

# IoT Based Innovation and Blockchain Applications for Advancing Global Supply Chain Management in Industry 4.0 Era

Komal Rauniyar<sup>1</sup>  
School of Management  
Zhejiang University  
Hangzhou, Zhejiang, China

Wu Xiaobo<sup>2</sup>  
School of Management  
Zhejiang University  
Hangzhou, Zhejiang, China

Kanchan Rauniyar<sup>3</sup>  
Bank Manager, Operation Department  
Nepal Bank Limited  
Kathmandu, Nepal

Deependra Kumar Sah<sup>4</sup>  
School of Management  
Zhejiang University  
Hangzhou, Zhejiang, China

**Abstract:-** The study aims to explain the use of innovations and technologies like the Internet of Things (IoT) and blockchain in advancing the global supply chain management in the Industry 4.0 era. This study evaluates the capabilities of blockchain technology (BCT) and IoT devices, in regard to supply chain from the existing literature. The integration of blockchain capabilities and IoT is contributing in operational performance to create the resilient digital supply chain system which is explained through the real examples in the case study section. The application of IoT innovations is playing a vital role in creating a smart environment for easing human life. The fit between the literature review and the case study has emphasized that the use of these innovations and technologies has been ensuring competitiveness, strengthening the business processes and, helps in overcoming supply chain risk globally. The architectural framework presented in the study depicts how adopting advance innovations and Industry 4.0 technologies like blockchain integrated with IoT can contribute towards reshaping the existing supply chain practices to promote hassle-free supply chain activities thereby boosting the global supply chain performance and other business practices. Hence, the objective of the study is pinned to offer the real view of the application of blockchain and IoT innovations to create a seamless supply chain network and describe the possibilities of its application in more comprehensive manner to address emerging business needs in future.

**Keywords:-** Blockchain Application; Global Supply Chain Management; IoT; Innovation; Industry 4.0.

## I. INTRODUCTION

The breakthrough innovations such as digitalization and Industry 4.0 have induced the advancement in global supply chain management [1, 2]. The term industry 4.0 refers to the fourth industrial revolution occurred due to the advancement of computers and automation leading to smart and autonomous modules fueled by data and machine learning.

Industry 4.0 is the umbrella term that integrates AI and Robotics, biometrics, IoT, AR and VR, Blockchain, Spacetech, Biotech, 3D printing, and such. All these technological advancements supports automation, real-time data management, intelligence system and information transparency which is vital for the global supply chain system [2, 3]. Some of these technologies like IoT and blockchain are emerging and well-positioned for innovative business models in regard to global supply chain networks [4, 5]. Literature from various studies support that Industry 4.0 technologies have transformed the way the global supply chain are designed and operated, thereby strengthening the supply chain decision support system, information sharing and transparency, and many others [6, 7].

The IoT- based innovation and technologies in a true sense has been proved to be vital for enhancing the quality of human life in every possible aspect. With the ability to transmit data without the need of human-to-human or human-to-computer interaction, IoT devices are an interrelated system of digital devices, computing machines, wireless communication technologies, human, animals, and objects which have made the world globally connected than ever before [8]. The sensors, actuators, and other devices offered by IoT are being used to communicate uniformly in a smart environment, and also being blended with the innovations like blockchain, cloud computing. The IoT devices integrated with other technologies have been applied across various industries like healthcare, supply chain, logistics, transportation, smart city, asset tracking and many other industrial domains [2, 9]. IoT includes several devices such as digital and mechanical equipment, communication devices, processors, computing hardware, sensors, and many others each tagged with specific unique identifiers (UIDs). All these devices work to accumulate and transfer data collected from the physical environment to make data processing efficient and speedy [10]. The application of IoT combined with the technologies like blockchain, cloud computing is a vital player in the global supply chain network as it addresses security and safety issues, reduces cost, saves time. Some of the giant companies

like Amazon, Volvo, and New Maersk line have employed these IoT technologies to ease their work processes [8, 11, 12].

