit time, stakeholder evaluation, and volume of shipment. Modern supply chains have grown into increasingly complex networks of value and have become a critical source of competitive advantage. The application of the Internet of Things can help companies to observe, track, and monitor products, activities, and processes within their respective value chain networks. (Rejeb, Keogh, & Treiblmaier, 2019)

(Fiorella, et al., 2018) make use of blockchain technology to electronically trace wood from the standing tree to its final use. Info tracing combines product quality details with those relevant

to traceability through an online information system whose steps can be safeguarded via the blockchain for proof of alteration. This is a decentralized and distributed ledger that holds digital transaction records in such a way that they are made available and accessible to multiple network users while keeping them protected without the need for a centralized certification body. The Unified Theory of Acceptance and Use of Technology (UTAUT) and the principle of adoption of technology advancement are used in another study by (Francisco & Swanson, 2018) as a basic basis for traceability of the supply chain. So here a conceptual model is developed and also the study culminates with implications for the blockchain supply chain inspired by the theory and examination of literature.

In fact, visibility of the supply chain is also a significant predictor for agility in the supply chain. In addition, more and more variables increase the supply chain complexity, but in academic literature, the effect of supply chain complexity on the relationship between ICT use and supply chain agility has received little attention. (Liu & Li, 2019) hypothesizes that supply chain complexity acts as a moderator between ICT usage and supply chain agility. Cycle time is the time needed to perform various workstation machining operations on the component. That is the average time of the Elapsed into the final product for the conversion of raw material. This not only includes machining service time, but also includes for two consecutive operations, the idle time or start-up time. Today, cycle time reduction is extremely necessary because long cycle time results in high inventories, high prices, and loss of goodwill from the consumer. By proper demand management, cycle time can be reduced considerably. Cycle time reduction has the benefits of reduced inventory, reduced cost and efficient resource usage. With proper coordination between separate departments concerned, the idle time between two departments. Subsequent tasks are decreased and hence the cycle time is gradually reduced.

Cycle time is, as described by the company and its client, the cumulative time from the beginning to the end of the process. (K. Wavhal, Mahadik, Angre, Shedje, & Kashikar, 2017). Another paper deals with the various business improvement systems to in order to improve business execution. Here to operate more effectively coordination is also an important factor just like the production network where the executives has been respected to be the urgent factor for the organizations to acquire serious edge. The authors see here at the initial level which generally explain the origination of coordination and also on the production network generally characterizes the extent of this related research papers. Also, important aspects explained in the centre of this paper which shows the relationship to the few hot issues basically guides to show how to contribute from changed research edges. At last, the paper with the bits of knowledge from the investigation and future examination this paper helps to show the issue and directions which basically related the supply chain. (Li, 2014).

A basic conceptual model relating product development cycle time to organizational performance was developed and tested by the authors. They find that faster cycle time alone is not correlated with higher accounting returns, revenue growth, or perceived overall efficiency, using data from two industries (automotive and computing) and four countries (European Country- Germany, North American country Canada, Asian country Japan, and the United States). Stronger support is found for the hypothesis that some product development activities interfere with rapid product development to boost performance, such as cross-functional teams and advanced design tools, while other practices, which comprises of reverse engineering of the product of competitors, generally suppress the possible benefits of lower cycle times. The study quantifies how product development cycle times increase with increased product complexity and product novelty, how the use of a cross-functional team interacts with product novelty in the way it acts to reduce cycle time, and how the use of a structured product development process interacts with the complexity of the product in the way it acts to reduce cycle time. The results indicate that in projects in which less of the design is a carryover from a previous generation, using cross-functional teams is more relevant. In comparison, the implementation of a well-thought-out method is more important in the production of complex goods or services by companies (or divisions of companies). The more complicated a product is, the more time it takes to remove a systematic method from the production cycle. (Griffin, 1997)

Research Methodology

Problem Statement

Traditional supply chain lack end to end visibility and also fail to address increasing customer demands. The supply chain also needs to tackle environmental and social impacts. The supply chain is getting complex leading to less profit margin, increased cycle time and new complications.

