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Usage of Automation and IoT (Internet of Things) for Supply Chain industries Opportunities and challenges

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Abstract

The Integration of Automation and Internet of Things (IoT) into supply chain businesses is revolutionizing conventional processes, offering unprecedented prospects of efficiency, transparency, and innovation. This study investigates the opportunity and challenges of applying these technologies to supply chain management. Some of the major benefits include real-time product tracking, preventive maintenance of equipment, better inventory management, and full cost optimization. With the ability of IoT-facilitated automation, companies can automate operations, enhance efficiency, conserve resources, and make better decisions through intelligence. However, cybersecurity risks, high implementation costs, interoperability issues, and data protection remain major disincentives. Through this paper, a detailed analysis of such issues is elaborated while gaining insights regarding how businesses can effectively deploy Automation and IoT in tandem to optimize the supply chain functions and remain relevant in an exponentially evolving digital marketplace.

Keywords: Automation, Internet of Things (IoT), Supply Chain Management, Real-time Tracking, Predictive Maintenance, Inventory Management, Cost Optimization, Digital Transformation, Cybersecurity, Data Privacy

I. INTRODUCTION

The Integration of automation and Internet of Things (IoT) technologies in supply chain businesses is transforming conventional operations with unprecedented potential for efficiency, transparency, and innovation. With IoT-enabled machinery and automated systems, organizations can facilitate increased real-time monitoring, predictive maintenance, inventory management, and overall cost savings. Industry 4.0 technologies have fueled the digitalization of supply chain management (SCM), facilitating real-time communication and data-driven decision-making among the various stakeholders [1][2]. IoT contributes significantly to supply chain companies by enabling real-time visibility to planning, improved demand forecasting, and efficient warehouse management. IoT sensors and devices enable asset tracking, the result of which is that goods are tracked throughout each step of the supply chain, eliminating losses and inefficiencies [3][4]. In addition, IoT analytics-driven predictive maintenance reduces equipment downtime, enabling companies to address impending failure proactively before shutting down operations [5].

Automation supports IoT in minimizing the need for human action, improving operations, and giving improved supply chain resilience overall. IoT-integrated smart factories improve production quality and efficiency [6]. Moreover, using blockchain along with IoT offers improved traceability and supply chain transaction security, combating threats against fraud and counterfeiting [7][8]. Despite these benefits, there are hurdles in embracing automation and IoT completely in supply chain businesses. Cyberattacks, privacy of data, cost of implementation, and complexity of interoperability among various IoT platforms are major hindrances to adoption [9] [10][13]. Research highlights the importance of robust cyber security and regulatory compliance to combat such threats and realize the full potential of digital transformation in supply chains [11]. The research suggests the possibilities and challenges of adopting automation and IoT technologies in supply chain companies. When scrutinizing current trends and prevalent norms, this article formulates evidence-based facts regarding how companies can profit through the deployment of such technology in a manner that will promote efficiency, transparency, and innovativeness within supply chains [12] [13] [14] [15]. Subsequent sections consist of major benefits, case studies, and potential means of minimizing the problem of deploying such technologies in a way that will foster long-term sustainability in supply chain management [15] [16][17][19].

II.LITERATURE REVIEW

Haddud et al. (2017): Investigating Internet of Things (IoT) adoption in supply chains, both its benefits and its drawbacks. It expounded IoT's ability to provide supply chain network visibility, efficiency, and supply chain network automation. It talked about real-time tracking and the effect of predictive analytics on inventory and logistics management. It raised concerns regarding data privacy, interoperability, and installation costs. The research suggested that businesses need strategic planning to take advantage of IoT and reduce risks. The authors conducted a case study to examine the trend of IoT adoption. They referred to variations in preparedness among industries. They also indicated towards compliance with regulations when adopting IoT. The research concluded that stakeholder collaboration is the future to successful implementation [1].