Apart from IoT, BCT has been proved to be a game-changer technology in several sectors where the supply chain is one of the most influenced sectors. Blockchain is a decentralized and distributed ledger pinned with cryptography in which each block-transaction, data file with a cryptographic hash is linked to the previous block [13]. This architecture of blockchain collaboratively works for data collection, data analytics, and decision making to create a higher level of transparency, security in the global supply chain process [14]. The unique features offered by blockchain such as transparency, immutability, traceability, and decentralized ledger, and many others are considered as a real solution for various conventional problems of the supply chain. One of the examples of blockchain includes smart contracts in supply chains that involve multiparty agreements which involves complexities in regulatory and operational matters [15]. The BCT hence facilitates the documentation process and contributes in reducing waste, insurance expenses, and risk factors. For instance, the estimation made by Maersk that the container of flowers while shipping from Kenya to Rotterdam needs about 200 communications. Through the use of BCT, they approach that each unique entity that comes across the transaction is permitted to get access to the system. The three signatures from different parties and six documents will automatically initiate the smart contracts as they receive these details in their system. With such an advanced transactional process provided by a blockchain, this technology has been helpful in regard to inspection of the documents, trucking, refrigerator sealing, and custom approval uploaded in the blockchain system. So, the entire nexus of blockchain is promoting an easily digitized global supply chain network [3, 16, 32].

The IoT and BCT are likely to bring disruptive changes across various sectors as the application of these technologies are contributing to re-examining the conventional way of doing business, mostly to lessen the necessity of human intervention in the affairs and business deals [17, 44]. With its prominent features, BCT assures to transform several institutional domain while regulating the business being supply chain one of them. Furthermore, such technology permits the disseminated data exchange security, which can have a huge effect on institutional administration. This also affects the way the relationship is being determined between the involved parties in the supply chain process and the way they interchange the data and commodity [18]. To cope with the growing complexity in transferring of goods and services and to acknowledge the imperative need for transparency, BCT furnishes a trajectory to growing IoT technology that aids the exchange of information that all the parties can discern and convict [7, 11]. Cost reduction, incepted observation, building customers' trust, and refraining complex documentation and stock monitoring are some of the basic advantages provided by the deployment of blockchain integrated with IoT devices which have extended the application of blockchain in the global supply chain. Therefore, these innovative technologies such as BCT and other IoT devices show a promising path to mitigate the

various inefficiencies in the traditional supply chain network and promote a digitalized network to enhance the global supply chain system [1, 16]. In particular, this study sought to answer the following three major research questions:

*RQ1: How blockchain is contributing to improvise the new face of the global supply chain in the industry 4.0 era?*

*RQ2: What are the roles of blockchain technology to promote the digital supply chain system?*

*RQ3: How modern technologies like blockchain and IoT devices has impacted the global supply chain system?*

## II. LITERATURE REVIEW

### A. Blockchain

One of the vital shifting technology which has driven the way businesses are being done is BCT integrated into the supply chain [6, 15]. A blockchain is an automated, decentralized, and distributed ledger in which deals are recorded and enumerated in sequential order with the purpose of generating perpetual and protected documentation [13]. It is created using cryptography in which each block transaction is a file of data, with a cryptographic hash that is connected to the previous block. Due to its unique features like transparency, security, reliability, traceability, real-time information sharing and, cybersecurity, this technology has captivated the observation of several sectors, especially, the supply chain network [19]. The logistics and global supply chain management group ascertain how blockchain fundamentals combined with IoT devices which is a digital innovation might influence this sector as well. Considering all the unique features, BCT is obtaining strength in global supply chains and exhibits huge capability in backing IoT as well as boosting interworking of IoT devices [7, 9]. The involved parties in the supply chain networking can garner aids from this combination of IoT and BCT. BCT can be responsible to exercise the use of IoT based supply chain in a powerful manner, assuring the cohesion and stability, and set up a marketplace for information administered by IoT devices [7, 20].

The promising solutions promoted by BCT have helped to transfigure the role of many prevailing industrial systems where supply chain one of them. Any company working with a blockchain ecosystem can strengthen its transparency that allows an entire hassle-free supply chain system [21, 22]. Several giant companies like Walmart, Alibaba, MAERSK, IBM, and many others have implemented blockchain-based pilot programs in several projects which proves this technology as a revolutionary shift in management [23, 24]. For instance, blockchain might help businesses to store a huge amount of sensor data without hindering the networking pre-requisites of the firm. Additionally, blockchain could alleviate the risk of data leakage and manipulation that are generally used to increase the firm's value [11]. Therefore, blockchain promotes a supply chain information system that integrates the supply chain strategy, information system engineering, and the pre-requisites [15]. Therefore, BCT is the digital innovation for a global supply chain that provides a highly secure network and improves the integration and coordination between the supply chain functions [2, 25].