Objectives

- To explore how technology can lead to supply chain optimization and assist the growth of an organisation
- To explore how blockchain and other emerging technology can help in cycle time reduction

Relevance and Importance

The right technology helps make the organization more relevant to supply chain which gain more control over the inventory, reduce operating costs, and ultimately outpace competition. A detailed overview of the effect of technology on performance parameters and knowledge parameters in the supply chain is analysed in this paper that can help to build quality control into the end-to-end process of production, from raw materials to customer delivery. Also, technology such as Blockchain has been discussed that will make end-to-end monitoring in the supply chain with more transparent and accurate process so that the companies can digitize physical assets and build a decentralized, permanent record of all transactions, allowing the end user to monitor assets from production to delivery.

Analysis

Supply chain optimization uses technological resources such as blockchain, AI and IoT to improve efficiency and performance in a supply network. A successful supply chain optimization process has three phases: Supply chain design in which network design processes and strategic objectives are also described, Supply chain planning which includes the creation of a strategic supply chain deployment plan, inventory planning and the coordination of assets to optimize delivery of goods, services and information from supplier to customers, and finally Supply chain-based execution which focuses on warehouse as well as the transportation management, inventory management global trade management, and other execution applications

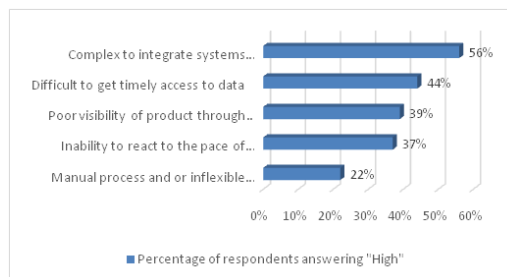
Gap Analysis

This paper addresses multiple gaps that has been identified in the supply chain and also been discussed by multiple authors. They are,

Gap	Description	Citations
Traceability	Overall Traceability is generally defined as the process of tracking the provenance and journey of products and their inputs, from the very start of the supply chain through to end-use.	(Yung Po Tsang, King Lun Choy, Chun Ho Wu, George To Sum Ho, Hoi Yan Lam, 2019), (Kristoffer Francisco, David Swanson, 2018), (Suruchi Mann, Raj Shekhar Gajavilli, Anulipt Chandan, 2018)
Visibility	Visibility of the supply chain is vital to an organization's performance. It will ensure there are no interruptions in the processes. Enhanced supply chain visibility will help in better tracking of performance expectations and estimate future demands.	(Haoyan Wu, Zhijie Li, Brian King, Zina Ben Miled, John Wassick, Jeffrey Tazelaar, 2017), (Deepak Prashar, Nishant Jha, Sudan Jha, Yongju Lee, Gyanendra Prasad Joshi, 2020)

Connectivity	There are hundreds of endpoints to manage in any supply chain across logistics, payments, scheduling, compliance and many more. In order to protect the supply chain effectively, there is a need to be able to understand what is happening at any point in space or time on a consignment’s journey, throughout production, storage and transportation system.	(Maciel M. Queirozr, Samuel FossoWamba, 2020), (Pan, S., Ballot, E., Huang, G.Q., Montreuil, B, 2017), (Ben Mohamed, I., Klibi, W., Labarthe, O., Deschamps, J.C., Babai, M.Z., 2017)
Crisis	Crisis management has been the biggest bane for most firms in the recent past. Crisis can be natural, manmade or discord. Especially in a crisis situation, the global supply chain faces many challenges and all this can lead to long-term problems if prompt action is not taken.	(MaliniNatarajarathinam, Ismail Capar, Arunachalam Narayanan, 2009), (Barry, J, 2004), (Closs, D., Speier, C., Whipple, J. and Voss, D.M., 2008)
Increasing costs	Theoretically, cutting costs sounds straightforward, but in fact, it’s an exceedingly difficult undertaking. Cost minimization metrics is often in conflict with other metrics. Today, supply chains are extremely complex and intertwined intricately, so a reduction in costs in one field of operations will lead to a cost spike in another.	(Christopher, M., Gattorna, J, 2005), (Annelie I. Pettersson, Anders Segerstedt, 2013)