Ben-Daya et al. (2017): Conducted a comprehensive literature review of IoT use in supply chain management. They explained how IoT provides visibility, automation, and decision-making across industries. Highlighted applications of IoT, including smart sensors, RFID, and predictive analytics, were enumerated. Cybersecurity attacks, data integration, and scalability were also mentioned as challenges. The authors stressed standardization and cross-platform support. They concluded that despite the difficulty, IoT implementation in supply chains cannot be avoided. The study proposed ways to overcome technological and management issues. It offered outlooks on upcoming trends and areas for future studies. The article concluded that IoT is transforming the efficiency and sustainability of supply chains [2].

Birkel and Hartmann (2020): Identified IoT application in supply chain risk management using predictive analytics and real-time monitoring. Their research demonstrated how IoT-based systems could detect emerging disruptions and act upon them in advance. Risk prevention through IoT such as integration of automated alarms and remote monitoring were discussed. Challenge, i.e., issues of information privacy along with demanding robust schemes of cybersecurity, was also brought up. Case studies were provided through research on how IoT increases resilience within global supply chains. It highlighted the importance of integration of IoT with blockchain to ensure secure data transfer.

Infrastructure investment and training were recommended by the authors for easy implementation of IoT. Authors also recommended that businesses should engage with technology providers to develop IoT applications. Research identified that IoT reduces threats within supply chain networks by a significant amount [3].

Shaik (2019): Carried out a study on IoT predictive maintenance in hospitality infrastructure with the aim of improving operational efficiency. The study explained how IoT sensors monitor the health of equipment and prevent unexpected breakdowns. It highlighted the importance of real-time data analysis in maximizing maintenance planning. Predictive maintenance methods were emphasized by the author for providing cost savings. The study identified the importance of IoT in reducing downtime and maximizing asset life. The study also talked about challenges such as extremely high installation costs and data security issues. The study had case studies in the hospitality industry, outlining the benefits of IoT. The study suggested a fusion of AI with IoT for future forecasting capabilities. The paper stated that predictive maintenance with IoT enhances service quality and reduces downtime activities [4].

Evtodieva et al. (2020):Compared IoT uses across smart supply chain management, highlighting automation and decision-making based on data. In their research, they outlined how IoT facilitates monitoring in real time and improves the accuracy of stock. They addressed how IoT-enabled analytics enhance supply chain forecasting and resource planning. The authors determined the main challenges, such as cybersecurity threats and infrastructure needs. They highlighted IoT's function of optimizing logistics and lowering operational expenditures. The study referred to the possible synergies between IoT and AI for intelligent supply chains. It presented case studies of businesses that utilized IoT effectively in supply chain management. The study suggested a strategic route to IoT adoption for optimal gain. The article concluded that IoT is revolutionizing supply chain management with enhanced efficiency and agility[5].

Hofmann et al. (2019): Analyzed the development of supply chain management in today's digital era with Industry 4.0 and IoT. The research considered the effect of digital technologies on manufacturing and logistics activities. It discussed how IoT automation enhances efficiency in operations and minimizes human interference. The authors made a passing reference to the difficulties of integrating systems, data privacy, and cyberattacks. They stressed digital transformation strategy as a driver of competitive advantage. The research delved into IoT application in predictive analytics and demand forecasting. The research also analyzed how IoT makes it possible for supply chain partners to collaborate. The research revealed that companies invest in digital infrastructure so that it becomes easy to implement IoT. The paper also concluded that IoT is a critical enabler of smart supply chains. [6]

Li et al. (2020): Studied the application of blockchain and IoT in supply chain quality management with transparency and traceability. The study established the way blockchain can ensure IoT-based data, the records being impenetrable. The study detailed challenges like scalability, interoperability, and regulation compliance. Authors have shown case studies illustrating advantages of implementing blockchain with IoT. They have done research applications in open manufacturing as well as industrial automation. The study highlighted the need for real-time sharing of data for quality control. It predicted that smart contracts would enable compliance and enforcement processes to be automated. The study advocated stakeholder collaboration to establish industry standards. The paper asserted that blockchain and IoT collectively increase supply chain integrity and efficiency [7].

