iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** V **Month of publication:** May 2022

DOI: https://doi.org/10.22214/ijraset.2022.42443

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

Blockchain Technology Applications for Industry 4.0

Darshika Agarwal[1], Prafull Varshney[2], Satyam Goel[3], Dr. Ankit Kumar[4]
[1, 2, 3]*(CSIT-IV Year)*
[4]*(Associate professor (CSIT))*
Kiet Group of Institutions, Delhi NCR-Ghaziabad

Abstract: ***Blockchain: Industry 4.0 involves innovations with upcoming digital technologies, and blockchain is one of them. Blockchain can be incorporated to improve security, privacy, and data transparency both for small and large enterprises. Industry 4.0 is a synthesis of the new production methods that allow manufacturers to achieve their target more rapidly. Research has been conducted on various Industry 4.0 technologies like Artificial Intelligence (AI), Internet of Things (IoT), Big data, and Blockchain, and how they could create significant interruptions in recent years. These technologies provide various possibilities in the world of manufacturing and supply chain. Blockchain is a technology that has gained much recognition and can enhance the manufacturing and supply chain environment. Various fields now have fascinating insights into the advantages of blockchain. Several research articles on "Blockchain" and "Industry 4.0" from Google Scholar, Scopus, and other relevant sources are identified and reviewed for this study. This paper discusses the major potential of Blockchain in Industry 4.0. Various drivers, enablers, and associated capabilities of Blockchain technology for Industry 4.0 are discussed for insights. Different Industry 4.0 spheres/sub-domains for Blockchain technology realisation are also discussed. Finally, we have identified and studied fourteen significant applications of Blockchain in Industry 4.0. It is a range of new developments and hope for immense opportunities that are changing Industry 4.0. This technology would work to achieve amplified outcomes and work individually to enhance the process.***

Keywords: Education, Online Product learning, Ledgers, Bitcoin, Blocks, Smart Contracts, EOS.

I. INTRODUCTION

In the current scenario, it is necessary to understand blockchain and its value for the effective implementation of Industry 4.0. Some fields have prospective advantages for blockchain, like financial transactions applications in which blockchains can provide trust. Foreign currencies and fiat currency problems are excluded, and a controlled supply transaction may take place. The product itself and its assembly's identification part can also be linked to other areas of Blockchain in Industry 4.0. It provides a reminder where the ability to recognise goods with the defect may be beneficial. Here, blockchain will protect all the details about a product: its sub-assemblies, parts, sales paths, etc. It reduces the expense and interruption of retrieval at any time in the supply chain. New data have been gathered by cameras and sensors that could be used to construct the Blockchains network. It gives us access to more knowledge than a person would gather in a short period.

In order to maintain end-user support, there must also be a corresponding structural transition within an organisation. Blockchain is one of the most influential technical breakthroughs in various fields. This technology is developed remarkably in recent years and provides many applications in manufacturing. It is used closely along with terms such as intelligent factories and Industry 4.0. Blockchain refers to a decentralised, encrypted, distributed ledger for filing computers that allow tamper-proof, real-time logs to be created. In Industry 4.0, several elements are still not well described and not fully understood. This new technology will ensure that the future effects of intelligent manufacturing solutions are amplified. The early sales experiences and the current deployments have been learned a great deal. It provides an inclusive distribution strategy, implementing and incorporating these emerging innovations being promoted and supported as resources to meet broader business goals. It could help SMEs (small and medium enterprises), in particular, to defend their inventions sinceblockchain may make the patent environment more straightforward, transparent and less intermediary. This would encourage competition between companies which has more difficulty in accessing the world of patents. It will allow individuals to generate green energy from a freely negotiated arrangement. This technology is exceptional and avoids transactions intermediaries, potentially providing an efficient and cost effective flow of goods and services. This record is connected to the previous block and cannot be changed or altered in the future.

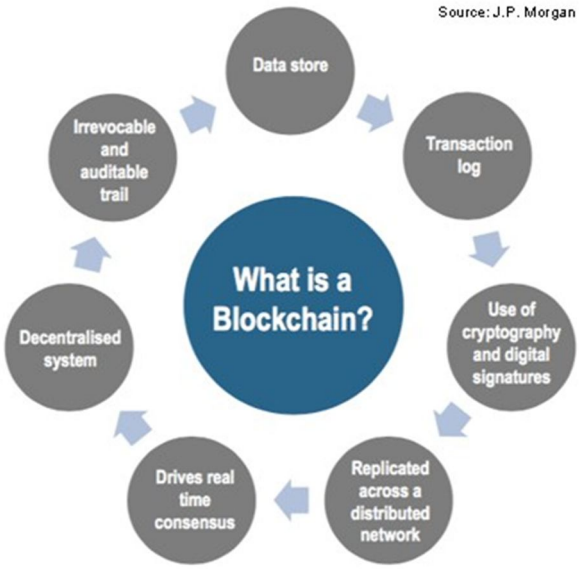
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An open, participatory space where anyone can read and write transactions, known as nonauthorised, is a decentralised forum. In comparison, blockchain is built for particular users with the advantage of reading and writing to an enclosed network. It is the main difference in the position of consumers and incentives to interact with the system among a private and a public blockchain. The supply chain is a dynamic structure comprising multiple businesses that work together to satisfy customers' needs by adding value from the raw material level to the final product. The main chain is supported by the secondary and tertiary chains that co-operate to form an ecosystem, the supplies chain network. Transactions and information transactions also create the complexity of the chain are required to balance. It is essential to believe that blockchain provides continuity and traceability across the supply chain. This paper aims to study the significant potential role of Blockchain for Industry 4.0. This article addresses the following research questions:

1) *RQ1:* To study major benefits of blockchain in the context of Industry 4.0;
2) *RQ2:* To identify and study major drivers & enablers of Blockchain technology for industry 4.0;
3) *RQ3:* To study associated blockchain capabilities for successful Industry 4.0 implementation perspectives; RQ4: To study different Industry 4.0 spheres/sub-domains for Blockchain technology realisation;
4) *RQ5:* To identify and study major applications of Blockchain technology for Industry 4.0.

II. BLOCKCHAIN

Blockchain is defined as a decentralised, distributed directory driving smart contracts and providing the chance to traceability aid, record management, automation for the availability chain, payment applications and other business transactions. Blockchain provides a record of virtually real-time replicated between a network of business partners and is unchanging. the method takes information that will have previously been stored within the Enterprise Resource Planning (ERP) of the corporate. It now makes it available in an exceedingly distributed network of records across disparate companies. Several benefits of blockchain enable organisations to higher understand their customers, particularly on the demand side. Data analytics and AI (AI) have wellunderstood cases of application. It may reach a cap when it involves technological viability, but several businesses strive for convenience. It improves the efficiency and protection of procedures and requires more resilience and stamina than accelerated financial consequences. In technology circles, the blockchain is employed as a permanent distributed directory to record all value transactions. The organisation has total ownership of the blockchain, apart from the nodes that make it superior to other data storage technologies. Each node participating within the transaction would have access to the ledger from multiple devices. this allows decentralisation and network-wide autonomy to make trust and confidence within the transaction ecosystem. Participants first go through all the transactions related to the blockchain. Blockchain technology, sometimes referred to as distributed ledger technology, may be a relatively new type of a database for transaction information stored during a decentralised and transparent manner. The database is go past a network of computers called nodes, so there's no singlepoint-of-failure, and data are often accessed in real-time. The industry is properly in line with the concept of influence in the marketplace of blockchain technologies. It allows users to preserve their exclusive and unchanging identity documents without their permission that no-one can read or view.



ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
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III. FUTURE OF BLOCKCHAIN

Blockchain will help us rethink commercial finance, supply chain activities, operations management and other related domains. this may help to resolve disputes quickly through customisation. this can minimise the big manual work now being made by financial services organisations. Any inconsistencies or crucial errors within the text can even be found within the AI process to assist decisionmakers with approvals and refusals. Many organisations seek to market the connection between IoT and blockchain. so as to assist companies use blockchains, like the corporate has developed the way to integrate the facility of connected devices with secure, accurate digital data archives. This technology will store and consistently share data. When blockchain is involved, it'll make the trail of products smarter in addition as secured, thus tracking the exposure of products in real-time. The blockchain contains holistic and lasting knowledge about each transaction data within the supply chain process. it'll allow linking to any vendors, manufacturing locations and fulfilment centres within the supply chain. Blockchain will change corporate procedures in many industries within the future, but its adoption will take time and energy. This technology will help to enhance financial and public services within the near future. Data is saved in blocks that are all linked to at least one another, are timestamped, and are unforgeable. Blockchain will allow users to look at a product's whole history, whether it's new or used. As proposed a ManuChain that's a bi-level hybrid intelligence model to adopt holistic planning together with individualized manufacturing systems. this sort of application of blockchain can reduce the inconsistency between the look and execution in Industry 4.0 environment within the upcoming future. this kind of interconnection is required for the success of the Industry 4.0 and researchers must listen to such issues. Further, the identified drivers, enablers and challenges have to be addressed during a quantitative way in order that policy planners and managers can adopt the blockchain and move a success within the direction of Industry 4.0.