Supply chains cannot get the insight they need because data is siloed, and they lack end-to-end visibility. This will impact the firm’s ability to meet customer needs. But a supply chain optimized through connected technology is the best solution for informational silos. Increasing customer expectations require supply chain that innovates and optimizes every step of the way to meet those needs. So here things that can make the process in a way that streamlining the supply chain that makes it a priority for organizations that want to continue to meet and exceed customer expectations. It is very important for supply chain to respond to change. Now a days agile is new concept so agile is important in modern supply chain to make it competitive. Supply chains have huge environmental and social impacts and also customers now wishto know if the goods are produced in a sustainable and ethical way, using renewable or low-impact extraction methods. A survey was conducted in order to assess the significance of some of the challenges and following were the results. Around 56% of the respondents felt that there is high chance of complexity to integrate systems across the supply network and around 44% felt it would highly difficult to get timely access to data.



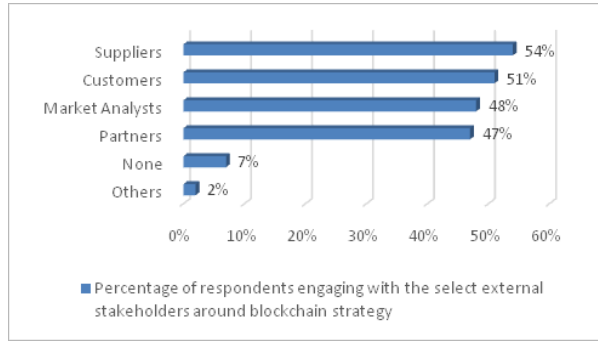
Source: Survey conducted by EVRYTHING at Internet of Supply Chain Business Conference

Based on the data, the following key challenges were identified in the supply chain,

Challenges	Description	Citation
Security	Data protection issues posed by technological developments and the way in which users, companies and other organizations use the technology will be a major concern. Virtually all emerging systems are affected by data-related problems.	(Ann Maruchek, Noel Greis, Carlos Mena, LinningCai, 2011), (H.L. Lee, S. Whang, 2005), (R. Sarathy, 2006), (C. Speier, J.M. Whipple, D.J. Closs, M.D. Voss, 2011), (Elmaghraby, A. S., and M. M. Losavio, 2014)
Compliance	There are many advantages and cost reductions provided by non-proprietary open-source software applications, but compliance with open-source license terms can be tricky.	(Norman, W., 2011), (Lu, R., Sadiq, S., & Governatori, G., 2008)
Privacy	Cloud computing, wearable computing and IoT continue to show tremendous potential for substantial business cost savings and customer convenience. However, as more software apps and other computer resources are hosted and accessed online, threats to data privacy and security are rising.	(Salleh, K. A., L. Janczewski, 2016), (Maple, C., 2017), (Luppici, R., A. So, 2016), (Elmaghraby, A. S., and M. M. Losavio, 2014)
Job Loss	Recent AI developments are very limited in nature, though apparently remarkable, and involve a lot of human monitoring and feedback to work in real applications. As with many new innovations that came before, through automating subtasks of a job, many AI tools would augment and not replace employees.	(Sadaat Ali Yawar, Stefan Seuring, 2015), (Dmitry Ivanov, Alexandre Dolgui, Boris Sokolov, 2019)
Skill Requirement	Advancing technology is finding its way through the supply chain, pushing companies to change processes continuously. With all these technological developments, the challenge is to keep supply chain managers and procurement experts up-to-date and educated.	(Murphy, P., Poist, R., 2007), (Giunipero, L.C., Handfield, R.B., Eltantawy, R., 2006), (Gammelgaard, B., Larson, P., 2001), (Daniel Prajogo, Amrik Sohal, 2012)