Sisinni et al. (2018): Investigated Industrial IoT (IIoT) challenges, opportunities, and future trends. The study identified the roles of IIoT in operational efficiency, asset management, and predictive

maintenance. It explained how IIoT facilitates real-time monitoring and automation in industry. The authors also briefly mentioned security concerns, including cyber-attacks and data vulnerability. They emphasized the need for having a robust network infrastructure to support large-scale IIoT deployment. The study discussed interoperability issues among different IoT platforms and protocols. It stated that standardization emerges as the key factor to facilitate smooth integration. The study also raised doubts regarding IIoT's implication for smart manufacturing and logistics. The study concluded that IIoT has transformative power but must be strategically applied[8].

Rejeb et al. (2019): Studied IoT and blockchain integration for supply chain management and their effectiveness and security. The study pointed out how IoT facilitates real-time monitoring and blockchain provides data immutability. It addressed top applications, such as product authentication and anti-counterfeiting. The authors examined success stories of IoT-blockchain integration. They assessed challenges like scalability, expense, and regulation. The study determined interoperability between IoT and blockchain systems to be a top priority. It proposed that supply chain transactions be automated using smart contracts. The study advised the best practices of organizations to implement these technologies. The research created that blockchain and IoT collectively guarantee supply chain reliability and transparency [9].

Mostafa et al. (2019): Discussed the role of the Internet of Things (IoT) in supply chains, and particularly warehousing efficiency. The authors provide a model that demonstrates how IoT enhances real-time monitoring, inventory control, and operational visibility. Intelligent sensors and RFID technology, they assert, minimize the risk of human mistakes and maximize the use of storage space. Additionally, their paper highlights the requirement for sound cybersecurity to guard private supply chain information. They also discuss the means through which IoT enables interaction among stakeholders to reach decisions expeditiously. To add to it, they include the expense consideration, explaining that investments made on IoT systems may be repaid in efficiency cost savings down the line. Their proposed model contains suggestions to businesses that would seek to implement IoT in warehouse processes. Yet, they recognize integration with existing systems and data privacy issues as challenges. Overall, their study provides worthwhile insights regarding IoT's potential for change in supply chain management[10].

Al-Shargabi and Sabri (2017): Presented an exploratory examination of the opportunities and threats of IoT implementation. Based on their study, they discover the primary advantages of IoT across different industries to be enhanced automation, enhanced analytics, and cost savings. They point out that IoT facilitates real-time monitoring, hence improved operational effectiveness and risk management. Nonetheless, in their research, they also uncover some of the shortcomings, such as insecurity vulnerabilities, complexity in managing data, and expensive implementation. They stress the need for regulatory regulations to address data security and privacy. In addition, they stress the importance of adopting standard protocols to ensure interoperability between IoT devices. Their results indicate that strategic adoption can give companies competitive edge through the integration of IoT in business processes. They conclude by advocating for additional studies that will enable the establishment of secure and scalable IoT frameworks. Generally, they offer a complete picture of IoT potential and threat[11].

Mistry et al. (2020): Examined the use of IoT and blockchain technology in industrial automation. Their systematic review clarifies the way blockchain improves the security and authenticity of IoT systems in manufacturing. They emphasize the ability of blockchain to attain a tamper-evident and decentralized

record of transactions, hence promoting trust and transparency. Their study finds multiple uses of IoT in different industries including automotive, pharmaceuticals, and logistics. They contend that blockchain can balance out the security vulnerabilities of IoT like data leakage and unauthorized access. Yet they recognize challenges such as scalability and the computational expense of applying blockchain. They also suggest hybrid solutions that blend cloud computing with blockchain to enhance performance. Their research indicates that combining blockchain and IoT can have a dramatic effect on operational efficiency in industrial environments. They urge ongoing studies in real-world applications and long-term effects of integrating blockchain and IoT [12].