**B. Supply Chain**

Ever since the concept of supply chain evolved, it has been through various transformational stages during the different time period which has been illustrated in figure 1 below. The late twentieth century has observed a substantial growth of supply chain network into international locations, across multiple sectors such as automobiles, food, pharmaceutical, warehousing, apparel, and such [26, 34, 46]. SCM is not just a local aspect anymore, supply chain has transformed a country’s boundaries, implementing the confrontations of transnational managers who plan global and digitalized supply chain networks for the prevailing and modern product line [16]. With globalization and growing technological advancement, global supply chain has become more and more complex which have gravitated the attention of supply chain managers to deploy industry 4.0 technologies in the supply chain to overcome the issues of traditional supply chain [3]. These applications of industry 4.0 technologies like IoT and blockchain ensure transparency, security and therefore shall contribute to promote the digital supply chain [27, 34].

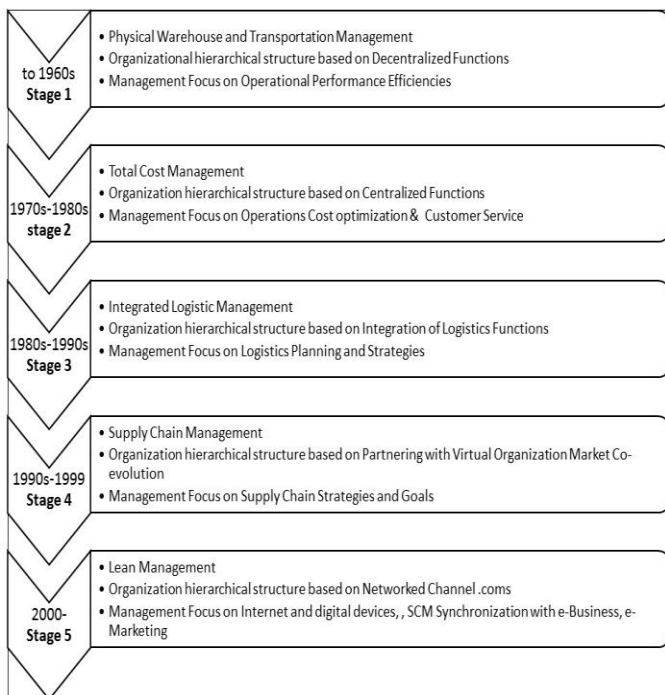


Fig. 1. Transformation of supply chain management.

The breakthrough technologies under the umbrella of industry 4.0 are addressing the major traditional issues for better decision making through real-time connectivity, monitoring via sensor technologies, potentially augmented predictive analysis, a higher level of transparency, and such [3, 26]. This all is promoting the digitization of supply chain networking and easing the globalized chain of transference of goods and services. Digitization, digitalization, and disruptive innovations such as blockchain, IoT, big data analytics, advanced robotics, cloud computing have dramatically affected the growth of new models, theories, and frameworks in supply chain management through smart controls [2, 28]. These digitalized technologies clarify data exchange and lessens the computational storage space needed while

escalating the security of global supply chain management [27]. For instance, QR codes and RFID systems enables firms to trace the history of the product such as the use of materials, the products where they have passed through the system, and the movement of these products from various points. For a higher level of traceability, the tags are digitalized and the records of disassembling, validating and labor practices are stored there [12, 22]. Hence, such factors prove the first step towards visibility and a better supply chain system.

**C. Internet of Things (IOT)**

Internet of thing is the huge global data network comprised of vast heterogeneous and decentralized tools that can be recognized, observed, and prepared based on systematized and interworking communication agreements [9]. In this era of digitalization, IoT has been extensively deployed in almost every sector including healthcare, supply chain, building, smart cities, asset tracking, transportation, and many [29, 44]. The IoT applications have been a platform to reduce costs, enhancing transparency, real-time information, and collecting the right data via sensors across the supply chain industry [10].