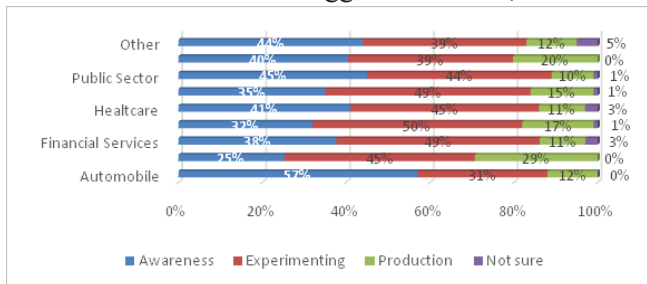
Coming to one such technology which can disrupt the supply chain would be Blockchain. Blockchain can be applied to many problems in the supply chain industry, such as inventory monitoring and cycle time reduction. As a better-automated and less corruptible alternative to centralized databases. Tracking the supply chain management in a blockchain-based supply chain is simple as the product details can be accessed using embedded sensors and RFID tags. The origin of an item can be traced via blockchain from its origin to where it is at the moment. This would help to reduce the Cycle time of the loop. In turn, this would lead to fewer counterfeiters and ensure the processes are secure.

Blockchain inherently involves multiple stakeholders actively throughout the process. A survey conducted by Deloitte in 2018 suggested that companies are asked or engaged by 54% of suppliers in active participation in blockchain. The below graph denotes the same,



Source: Survey conducted by Deloitte in 2018 as a part of global blockchain survey

In the supply chain, Blockchain will also allow manufacturers, transporters, and end-users to gather data, research patterns, and apply predictive monitoring to enhance product experience. This whole process tends to improve the cycle time of any supply chain. In order to overcome the problems of the seafood supply chain industry, big names like Hyperledger have also started incorporating the technology in their ventures. Blockchain inbound logistics and smart manufacturing will help the automotive supply chain to be efficient, which also improves cycle time. The firms are currently majorly into awareness and experimenting stage with block chain and are not using in production a lot. A survey by Deloitte conducted in 2018 suggests the same,

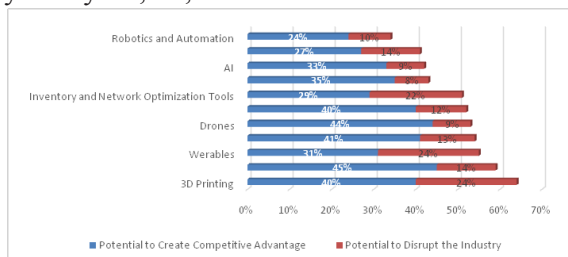


Source: Survey conducted by Deloitte in 2018 as a part of global blockchain survey

Blockchain is a useful tool, and its power is dynamically increased when used in conjunction with AI and IoT. The relationship begins with blockchain, which migrates from a traditional business network and brings together data of good quality across stakeholders. AI takes data from blockchain and draws from it a concrete context and creates valuable insights into potential benefits. IoT acts as the interface and converts the physical information into virtual.

Earlier, supply chain optimization focused on investments in the design phase which focused on strategies to get the lowest trucking costs, easiness to locate the warehouse and ensuring inventory was in the right place at the right time.

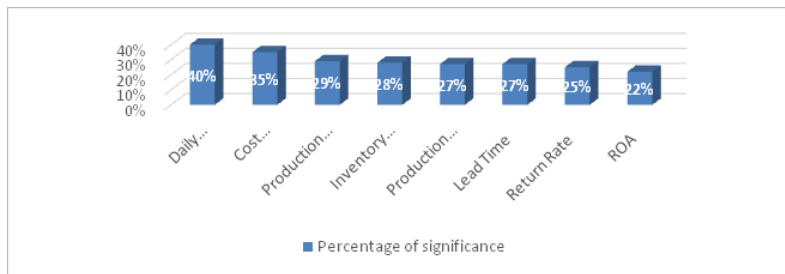
The following graph portrays the potential of some of the emerging technologies on creating competitive advantage or to disrupt the industry. Robotics leads the way with 40% of the respondents think it has the potential to create competitive advantage and 24% believe it has potential to disrupt the industry. Followed by Analytics, AI, IoT and so on.