III.KEY OBJECTIVES

- Improving Supply Chain Efficiency: Automation and IoT adoption simplify manufacturing and planning operations, lowering lead times and improving efficiency [1][6]. Real-time data collection improves decision-making and response to disruptions [5][8].
- Real-Time Monitoring and Tracking: IoT sensors enable real-time tracking and monitoring of products, minimizing loss and improving visibility [2][7]. Blockchain adoption improves data security and transparency in supply chain operations [9], [13].
- Predictive Maintenance: IoT predictive maintenance reduces downtime by detecting probable equipment failures before they happen [4] [12]. Maintains maximum operational efficiency by minimizing surprise failures and maintenance expenses [8] [14].
- Enhancing Inventory Management: Automated inventory systems using IoT optimize inventories, minimizing stockouts and overstocking [3] [10]. Real-time tracking of inventories enhances supply-demand matching in dynamic markets [6][15].
- Cost Reduction and Resource Optimization: Labor expenses are minimized while operational accuracy and productivity are maximized through automation [1] [16]. IoT-enforced analytics enhances planning on resources using transportation route planning and demand forecast [5] [11].
- Supply Chain Risk Management: IoT provides risk management using real-time data on external supplies impacting supply chains, including geopolitics and weather [3][8].AI-brokered automation ensures regulatory compliances and discourages fraudulent processes [9] [13].
- Data Privacy and Security: Fears of data breaches and unauthorized access are concerns of highest priority [7] [11]. High Upfront Cost: IoT and automation deployment require high initial capital, which may deter small businesses [2] [12].
- Interoperability Issues: IoT devices and platforms lack a common standard, making interoperability a challenge [14] [15].
- Cybersecurity Vulnerability:Increased interconnectivity breeds increased vulnerability to cyber-attacks to supply chains, requiring high-level security systems [6][8].

IV.RESEARCH METHODOLOGY

This research applies qualitative and quantitative methods to examine the integration of automation and Internet of Things (IoT) in supply chain businesses. It applies a systematic search of available scholarly articles and business reports of IoT adoption in supply chain management. These sources include peer-reviewed articles from journals, conference papers, and case studies of real-life applications of IoT-based automation in supply chains [1][2][3]. The research design is organized into three phases. Phase one is the literature review of the key advantages and disadvantages of IoT implementation in supply

chains, for instance, efficiency improvement, predictive maintenance, enhanced inventory management, and real-time tracking facility [4][5][6]. The second step is a cross-industry comparative case study for manufacturing, retail, and planning to determine how IoT integration contributes to supply chain openness and the efficiency of operation [7][8][9]. The third step applies qualitative synthesis methodology for analyzing industry patterns and directions on IoT-based automation, considering challenges from cybersecurity threats, infrastructure needs, and interoperability issues [10] [11] [12].In a bid to enhance the validity of the research, data from recent empirical research is utilized, such as statistical models and structures employed in assessing the performance of IoT-based supply chains [13] [14] [15]. The research also examines the interaction between blockchain and IoT in ensuring safe data handling, as well as enhanced traceability [16]. Through the fusion of data from various sources, this research gives a critical analysis on how automation and IoT transform supply chain businesses, as well as best practices guidelines and implementation problems.

