Stochastic Modeling and Applications
Vol. 24 No. 2 (July-December, 2020)
ISSN: 0972-3641

Received: 09th September 2020 Revised: 21st October 2020 Accepted: 26th October 2020

ROLE OF BLOCK CHAIN IN INDUSTRY 4.0

GIRISH KUMAR SHARMA, ANANT BHARDWAJ

Abstract: Industry 4.0 is one of the emerging developments which is shaping the modern era. Itinvolves innovations with upcoming digital technologies, and blockchain is one of them. With the growth of modern industries there is a need of modern techniques which could cater the need of these modern industries. Industry 4.0 is categorized as the modern industry where the concept of man and machine comes into the reality. Modern industrial concepts like Internet of things (IoT), Big Data Analysis, Cloud Computing, Cyber Security, Horizontal and vertical integration, Robotics, Augmented Reality, Additive Manufacturing and Simulations comes into the picture when the discussion of internet of things comes into the picture. Block chain is one of the important concepts whose application is one of the key factors in the industry 4.0. This paper covers the role of the block chain in Industry 4.0.

Keywords: Internet of things, Big Data Analysis, Cloud Computing, Cyber Security, Robotics, Augmented Reality, Additive Manufacturing.

Introduction

The world is now becoming online centric. In this fast-changing world, it will become very difficult to survive and act if one is not comfortable and ready to adopt the changes. Keeping in view of this, a new technological invention was introduced by Satosi Nakamoto in 2008 with a white paper. Later on in 2009 the technology was used by BitCoin- A Cryptocurrency which is still relatively new and have been made a legal tender by few of the Countries. The technologies like Artificial Intelligence, Internet of Things, Big Data, Machine Learning are deeply penetrating in to the life and making the life full of ease. But on the contrary issues like Security needs to be severely addressed. Blockchain is the technology which is being given the priority by the industry nowadays and the Industry is adapting this with open hands.

The main attribute and characteristics of this technology is that this is fully Decentralized and Distributed network where in depending upon the number of participants and the nature of Industry customization can be done.

There are multiple sectors in Industry and Startups where it has been adapted successfully. For Example, Finance, Supply Chain, Healthcare, Governance, Logistics etc.

The Media has given widespread publicity to this technology, but it does not mean that it can be adapted by all the industries.There are still some industries where the contemporary system of Centralized network is still

useful and more workable. The idea is that there are industries where the blockchain implementation failed.

Industry 4.0 is the modern era of industry where the inference is given on the internet and technology driven element. Industry 4.0 cyber network for its working with prominent features like real time communication, Instant and autonomous decision making, Self-fault diagnostic and preventive maintenance, Remote access, Modularity of the system and system and self-awareness to machine. Figure 1 describes the prominent features as mentioned above. Industry 4.0 has enabled the development of machine and technology to cater the growing needs of the world. Today the concept of mass production is not only confined into the products but also to the service which are the important part of the factories. Many Mechanical concepts like CIM (computer Integrated Machining), CAD (Computer Aided Design), CAPP (Computer Aided Process Planning) and Computerized system for supply chain management.