The high-tech businesses globally are constantly innovating and coming up with some astounding innovations. Some of the widely popular IoT-based innovations made by some giant companies include Amazon echo, Neuroio, Ring, Ecobee, Google home which are considered incredible IoT innovations proving how fast technologies are evolving and creating a smart environment for better human life [30]. The use of IoT devices induces a smart environment that contributes to cut down on waste, automate processes and labor costs reduction, enhance service delivery, and transparency into customer transactions. Resultantly, IoT devices have been one of the most important technologies influencing almost every sector of human life including both personal and professional [31, 32]. The supply chain is also one of the most influenced sectors from the application of IoT devices. The major problem involved with the supply chain process is to confront the clarity with regard to the trust, conditions of goods and materials, the practices, mismanagement of data, security uncertainty in demands. Along the process, multiple risks tend to surface during the supply process. The integration of IoT devices can contribute to such risk elimination in the supply chain process [7, 9]. The feasible solutions offered by IoT have enhanced the logistic and supply system. The asset tracking enables businesses to adapt their set of strategies and helps build trust among to the parties. The IoT sensors can furnish a considerably more accurate prediction methodology which contributes to creating trust among suppliers. The level of transparency elevates as the customers can trace the history regarding the origin of production, the materials used, its conditions, and such [7, 37]. The integration of IoT devices leads to higher viability to design a strong logistics nexus. The global shipping routes have become smarter through the use of smart pallets, containers, and ports. Approximately 70% of the fortune listed companies have been using IoT, and the usage has been contributing in efficient business processes due to real-time visibility and transparency [8]. Therefore, IoT is the modern



innovation contributing to better serving the customer and enhancing the progress of logistics and distribution [8, 10, 33].

### III. CASE STUDIES

Several industrial domains such as health, shipping and logistics, agriculture, finance, food business, and many others aim to embrace advanced technologies like blockchain and IoT devices in the work processes [1, 8]. But in the present context, administering the global supply chain is exceptionally complex. With multiple unique features like real-time information, transparency, traceability, reliability, cyber-security, the BCT along with the IoT devices has enhanced the supply chain performance and promoted the digital supply chain system, shaping the new face of the global supply chain scenario [34]. This study presents the case studies of some of the well-known companies that have employed BCT in their supply chain system. Hence, with a view to providing a realistic picture regarding the use of IoT integrated with blockchain technology, the case study is discussed below:

#### A. IBM

International Business Machines (IBM) corporation, one of the most widely recognized American multinational technology companies based in New York has always been an innovative company testing several technologies and trying new things. It has been serving blockchain as a service (BaaS) and offering reliable solutions such as decentralization, durability, transparency, and auditability [35]. The major objective of IBM is to provide a very accessible solution in terms of privacy, confidentiality, auditability, performance, and measurability. This technology has supposedly shown to be scalable and developed to be equipped on any cloud and aids in cost-cutting and gives a leading-edge [36].

For the supply chain industry, the contingent labor management accelerator, brought by IBM Blockchain services has re-engineered the organizational purchasing, managing, and settlement for assemblers. The data has shown that this platform offers a seamless solution for the volume of invoices to be handled (i.e. the record shows that the volume of invoice approximately dropped from 10% to 0.5% and the related expenses has been reduced from 50% to 30%). IBM Blockchain service integrated with IoT has helped more than 150 manufacturing networks furnishing values and developing the way businesses are handled. It has a total of 2000 blockchain specialists contributing to 1000 of clients' businesses who are adopting this technology [8, 36]. Next, IBM offers IBM Sterling Supply Chain Business Network which offers 51% enhanced efficiency for Business to Business transactions pinned on the cloud-based network which is fully secured. The foundation of such technologies are AI-powered transactions, real-time transactions, quick error identification and prudently eliminating disruptions. The services include IBM Sterling transaction manager, Document conversion services, IBM Sterling eInvoicing. The IBM blockchain supply chain has used smart contracts as a part of the solutions which are helpful in the operational activities in the real-time scenario [19]. All these services pinned with such advanced features have been relevant in the supply chain industry. Some of the major collaborations of IBM are with

the eProvenance (wine industry), Sonoca (Health care), XCEED (automobile industry) and Maersk (shipping company), Vertax oil and gas, coffee industry, insurance and bank, seafood, diamonds [36, 37]. Hence, IBM is one of the leading corporations offering blockchain services in multiple industries, especially in the supply chain nexus with a deep foundation and a great future prospect.