Source: 2019 Material Handling Institute (MHI) Annual Industry Report

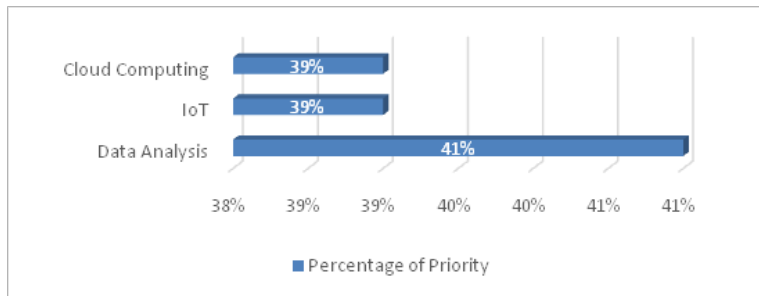
Supply chain optimization makes it possible to keep supply chains on schedule also at times when conditions become generally less than optimal. Supply chain optimization helps keep a firm’s operations steady, despite potential disruptions. Optimization of the supply chain uses technology today to have superior exception management. Another factor in the evolution of the optimization of the supply chain is this trend towards business networks of trading partners operating and collaborating with a mutual end-to-end emphasis on business processes that spread across several companies. Via real-time communication, these multi-enterprise business networks enable better business processes. Important concerns also decide various aspects such as technology, globalization, and empowered consumers are also changing the way businesses manage their supply chains with control. Supply chain operators can use emerging technologies to transform supply chain optimization.

As per the studies done by Forbes, IDC and GEODIS, the most common KPIs for supply chain would be,



Source: Survey conducted by GEODIS as a part of Supply Chain Worldwide Survey

And the top priorities for these firms is the emerging technologies with data analysis leading with around 41%.



Source: Survey conducted by Forbes and GEODIS in 2017 as a part of Supply Chain Worldwide Survey

Bases on these studies, the benefits of the emerging technologies are listed in this paper. They are as follows,

Benefit	Description
Real-time Problem Solving	Supply chain managers can be alerted about a potential problem by linking supply chain assets via IoT, drawing conclusions from this real-time data using AI, and then making this information readily available through visual representations of those assets before it even happens to quickly fix the issue.
Remote and Global Access	Supply chain managers can now proactively track their entire supply chain on any mobile device from any location, with cloud-based emerging technologies. Connectivity also enables the manager to remotely effect a change to the equipment or operation.

Analytics	Companies may see an explosion of more benefits as technologies such as AI become more prevalent in supply chain analytics. Data that was not previously processed due to the limitations of natural language data processing can now be analysed in real time. AI can read, interpret and compare data from various sources, silos and systems quickly and comprehensively.
Virtual Reality	To help provide remote worker training, augmented reality systems can be used to explore a digital manufacturing floor. This form of training not only enhances the experience of workers by gamification, but also ensures that employees have a clear understanding of best practices in the production line.
Crisis Management	Crisis Management can be managed in the system for greater traceability. To help companies better handle supply chain-related crises, Blockchain will provide the right checks and balances. From where a product is sourced to where it is processed and transported, Blockchain can provide full accountability and transparency in anything.
Waste Management	The IoT technology inventory management system will provide managers with visibility into trailers on the road and in the warehouse, so that they know exactly what they have. In ordering processes, AI can help define patterns to predict when an order should be put and exactly how much to order.

The tracking of individual components of an inbound supply chain is currently complicated and vulnerable to mistakes. For the successful functioning of the supply chain, collaboration between multi-tier suppliers, 3PL and transport companies through the manufacturing plant is important. One can ensure the availability of accurate and real-time information among various parties by using blockchain. The condition, quantity and the location of individual parts can be verified by the people concerned. Likewise, the outbound supply chain is also a dynamic network of dealers, suppliers, importers and distributors. A common blockchain-based system ensures transparency and visibility, which, in turn, ensures faster transactions and reduces settlement times which again helps in cycle time reduction as well.