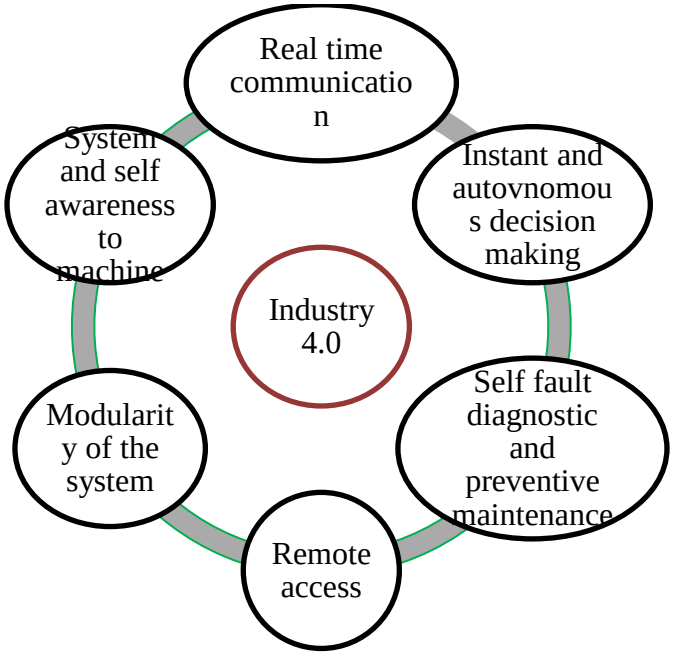

Figure1. Salient features of Industry 4.0 (Sources: Kumar et al. 2020).

The era of first revolution of industry started around 18th century. It is characterized by the first weaving loom in 1784.The concept behind the development of this era is the use of the steam power for the mechanical production. In this era steam engine was developed and they were the source for production and transportation. Steadily with the development of the scientific innovation and industrialization the concept became popular in that era. The second era of the Industrial Revolution was recognized around 1870.It is identified by the use of assembly line for the production in mass level in the factories. The first assembly line was started by Ford Motor for the production of the Model T car n USA which was a great success at that time. The next era of industrialization came around 20th Century. This era of industrialization is

characterized by the development of the programmable machine based on the numerical and computerized machine. The working of this machine was based on the logical input that consists of magnetic tape and computerized system. The first logical programmed came in the era of 1969 and it was so successful that it became the basis of mass production in the world. So, this is the era where the development of automation came into existence. It plays a vital role today in the field of medicine, automobile, communication and transportation and has exists as a major source of the development of the world.

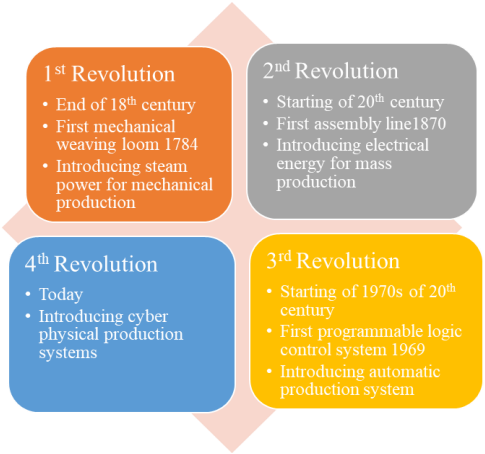

Figure 2 Industrial Revolution (Source: Horváth et al., 2019), (Deloitte, 2014)

The era of industrialization which we observe today is an era of Industry 4.0 where the emphasis is given on the cyber physical network where a person sitting in Germany is operating a Computerized Control Machine running in India. This is the beauty of the system where the globalization is actually coming into the picture and this is actually possible due to industry 4.0. Industry 4.0 is a system where the concept of internet of things and cyber physical network comes into picture. It is collaboration of mechanical industrial elements and the software concept like the big data analysis, Cloud Computing, Internet of Things, Machine to machine interaction and the cyber physical network connection, which are the basis of the interaction and development of industry 4.0. Figure 3 shows the essential elements of Industry 4.0.