#### B. Moderna: A Vaccine oriented Biotech and pharmaceutical company

Moderna one of the most giant biotechnological and pharmaceutical company has particularly focused on vaccine technologies based on messenger RNA. Lately, Moderna has developed the COVID-19 vaccine and working closely with IBM to test blockchain integrated with IoT devices such as AI and hybrid cloud to enhance the efficient and effective management of the COVID-19 vaccine [20, 36]. The major purpose behind this is to promote transparency leading to increment in the public confidence in regard to vaccine programs so that people get vaccinated and this would reduce the infection level, ultimately contributing to lessen the pandemic effect [37].

The employment of BCT can scale up the distribution channel, inventory management and management efforts since the level of transparency and accountability is highly considerable [44]. The vaccine distribution network is in dire need of a high level of transparency to fight against the public health crisis of such a time. IBM and Moderna are working together to help address the global pandemic. All these enable end-to-end traceability, safety and efficacy assurance, and reduced risk. If the vaccine is not productively disseminated among people, vaccines cannot be proven to be functional and viable. Therefore, incorporating BCT for this distribution series can help gain real-time accountability, a higher level of transparency, and security inspection [20, 21]. The public then can have increased trust level and confidence in getting vaccinated. Therefore, BCT seems to be contributing to boosting the distribution pattern as the transparency level is relatively higher and the sense of security relatively increases [22].

#### C. Maersk: a shipping company

One of the major problems of the supply chain system of the shipping companies is the inefficient approach of operating the cargo and containers. The inefficient document management is one of the most critical issues that surfaced for port management. With multiple parties involved like the cargo agents, customs, terminal operators, customs, freight forwarders, there are hundreds of interaction and agreements which needs to be documented and stored and hence, it creates a huge problem in regard to cost and efficiency [4]. Therefore, technologies like blockchain and other IoT devices have been proved to be a boon for such companies. The modern supply chain is a multi-layered ecosystem of suppliers, associates, and clients all functioning a lot more in close proximity due to the multi-regional, multi-geographical and cross-sector complications. BCT in the supply chain provides the prospects to deliver cost efficiency, transparency, and trust [6].

The shipping giant, Maersk which is one of the popular logistic company transporting commodities via ocean and inland is helping to connect and simplify the global trade for the growing demand of goods and commodities in the world. In alliance with IBM, the world's biggest container cargo company, Maersk has initiated a venture to restructure ocean shipment with the BCT integrated with other IoT devices which trace international shipment in real-time [38]. The BCT will contribute to digitalization and digitization in the work frame which permits each shareholder in the chain to observe the movement of commodities in the course of conveyance. The ideal approach of BCT is to confirm the safety and security while sharing data and protect containers with bills of shipment, invoices, and other data to the shareholders [16]. IBM has gauged that Maersk can save up to \$38 billion each year if they fully go digital and employ blockchain in their supply chain system. This definitely can help with the cost-efficiency. For instance, back then in 2017, Maersk and IBM conducted a test case using avocados fruit, transporting it from Mombasa to Rotterdam. The total computed expense for the shipment was approximately about \$2300, which was roughly about 20% of the total cost [39]. This clarified that the BCT has a huge potential to make massive savings in such aspects. The system entailed a thorough procedure and encapsulated the significant data, documents, and sanctions made. Hence, the BCT has helped in proper information channelization as they are highly secured, transparent and available in real-time which helps in proper decision making and strategy making [23, 27].

#### *D. Walmart: Food and agricultural products*

The American multinational Walmart that has been dominant in the world of department stores, has employed BCT in collaboration with IBM, to improve the transparency level and tracing the products continuously [36]. As multiple illness cases surged in Walmart when a lot of people got affected because of eating infected food (i.e. Romanian lettuce), hence, it became a necessity to find out the root source. Though it can take weeks and months to find the origin and the major cause behind such food-borne sickness, it is highly important to trace the origin of such products and the refinement procedure involved [36, 44]. This is of great help to ensure the safety of people's lives by empowering firms to makes a faster mover and also safeguard the livelihood of agronomists by eliminating the staples that are from the contaminated farms.