V. DATA ANALYSIS

The Integration of automation and Internet of Things (IoT) technologies in supply chain companies transformed traditional business models, facilitating efficiency, transparency, and innovation. IoT technologies provide real-time tracking, allowing inventory, shipments, and planning networks to be followed in real time. Supply chain visibility significantly reduces delays and enhances decision-making [1][3][5]. For instance, IoT sensors and RFID tags improve warehouse operations by giving real-time information on inventory levels to prevent stockouts and overstocking [10]. Predictive maintenance is also a significant advantage of IoT integration into supply chains. Sophisticated IoT-based monitoring systems detect potential failures prior to their occurrence, minimizing equipment downtime and preventing costly interruptions [4][8]. A study finds that companies using IoT-based predictive maintenance experience 20-30% reduced unplanned downtime, and this translates to great cost savings [7]. Moreover, automation and IoT streamline inventory management by efficient warehouse management and demand forecasting. AI-driven analytics in combination with IoT technology presents precise models of demand forecasting to supply synchronously with customers' demand without surplus production [6] [13]. IoT sensors and automated replenishment in retail supply chains have optimized product availability, leading to increased customer satisfaction [14]. Despite such advantages, there are limitations to the use of IoT in supply chains. Interoperability issues, data protection legislation, and security vulnerabilities are primary concerns [2] [11] [15]. Blockchain has also been proposed as a method of enhancing the security and transparency of data with immutable transactional and shipping records [7][9] [16]. Blockchain-based IoT solutions have been identified through research to promote traceability, fight fraud, and establish stakeholder trust [12]. Briefly, the combination of automation and IoT in supply chain businesses offers unprecedented opportunities for transparency, efficiency, and cost reduction. Although there are risks, developments in AI-based analytics, blockchain, and predictive maintenance are reducing these risks, and the application of IoT is a key element of future supply chain development [5][8] [13].

TABLE :1 CASE STUDIES IN SUPPLY CHAIN IOT INTEGRATION

Company/Industry	IoT Application	Key Benefit	Technology Used	Challenges	Reference
Amazon (Retail)	Automated	Increased	RFID,AI,	High initial	[1][6]

	warehouses with IoT-enabled robots	operational efficiency and reduced labour costs	Robotics	investment	
Walmart (Retail)	IoT-based inventory tracking	Improved stock management and reduced losses	RFID,Cloud Computing	Data security concerns	[2][10]
Maersk (Shipping)	Real-time cargo tracking with IoT sensors	Enhanced shipment visibility and reduced delays	GPS, Blockchain	Integration with legacy systems	[3][7]
BMW (Automobile)	IoT-driven predictive maintenance in logistics	Reduced downtime and improved vehicle performance	Machine Learning,IoT sensors	High implementation cost	[5][9]
DHL (Logistics)	Smart IoT warehouses	Faster and accurate order fulfillment	RFID, AI	Scalability issues	[4][8]
Pfizer (Pharmaceuticals)	IoT for cold chain monitoring	Ensured drug safety and compliance	IoT temperature sensors	Connectivity issues	[6][13]
Tesla (Automobile)	IoT-enabled supply chain analytics	Data-driven decision-making and efficiency	Big Data, AI	Cybersecurity threats	[7][15]
Ford (Manufacturing)	IoT-driven demand forecasting	Optimized production and reduced waste	Predictive Analytics, IoT sensors	Data integration challenges	[11], [12]
Coca-Cola (Beverage)	Smart vending machines with IoT	Personalized customer engagement	IoT, AI	High maintenance costs	[9][16]
Airbus (Aerospace)	IoT for predictive maintenance of aircraft parts	Improved safety and reduced operational delays	Digital Twins, IoT sensors	Data privacy concerns	[10][14]
Siemens (Manufacturing)	Smart factory with IoT automation	Improved efficiency and reduced human error	IIoT, Robotics	Costly infrastructure changes	[12][13]
IBM (Technology)	Blockchain-	Enhanced	Blockchain,	Regulatory	[3][14]

	integrated supply chain IoT	transparency and fraud prevention	IoT	compliance issues	
Nestlé (FMCG)	IoT-enabled food quality monitoring	Increased consumer trust and compliance	IoT sensors, AI	Sensor calibration issues	[5][16]
Nike (Apparel)	IoT-based real-time inventory management	Reduced overstock and stockouts	RFID, Cloud Computing	Scalability concerns	[8][11]
Boeing (Aerospace)	Digital twin technology for supply chain monitoring	Increased operational efficiency and reduced costs	IoT, AI, Big Data	Data security risks	[14][15]