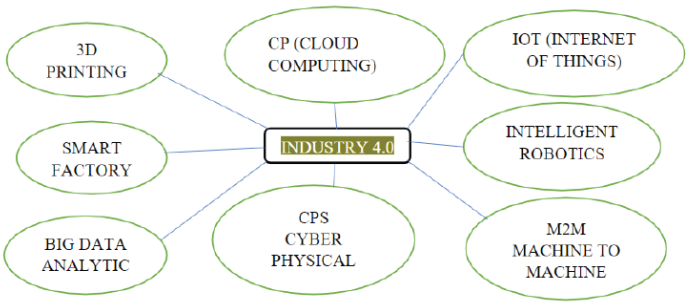

Figure 3 Essential Elements of Industry 4.0

2. Literature review

Block Chain has proved one of the important concept in the development and implementation of effectiveness of industry 4.0. Today the era of globalization has opened a global market which has its root in all the countries. The modern era is an era where the market not only contains the local goods and services but most of them are foreign goods and when we talk about the services these are generally come from MNC (Multinational Company). The blockchain plays a key role in the industrial 4.0 implementation role due to its cyber physical network effectiveness, it poses some advantage mainly in financial transactions in which trust is most prominent factors. Apart from these generally market and industries involve foreign and fiat currency issues and also the control of supply transaction is also the prominent application. Chang et al. [1] studied the application of blockchain technologies in the financial services. Researchers went through various scenario of the industrial application and noticed the advantage of block chain for its application in the financial application. The blockchain technology not only limit itself to the implementation of the industry 4.0 but it has its application in the logistics sector.It is mentioned by Tang et al [2]. In this the researcher highlighted the advantage of blockchain technologies in the areas of logistic and its implementation in the selected area. Ferreira et al [3] studied the effect of Blockchain in the machine-to-machine interaction concept. Machine to machine interaction is one of the prominent methods in the industry 4.0 where several machine and devices are connected to each other either physically (wired network) or by Cyber physical network or by wireless network. It is the important source for the transfer of information and removing barriers in the implementation of industry 4.0.Huang et al [4] highlighted the importance of blockchain technologies in the financial transactions. Faramondi et al [5] studied the hospital management system and highlighted the application of blockchain technologies in the hospital management system. Hospital is one of the important places where the data consist of private information of patient, important organs management system and also the transactions and banking statements of hospital transaction which can be managed securely by block chain technologies. Epiphaniou et al [6] also highlighted the importance of blockchain technology in the health care sector .Sandner et al [7] studied the application of block chain in the field of financial application. they studied the role of CFO and its importance in the implementation of the financial matters and running of the industries.Liu et al [8] studied the blockchain in the area of product lifecycle. They also commented uponthe role of blockchain in removing the barriers of implementation of industries 4.0. Esmaeilian et al [9] studied the role of blockchain in the supplychain management. Supply chain is one of the important factors in the establishment of industry and establishment of trusted and transparent financial transaction by the application of the block chain management. Sikorski et al [10] commented on the application of the block chain technology in the chemical industry and also highlighted the importance of blockchain technology in the implementation of the industry 4.0.

In order to run a industry there is a involvement of the computer and cyber based system. The industrial works start from purchasing a raw material which emerges

from various already established supply chains which are complex and is the topic of research. The next step in this process is the allocation of raw material to the various departments where the processing of raw materials occurs at different department. After the fabrication of the products, it goes to the inventory control system where the process is control by the cyber physical system which is in turn required in the application of industry 4.0. In every step, which is required in industry 4.0, there is a need for transaction of money and a timebound delivery which readily comes into picture and to cater that problem block chain technology is a solution to the problem which caters the information related to the transaction and links it into the cyber-physical world. The idea of working of the block chain may be understood by the example of a spreadsheet in which a information is fed and is shared to the peer group where the information is read but not edited where the information is fed in the form of rows and column. The working of block chain technology may be understood by the following figure which is taken from the internet source.