Walmart initiated a Hyperledger fabric, basically underpinned under BCT integrated with IoT that would be beneficial for tracking the food supply [40]. Along with IBM, Walmart conducted two proof of concept trials to test on food items, one is mango and the other one is pork in the USA and China respectively. The results were positive and the traceability system in China allowed transferring certificates of authenticity to the blockchain, creating more trust to the system which was a critical matter. And in USA, the time required to track the origin was reduced by days, noticeably from a week to a couple of seconds. This showed the efficiency and effectiveness of deploying BCT proving it to be as a breakthrough technology. Now, Walmart has deployed the technique for fifteen commodities from five different parties. Recently, Walmart has announced that it will mandate

the merchants of green vegetables to track the crops employing these technologies. BCT is going to be dominant to get the best out of it and enhance the transparency and safeguard the type of product that is being sold in the market as it displays the entire details from the place of origin to the final destination. Walmart has been successful in tracing the products through the use of blockchain [40, 41]. And hence has planned to it employ in the traceability of other different products as well.

#### *E. Alibaba: An E-commerce company*

Lynx International, a subsidiary of Alibaba has been overlooking its blockchain services to trace the information for the intercontinental logistics operations. Lynx has a symbiotic relationship for the digitalization and digitization of the payment systems. It has been equipping a congenial, effective, logical and extended assimilation with the magnitude to provide for the requirement of a comprehensive game of electronic cash, other digital assets (NTF's), cryptocurrency and such [41]. Lynx convergence approaches a dominion full-cycle BCT combined with IoT devices to aid the decentralized system with one multifaceted architecture. The electronic payment system has lessened the exchange charges and additional convergence cost while the supply chain system.

The subsidiary of Alibaba is successful to address the global solution for the particular necessities of the trader, banking channels, and decentralized finance. This all enables for absolute interworking and administering banking, deposit, saving, selling, and including digital assets consolidated in a place. It offers end-to-end payment, modular architecture, deep domain architecture [23]. NFTs are a big part of Lynx convergence offering BCT-based assets, first launched in 2012 as CryptoKitties which has a unique feature, unlike Bitcoin and Ethereum. 2020 is supposedly a breakthrough year for such NFTs that includes crypto-collectibles, digital artwork, tickets to events, in-game items, items in virtual worlds, and real-world assets. Alibaba is a forerunner in creating a visionary for digitalized solutions. The easy payment gateway shall help to have a secured supply chain system and increase the transparency level [23, 42]

#### *F. Merck: A pharmaceutical company*

According to WHO, more than half of the medicines that are traded on illegal web pages are forge. Such forge commodities and debauched supply chain nexus is a spreading issue that might have critical results. This is particularly pinned for industries like pharmaceutical and food-based sectors [43]. Considering the technological advancement in industry 4.0, BCT combined with IoT and digital devices can be a major tool for ensuring transparency and paving a path for a better global supply chain [22].

One of the well-recognized pharmaceutical multinational company, Merck, has adapted the BCT in its operating system. It has employed the SAP Pharma Blockchain, POC App in partnership with SAP anchoring a unique fingerprint (like a record) from physical commodities to the digitalized world, through AI and BCT. It is developing this BCT solution that addresses the supply chain issues regarding transparency and

security [43]. It has been particularly working to prevent counterfeit products. The unique fingerprints like identity are identified through the AI and this is linked to the digital signatures recorded and secured via blockchain. Any such peculiar feature can be used such as chemical signature, DNA, or image patterns for this unique identity [19]. The unique features are transferred into machine-readable data via technologies like AI and the data then is processed and stored in a secure manner via BCT. The commodity then can be verified via a digital signature. And if the digital signature does not complement its digital record, the measures can be employed so that the fake products do not reach to consumers and this halts the harm [5]. The trader registers on the SAP Pharma Blockchain and the item number, serial number, batch number, and expiration date are recorded from the product's barcode. This enables the involved parties to know that the product is delivered without any misfits [44, 45]. Hence, BCT application can be a promising solution for the pharmaceutical industry.