Recommendations

Based on the Analysis conducted through this paper, future supply chains can benefit from the following recommendations,

Recommendations	Description
Blockchain based system for transparency	Blockchain will provide greater transparency in the supply chain, as well as lower costs and risks across the supply chain. In particular, advances in the blockchain supply chain can provide enhanced material supply chain traceability, lower counterfeit trade losses, enhance visibility and comply with outsourced contract manufacturing. Blockchain will make end-to-end monitoring in the supply chain more transparent and accurate: companies can digitize physical assets and build a decentralized, permanent record of all transactions, allowing the end user to monitor assets from development to distribution or usage. This increased accountability in the supply chain offers both companies and customers greater visibility. Blockchain gives access to the same information to all parties within the respective supply chain, potentially reducing communication or transmission data errors. By allowing an efficient audit of supply chain data, Blockchain can streamline administrative processes and decrease costs.

AI based Supplier Management	Suppliers are not prepared to exchange knowledge, which is a major challenge in the digital supply chain. However, by using technologies such as machine learning and artificial intelligence to increase supply chain transparency, businesses can drive product excellence and organizational productivity through quick decision-making without any human intervention. Operations in the supply chain produce vast amounts of data from numerous ever-changing sources. AI will use historical knowledge to evaluate patterns that can aid in streamlining the operation of the supply chain. Slowly making inroads into chain management is the knowledge and willingness to make fact-based choices that AI solutions make possible. It is anticipated that this technology will create a sensible supply chain for the future that can sense, interpret and respond to situations at a granular level.
Technology based Warehouse Management System	Prevention of stockouts and efficient prediction of future orders will drastically reduce cycle time. If there is a stock out or no inventory, one of the most damaging setbacks to demand and therefore the overall order cycle period. This can shut down the activities of the business completely while the production is waiting for a new shipment of the material or product required. This would significantly reduce the overall productivity and ability to fulfil the demands of timely and precise delivery by customers. IoT and AI-based systems can be introduced by businesses that can automatically monitor inventory and alert when a reorder is required before there is a stock out. The loss of time and efficiency that would occur if a forward picking position is empty until it can be refilled can be avoided by warehouse control systems or warehouse management systems. They have minimum and maximum inventory levels that can be programmed, so replenishments are planned automatically until the picking place is empty

These recommendations can further strengthen the supply chain and provide ample amount of growth to the respective industries. Industry 4.0 is a significant disruption in the present scenario and causes enterprises to revalidate the way their supply chain is run. Technologies have arisen that are transforming the conventional working strategy, such as IoT, Virtual Reality, Robotics and Cloud Computing. To make the supply chain more complex, omni-channel techniques have been developed. Big Data and Analytics are helpful to make supply chain more efficient and effective. The new millstones for leveraging the business model and transforming the organization from an operational perspective are Artificial Intelligence and Blockchain. But the emerging AI and blockchain deployments now offer an even larger leap to the next stage. As well as substantial long-term prospects, each has strong immediate consequences. A significant insight into where each technology may be used in the future supply chain is given in the following table.

Artificial intelligence	Inventory Monitoring
Internet of Things	Inventory Location and Status
Blockchain	Verify authenticity, improve traceability and visibility, improve transactional trust
Analytics	Inventory visibility, improve demand forecasting and automation
Quantum computing	IT Infrastructure

Conclusion

Supply chain management and optimization is a crucial aspect of modern organizations and a successful research area. As an important problem for efficient capacity utilization and difficult

infrastructure choices, the presence of uncertainty within supply chains is addressed. Organizations are continually refining processes by implementing business process improvement solutions to deliver better business outcomes, even in times of disruption. This paper focuses more on Blockchain, which is a distributed digital ledger technology ensuring transparency, traceability, and security and is an ideal solution for many global supply chain management problems. Further, Cycle time improvement has been discussed where lower cycle time makes greater efficiency, lower costs with high profitability and ROI in the supply chain process. With the help of technology such as IoT and Software Process Improvement, Cycle time optimization has been done.

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