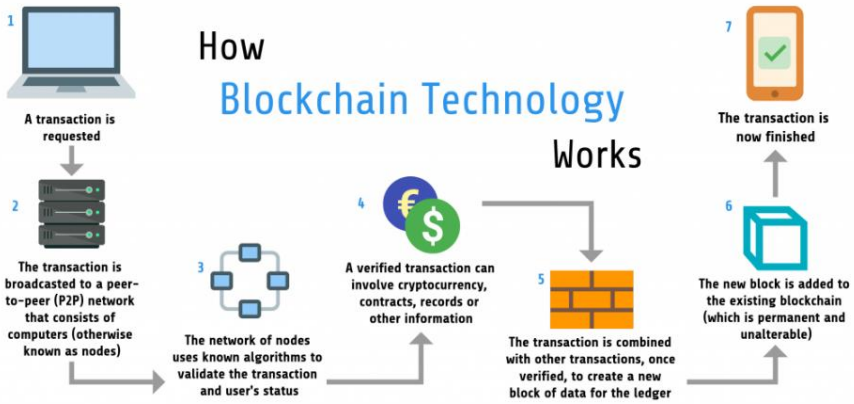

Fig 4. working of block chain (Source-IP Specialist)

]. Major applications of Blockchain Technology for Industry 4.0 are discussed Below:

S.NO.	Application Area	Descriptions	References
1.	Finance	Many startups and Industries are adopting the finance transactional model supported by Blockchain. Japan stock exchange is pioneering in implementation of blockchain technology.	12,13,14
2.	Manufacturing Data Protection	The blocks in the blockchain are chained together very securely by the hash function. This message digest is almost impossible to break and decrypt which will make the industrial data very secure and robust.	15,16,17
3.	Identification of Product and Assemblies	The adoption of blockchain technology in the assembly lines will help in optimizing the time and machine in delivering a certain product, because by using this a perfect estimate of time can be established.	18,19
4.	Automotive	In Automobile sector, several stakeholders are works for a common goal. Making them all as participant in the network and sharing the transaction with all of them will definitelyhelp in achieving the maximum throughput from the system.	20
5.	Information and Security	The concept of hash chain is unique in securing the data in blockchain, such as how goods are produced, how they begin to ship and how data are managed, and much more. So, industries choose blockchain networks for better management solutions and cyber-attacks.	21,22
6.	Digital Purchasing	Blockchain takes the next step of property. This technology has opened new use cases and opportunities for future buyers in the real estate economy worldwide. Digital signatures and Smart Contracts opened up the new avenues in establishing the trust for selling and buying of estates and other commodities.	23,24
7.	Business	The Blockchain technology has moved beyond the financial services world in recent years, with businesses in a wide range of sectors. It is also incredibly transparent, effective and flexible, and	25,26

		highly stable to the business purpose.	
8.	Supply Chain	Supply chain is the biggest component of Industry. Blockchain and its use has made a revolution by introducing accountability, transparency and immutability in the businesses.	27,28
9.	Data Storage	Blockchain has the potential for the better storage of data over cloud where there are more chances of theft and vulnerability of data. This technology can also reduce the risk with the help of a good data sharing and storage system.	29
10.	System Integeration	Blockchain technologiescannot work without seamless integration. It is the only beauty associated with this technology that here there is no single boss but everybody is the boss in the system can involve its partners, clients, and supply chains through an organization, providing more possibilities for integration beyond the ecosystem of a business.	30
11.	Digital Directory	A blockchain is a distributed, peer to peer connected digital directory, archives public and private peer-to-peer transactions. Each transaction contains a unique Merkley tree tightly coupled with the hash of neighbor block validates, protects against revocation, manipulation and revision. It has the capacity to exclude intermediaries and central from the new method of data exchange and asset transfer.	31,32

3. Conclusion

The following points can be concluded from the above discussion-

- Industry 4.0 is the major point for the development of the world.
- Industry 4.0 depends upon cyber-physical network for the implementation.
- Block chain technology is one of the prominent features of industry 4.0 due to the fact that it will incorporate entire transparency in to the system.

- Block chain technology is one of the prominent features which can caters the transactions and ensure smooth and traceable flow of material and resources.
- Block chain is smooth, trusted and transparent technology for the implementation of industry 4.0
- Immutability, Trustless and Transparency are the major attributes which are the key parameters for the business transactions.
- Due to the varying types Permissioned, Permissionless and Hybrid of Blockchain it is widely acceptable in may sectors.
- The Consensus algorithm used for making consensus among the participants which includes Proof of Work and Proof of Stack are scalable and highly efficient.