**IV. THEORETICAL ARCHITECTURE**

The notable transfiguration in the way the goods and services are being produced is all because of digitization. The alteration in the manufacturing sector has been so huge that it is known as the fourth revolution, and termed as Industry 4.0 [26, 46]. The Industry 4.0 refers to an umbrella term that holds modern innovative technologies like AI and Robotics, IoT, 3D printing, Geo engineering, NeuroTech, AR and VR, SpaceTech, Blockchain and Biotech [30]. As aforementioned in section 1, the four main aspects that it opts for are digitalization, inter-workability, actionable sights, and information transparency. All these disruptive changes are pushing the need for new management and organizational structure and hence, incorporating the real-time information system through such applications which are helping to reduce the uncertainty in demand, the inefficiency in performance, and delays in the transition. All this is enhancing the overall operational performance accelerating the pace of the global supply chain and a new business environment [15].

The two major applications underpinned in the global supply chain system are IoT and BC. IoT devices contribute to ensuring security, safety, cost reduction, speed, and most importantly, transparency. And BCT has been contributing to the best cyber-security features thereby enhancing transparency and reducing fraudulent activities. The BCT is definitely appearing as a modern approach to magnify the organization's performance [31]. The BCT has been the major one that has been brought into use considering its notable qualities like smart contracts, real-time tracking, ledger trust, tracking provenance, preventing fraud, reducing human error, and counterfeit goods in a transparent manner. And all these activities have been supported by IoT devices. All such automation and digitalization are shaping the digital supply chain system [29, 32]. The term digital supply refers to the delivery of digital products involving the nexus of technology companies which ultimately refers to the global supply chain system.

BCT can affect the way alliances takes place between transaction parties in the digital supply chain by remodeling the data exchange systems, making decisions and pursuing a new business models, and bolstering informative-conversational relationships with supply chain parties [22]. The blend of IoT and BCT has been contributing to overcoming the moral hazard and shortcomings found in traditional technologies and establishing strong ties between the parties. This ensures the smooth flow of the global supply chain network [4, 44]. The IoT enables the sensors, actuators and other devices to communicate effortlessly within a smart environment [10]. And the BCT is the Holy Grail for a digitalized global supply chain system considering its abilities to offer a higher level of transparency, security, and real-time information, which is essentials for proper implementation of a supply chain system [14]. Hence, in this context, we propose a theoretical framework to illustrate the unique role of BCT integrated with IoT devices for advancing the global supply chain as depicted in figure 2 below.

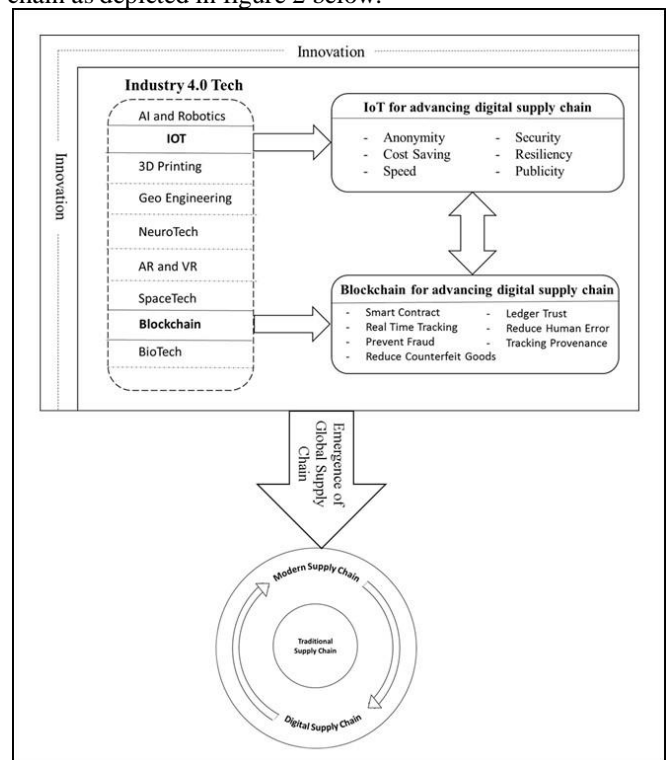


Fig. 2. Proposed theoretical framework based on IoT and Blockchain for advancing global supply chain

**V. CONCLUSIONS**

This paper discusses how the global supply chain can be benefitted through the application of blockchain integrated with IoT devices in the era of industry 4.0. From the aforementioned case study, it is clear that many giant corporations have realized the benefits of and BCT and IoT devices like AI, Robotics, Biometrics, cloud computing and many others, and hence, implemented these breakthrough technologies in their distribution system. The unique attributes offered by BCT integrated with IoT devices like real-time information, cyber-security, transparency, accountability, visibility and reduction in cost are highly considerable to



promote the digital supply chain, and advance the global supply chain nexus.