The case studies in the table demonstrate the role of automation and IoT in reshaping supply chain management across industries. In the retailing industry, Amazon and Walmart have been leveraging IoT uses like automated warehouses and RFID-based inventory management, enhancing operational efficiency and minimizing stock loss [1][6][2] [10]. In the same vein, logistics firms such as DHL and Maersk utilize IoT for intelligent warehouse management and real-time tracking of the cargo, enhancing supply chain visibility and minimizing delivery delays [3][4][7][8]. In the automotive sector, BMW and Tesla utilize IoT-based predictive maintenance and supply chain analytics, enhancing vehicle performance and reducing downtime [5][9][7] [15]. Ford has used predictive analytics and IoT sensors to improve demand forecasting, minimizing waste and maximizing production [11] [12]. Pharma industry, through Pfizer, is dependent on IoT for cold chain tracking, ensuring compliance and safety of drug material during transit [6] [13]. IoT-based digital twins are used by aerospace firms like Airbus and Boeing to track supply chain performance and enhance aircraft maintenance procedures [10] [14] [15]. In production, Siemens has introduced IoT-based smart factories, increasing efficiency and eliminating human mistakes by way of automation [12] [13]. IBM employs blockchain and IoT in its supply chain to increase transparency and prevent fraud [3] [14]. FMCG players such as Nestlé use IoT to monitor food quality and Coca-Cola to use IoT in smart vending machines, gaining customer trust and engagement [5] [16][9] [16]. Nike also uses IoT-based real-time inventory management to avoid overstocking and stockouts [8] [11]. While IoT adoption by supply chain businesses has much to benefit from, problems like costly setups, cyber threats, data privacy, and regulations are cross-industry ubiquitous issues. Businesses will have to counter such problems through investment in cost-efficient, scalable, and secure IoT solutions.

TABLE: 2 REAL-TIME EXAMPLES OF IOT IN SUPPLY CHAIN

No.	Industry	Company Name	IoT Application	Benefit Achieved	Reference
1	Retail	Walmart	Smart Shelves	Improved inventory accuracy	[14]
2	Logistics	FedEx	IoT-enabled tracking	Real-time shipment	[6]

				visibility	
3	Automotive	Tesla	Predictive maintenance	Reduced downtime	[5]
4	Aerospace	Boeing	Smart asset monitoring	Enhanced operational efficiency	[7]
5	Healthcare	Johnson & Johnson	IoT-driven cold chain	Safe transportation of vaccines	[3]
6	Manufacturing	Siemens	AI-powered supply chain	Improved production planning	[9]
7	Banking	HSBC	Blockchain for supply chains	Enhanced transparency	[13]
8	Défence	Lockheed Martin	IoT-enabled logistics	Efficient resource allocation	[8]
9	Software	SAP	IoT-integrated ERP	Seamless workflow automation	[10]
10	Steel	Tata Steel	Smart factory solutions	Reduced energy consumption	[16]
11	Trading	Alibaba	IoT-powered order management	Faster order processing	[12]
12	Power Sector	GE Power	Predictive maintenance	Increased operational reliability	[5]
13	Navy	US Navy	IoT for fleet management	Real-time vessel tracking	[11]
14	Air Force	Airbus	Smart logistics	Optimized aircraft parts supply	[4]
15	Finance	JPMorgan Chase	AI & IoT for fraud detection	Enhanced security measures	[8]

The table above indicates real-world applications of IoT in various industries, reflecting how various firms have leveraged IoT to streamline the efficiency of their supply chain. Walmart, for example, has used smart shelves to make inventory more accurate, reducing stockouts and overstocked items [14]. FedEx has employed IoT-enabled tracking systems to achieve real-time tracking of shipments, improving logistics efficiency and customer satisfaction [6]. Likewise, Tesla uses predictive maintenance technology to predict car problems beforehand, minimizing unexpected downtime and maximizing fleet performance [5]. Boeing has also implemented smart asset monitoring to maximize operational efficiency in aerospace supply chain management [7]. Johnson & Johnson, in the pharmaceutical industry, uses IoT-based cold chain tracking to facilitate safe transport of vaccines, solving critical temperature-sensitive logistics issues [3]. Siemens has used AI-based supply chain solutions and facilitated more optimized production planning, which has supported improved demand prediction and supply chain optimization [9]. HSBC has utilized blockchain technology to support transparency in the supply chain and minimize the chance of fraud as well as allow secure financial transfers [13]. Lockheed Martin has utilized IoT-based logistics in the defense sector to facilitate efficient allocation of resources and hence improve operational readiness and efficacy [8]. SAP has implemented IoT-based ERP solutions in the software sector to effectively automate workflow and