4. References

1. Chang, V., Baudier, P., Zhang, H., Xu, Q., Zhang, J., &Arami, M. (2020). How Blockchain can impact financial services–The overview, challenges and recommendations from expert interviewees. *Technological Forecasting and Social Change*, *158*, 120166.
2. Tang, C. S., & Veelenturf, L. P. (2019). The strategic role of logistics in the industry 4.0 era. Transportation Research Part E: Logistics and Transportation Review, 129, 1-11.
3. Ferreira, C. M. S., Oliveira, R. A. R., Silva, J. S., & da Cunha Cavalcanti, C. F. M. (2020). Blockchain for machine-to-machine interaction in industry 4.0. Blockchain Technology for Industry 4.0 (pp. 99-116). Springer, Singapore.
4. Huang, J., Kong, L., Chen, G., Wu, M. Y., Liu, X., & Zeng, P. (2019). Towards secure industrial IoT: Blockchain system with credit-based consensus mechanism. IEEE Transactions on Industrial Informatics, 15(6), 3680-3689.
5. Faramondi, L., Oliva, G., Setola, R., & Vollero, L. (2019). Iiot in the hospital scenario: Hospital 4.0, blockchain and robust data management. Security and privacy trends in the industrial internet of things (pp. 271-285). Springer, Cham.
6. Epiphaniou, G., Daly, H., & Al-Khateeb, H. (2019). Blockchain and healthcare. In Blockchain and Clinical Trial (pp. 1-29). Springer, Cham.
7. Sandner, P., Lange, A., &Schulden, P. (2020). The Role of the CFO of an Industrial Company: An Analysis of the Impact of Blockchain Technology. *Future Internet*, *12*(8), 128.
8. Liu, X. L., Wang, W. M., Guo, H., Barenji, A. V., Li, Z., & Huang, G. Q. (2020). Industrial blockchain based framework for product lifecycle management in industry 4.0. Robotics and computer-integrated manufacturing, 63, 101897.
9. Esmaeilian, B., Sarkis, J., Lewis, K., & Behdad, S. (2020). Blockchain for the future of sustainable supply chain management in Industry 4.0. Resources, Conservation and Recycling, 163, 105064.
10. Sikorski, J. J., Haughton, J., & Kraft, M. (2017). Blockchain technology in the chemical industry: Machine-to-machine electricity market. Applied energy, 195, 234-246.
11. Nakamoto, S., Bitcoin: A Peer-to-Peer Electronic Cash System. 2008.
12. A.N. Hidayanto, H. Prabowo **The latest adoption blockchain technology in supply chain management: a systematic literature review** ICIC Express Letters, 13 (10) (2019), pp. 913-920