Across different industries like shipping, pharmaceutical, food, and many others; BCT and IoT devices gradually seem to play a vital role in improving the supply chain operational performance. Six different companies discussed here viz IBM, Moderna, Maersk, Walmart, Alibaba, and Merck have made an attempt to employ blockchain in their system making the global supply chain seamless. The conceptual framework presented in this study describes the role of IoT and BCT in advancing supply chain system in Industry 4.0 arena. One of the major transfigurations is accommodated in the supply chain system through blockchain application integrated with IoT. The digitalization has aided in global supply chain nexus. Infield Solutions research stated that 70% of the fortune companies had used IoT in their business framework for multiple objectives like anticipating maintenance needs, sensors for jet engines, smart grids for utility services. Hence, BCT integrated with IoT things could significantly contribute towards the issues of security and data reliability in several domains. However, the huge cost associated with integrating the BCT in the action series is undeniable but considering the benefits provided by blockchain make it is an ideal tool for solving the issues of traditional supply chain networks. Therefore, to assimilate the global digital supply chain nexus, the decentralized network (i.e. blockchain application) is to be connected with a physical network (IoT devices). Firms have been focused on creating a good customer experience and seamless distribution network in this global business landscape and hence, they will be benefitted from the application of such innovative technologies.

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#### Author's Profile:-

**Author 1:- Komal Rauniyar, PhD Research Scholar, School of Management, Zhejiang University, Hangzhou, Zhejiang, China,**

Author is currently a PhD research scholar in School of Management, Zhejiang University, China. She received her Master of Business Administration degree in finance from top University of Nepal, Pokhara University in 2017. She has more than five years of work experience in multiple sectors such as: Banking, E-Commerce, Teaching as well as Research experience in Blockchain, Statistics, Big Data Analytics and Cloud Computing.

**Author 2:- Prof. Wu Xiaobo, Professor, School of Management, Zhejiang University, Hangzhou, Zhejiang, China,**

Author is currently the Qiushi Chair Professor of Strategy and Innovation Management, Professor of School of Management, and Director of National Institute for Innovation Management (NIIM) at Zhejiang University. He is also the Director of the Zhejiang University—Cambridge University Joint Research Center for Global Manufacturing

and Innovation Management and Ruihua Institute for Innovation Management, Chang Jiang Scholar of Ministry of Education, China, the board member and the vice-president of the Central, East European and Middle Asian Network on Management Development Association (CEEMAN), and a member of a number of governmental and professional bodies, providing consultancy services for the industries. His research interests include managing technological innovation, global manufacturing and competitive strategy. He has published over 30 books and over 300 articles in journals such as *International Journal of Technology Management*, *Asian Journal of Technology Innovation*, *International Journal of Mobile Communications*, etc.

**Author 3:- Kanchan Rauniyar, Bank Manager, Operation Department, Nepal Bank Limited, Kathmandu, Nepal,**

Author is currently working as a government employee in the head office of very first established bank of Nepal "Nepal Bank" positioned as bank manager. She received her Master of Business Administration Degree in finance from top university of Nepal, Pokhara University. After completion of her MBA Degree, she have grabbed the honored Erasmus Scholarship to study further short-term management program in the University of Padova, Italy. She has more than three years of work experience in multiple sectors such as: Banking, Information Technology, Teaching as well as published offline articles in many reputed national dailies, magazines and university publications in Fintech sector.

**Author 4:- Dr. Deependra Kumar Sah, Research Scholar, School of Management, Zhejiang University, Hangzhou, Zhejiang, China,**

Author holds a PHD degree in Management Science and Engineering from School of Management, Zhejiang University, China. He is young successful Entrepreneur and Business Consultant having solid 10+ years work experience in reputed multinational companies (Such as: Alibaba, Paytm, Yealink, The Times Group etc.) that are specialized in E-commerce, Payment System, Financial Technology and Telecommunications. He have been awarded as one of the Top 5 young foreigner entrepreneur in Hangzhou city in 2019 from Government of Hangzhou, China. At present, author is playing a key role as a bridge to connect Foreign and Chinese Hi-Tech Companies along with government of China to explore different possible business ventures.