thereby enhance supply chain efficiency overall [10]. Tata Steel has developed smart factory solutions, which have reduced energy consumption and enhanced production efficiency [16]. Alibaba, a global trade company, has implemented IoT-based order management systems to improve order processing speed and thereby enhance customer service and business efficiency [12]. GE Power has utilized predictive maintenance practices to improve power sector operations' reliability, reducing equipment failure and downtime [5]. On the defensive side, the US Navy has embraced IoT to control naval fleets to facilitate real-time tracking of ships to enhance naval planning [11]. Airbus has streamlined aircraft component supply through intelligent planning to provide timely availability of essential components during maintenance and operation [4]. Finally, JPMorgan Chase has used AI and IoT to identify financial transaction fraud, enhancing security controls and minimizing financial risk [8].

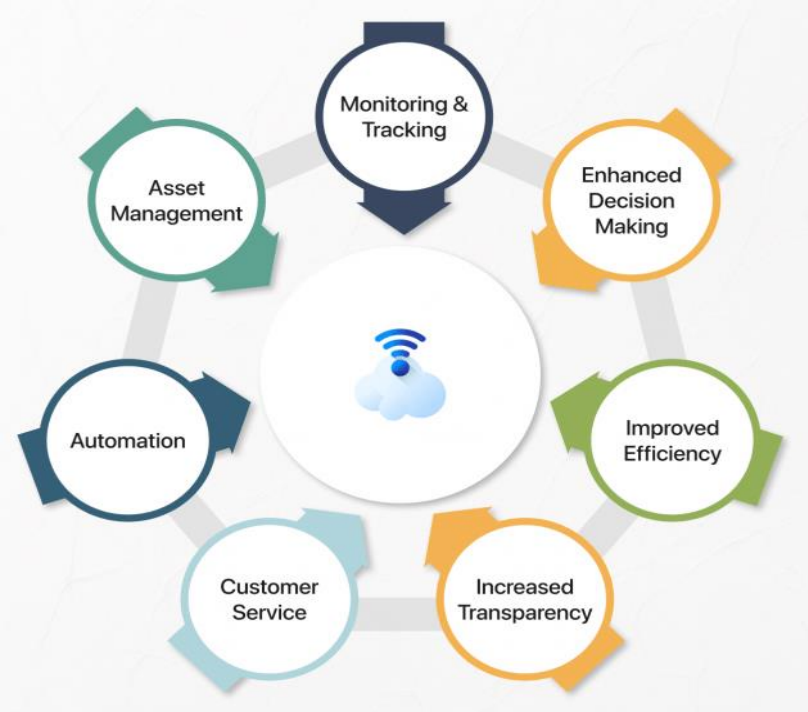

Fig 1: Benefits of IOT in supply chain Management [5]

Fig 2:Benefits of IoT for supply chain and logistics [2]

VI CONCLUSION

The Implementation of Internet of Things (IoT) in supply chain management has revolutionized a new era of connectivism, effectiveness, and data-driven decision-making. Current literature identifies various compelling benefits such as enhanced real-time visibility, maintenance in anticipation of breakdown, control of inventories through smooth processes, and better risk management. Cyber threats, interoperability, and privacy concerns over data are issues to be overcome for optimizing the use of IoT. New technologies such as blockchain also augment IoT capability through the provision of secure and transparent data sharing along supply chains. Future studies need to work on developing harmonized models for IoT adoption and investigating new AI-based analytics to propel automation and decision-making. Finally, IoT's effective deployment in supply chains will rely on overcoming technology and organizational challenges and realizing its potential for sustainable and resilient supply networks.

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