13. P. Fraga-Lamas, T.M. Fernández- Caramés **A review on blockchain technologies for an advanced and cyber-resilient automotive industry** IEEE Access, 7 (2019), pp. 17578-17598
14. S. Sajid, A. Haleem, S. Bahl, M. Javaid, T. Goyal, M. Mittal **Data science applications for predictive maintenance and materials science in context to Industry 4.0**
Mater. Today: Proceedings (2020 Feb 19)
15. Y. Guo, C. Liang **Blockchain application and outlook in the banking industry** Financial Innovation, 2 (1) (2016), pp. 1-12
16. Y. Lu **The blockchain: state-of-the-art and research challenges** Journal of Industrial Information Integration, 15 (2019), pp. 80-90
17. J. Dai, N. He, H. Yu **Utilising blockchain and smart contracts to enable Audit 4.0: from the perspective of accountability audit of air pollution control in China** J. Emerg. Technol. Account., 16 (2) (2019), pp. 23-41
18. S.B. ElMamy, H. Mrabet, H. Gharbi, A. Jemai, D. Trentesaux**A survey on the usage of blockchain technology for cyber-threats in the context of industry 4.0** Sustainability, 12 (21) (2020), p. 9179
19. B. Putz, M. Dietz, P. Empl, G. Pernul **Ethertwin: blockchain-based secure digital twin information management** Inf. Process. Manag., 58 (1) (2020), Article 102425
20. P. Pinheiro, M. Macedo, R. Barbosa, R. Santos, P. Novais**Multi-agent Systems Approach to Industry 4.0: Enabling Collaboration Considering a Blockchain for Knowledge Representation** International Conference on Practical Applications of Agents and Multi-Agent Systems, Springer, Cham (2018, June), pp. 149-160
21. H.R. Hasan, K. Salah, R. Jayaraman, M. Omar, I. Yaqoob, S.,. Pesic, D. Boscovic **A blockchain-based approach for the creation of digital twins** IEEE Access, 8 (2020), pp. 34113-34126
22. O. Bouachir, M. Aloqaily, L. Tseng, A. Boukerche **Blockchain and fog computing for cyber physical systems: the case of smart industry** Computer, 53 (9) (2020), pp. 36-45
23. Y. Madhwal, P.B. Panfilov **Industrial case: blockchain on aircraft's parts supply chain management** American Conference on Information Systems 2017 Workshop on Smart Manufacturing Proceedings, vol. 6 (2017), pp. 1-6
24. A.H. Sodhro, S. Pirbhulal, M. Muzammal, L. Zongwei **Towards blockchain-enabled security technique for industrial internet of things based decentralised applications** J. Grid Comput. (2020), pp. 1-14
25. T. Zheng, M. Ardolino, A. Bacchetti, M. Perona **The applications of Industry 4.0 technologies in manufacturing context: a systematic literature review** Int. J. Prod. Res. (2020), pp. 1-33
26. M.S. Kumar, R.D. Raut, V.S. Narwane, B.E. Narkhede **Applications of industry 4.0 to overcome the COVID-19 operational challenges** Diabetes & Metabolic Syndrome: Clin. Res. Rev., 14 (5) (2020), pp. 1283-1289
27. P.T. Duy, D.T.T. Hien, D.H. Hien, V.H. Pham **A Survey on Opportunities and Challenges of Blockchain Technology Adoption for Revolutionary Innovation** Proceedings of the Ninth International Symposium on Information and Communication Technology (2018, December), pp. 200-207
28. N. Mohamed, J. Al-Jaroodi **Applying Blockchain in Industry 4.0 Applications** 2019 IEEE 9th Annual Computing and Communication Workshop and Conference (CCWC), IEEE (2019, January), pp. 852-858

29. S.H. Jang, J. Guejong, J. Jeong, B. Sangmin **Fog Computing Architecture Based Blockchain for Industrial IoT** International Conference on Computational Science, Springer, Cham (2019, June), pp. 593-606
30. I. Islam, K.M. Munim, S.J. Oishwee, A.N. Islam, M.N. Islam **A critical review of concepts, benefits, and pitfalls of blockchain technology using concept map**
31. Y. Yan, B. Duan, Y. Zhong, X. Qu **Blockchain Technology in the Internet Plus: the Collaborative Development of Power Electronic Device** IECON 2017-43rd Annual Conference of the IEEE Industrial Electronics Society, IEEE (2017, October), pp. 922-927
32. C. Hennebert, F. Barrois**Is the Blockchain a Relevant Technology for the Industry 4.0?. *2020 2nd Conference on Blockchain Research & Applications for Innovative Networks and Services (BRAINS)*** IEEE (2020), pp. 212-216

GIRISH KUMAR SHARMA: PROFESSOR BHAI PARMANAND INSTT. OF BUSINESS STUDIES DELHI, DELHI
EMAIL-GKPS123@GMAIL.COM

ANANT BHARDWAJ: RESEARCH SCHOLAR, DTU, DELHI
EMAIL- ANANT5892@GMAIL.COM