IV. DISCUSSION ON THE STUDY

The collection and verification of the information for accuracy may be a great challenge. the info would traditionally be gathered by several trackers and sent to an authentication facility until data scientists were contacted for analysis. Using blockchain and intelligent agreements to confirm the reliability and possession of information gathered, the knowledge could also be submitted to the information scientists using the information for developing machine learning models directly from the driving force. Blockchain responds to key issues such as scalability, anonymity and reliability. Blockchain software is an unbelievable thanks to track and control many connected devices so transfers between connected devices will be shared and processed. it'll also remove single points of failure by decentralising and build an environment that may make computer operating robust. Blockchain can promote secure and stable IoT network cooperation amongst connected devices. Blockchain and AI have, over the last number of years, formed their ways with a small overlap of themselves.

V. BLOCKCHAIN TECHNOLOGY APPLICATIONS FOR INDUSTRY 4.0

A. Finance

Blockchain's main emphasis is on financial sector applications. The management of economic transactions are often done through the utilization of blockchains. Via blockchains, foreign currency problems may be resolved, and a controlled spectrum may be reached within the supply transaction. At present, the finance and payments sector tend to act as an important corporate of blockchain and also the pace of adoption in many other industries.

B. Manufacturing Data Protection

The underlying encryption of a blockchain is additionally a possible use for data protection in Industry 4.0. this could prevent unwanted viewing of some data transmitted through a public network. Blockchain is also employed in several ways within the space of belongings for proof of copyright, registers and clear rights, keeping a record, monitoring and tracking distribution rights, putting in place IP contracts and even managing the acquisition of the rights within the context of Industry 4.0.

C. Identifications of Products and Assemblies

Blockchain supplies information for identifying products and assemblies. This could contribute to the quantification and resolution of high quality problems. Blockchain provides full information about a product, sub-assemblies, components and business delivery direction. This technology is used to collect data at each step, which can dramatically reduce recall costs and disruptions in the current environment. This is the perfect way to manage products and their assemblies. In Industry 4.0, blockchain has the potential to add value in a variety of other areas.

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D. Automotive

Blockchain can be used by all **sorts** of initiatives and partners in the **automobile industry**. Its value for output is promising with the continued increase of industry 4.0. Blockchain has a significant impact on many industries around the globe. In a blockchain, buying and other data may be stored digitally in the auto industry.

E. Information and Security

All the information provided by blockchain is stored digitally, like how goods are produced, how they start shipping and how data is managed, and a lot. Security features inherent to the blockchain using data structure. It provides precise monitoring and tracking capabilities. whether data is persistent and conveniently exchanged with appropriate information. In a traditional security system, this can be easily hacked by anyone and hence risky.

Blockchain, rather than traditional ways, uses the best cryptographic technologies to maintain knowledge in a more secure manner. As a result, companies are turning to blockchain networks for improved management software and protection against cyber-attacks.

F. Digital Purchasing

Blockchain is the next phase in the evolution of property. In the global real estate sector, this technology has created new options for future buyers. Blockchain provides a number of advantages in the market, including the ability to authenticate digital purchases and develop trust in the solution for buying and selling properties, both commercial and residential. In the healthcare industry, blockchain technology has shown to be more than just a fad.

G. Business

In recent years, this technology has spread outside the financial services industry to a wide range of industries. It begins to consider its potential role in infrastructure development. It starts the process by creating a bar that is validated over the internet and linked to a network of thousands of computers. The network is set up to upgrade itself on a regular basis so that it can access trustworthy information in real time from any source. It's also extremely clear, effective, and adaptable, as well as extremely stable for business needs.

H. Supervision

The notion of smart contracts has been utilised by blockchain in the domain of crowdfunding and investment capital. This helped to improve the oversight of each associated agency's separate campaigns while also lowering the risk of fraud. Users may now accurately track their donations thanks to blockchain technology. It helps charities deal with the increasing issues of contributed cash being used for other reasons by allowing them to stay up to date and adding a feeling of obligations and accountability.

I. Transaction Recording

Blockchain is a distributed ledger of transactions. The transactions are recorded in a global blockchain notebook that is stored on tens of thousands of computers throughout the world.

In the ledger, transactions are recorded and organised into blocks. The preceding block hash is stored in the blockchain, and attempts to change or fabricate transactions are immediately recognised and avoided. The most well-known application of blockchain technology is for people to send and receive information electronically.

J. Supply Chain

Several new developments are improving the way industrial organisations manage their supply chains. As blockchain technology advances, the supply chain industry will definitely look for real ways to increase transparency, accountability, and productivity. The centralisation of ERP programmes, when combined with real-time data alerts, gives Industry 4.0 enterprises entire control over their in-house activities and allows them to make data-driven decisions about the future**.**

VI. CONCLUSION

The blockchain's growth and expansion in this decade will most likely take place in a variety of methods.

One of the most important parts of Industry 4.0 is digitalisation, which helps firms to gain efficiency in all areas, from management and technology consulting to supply chain planning and solutions.

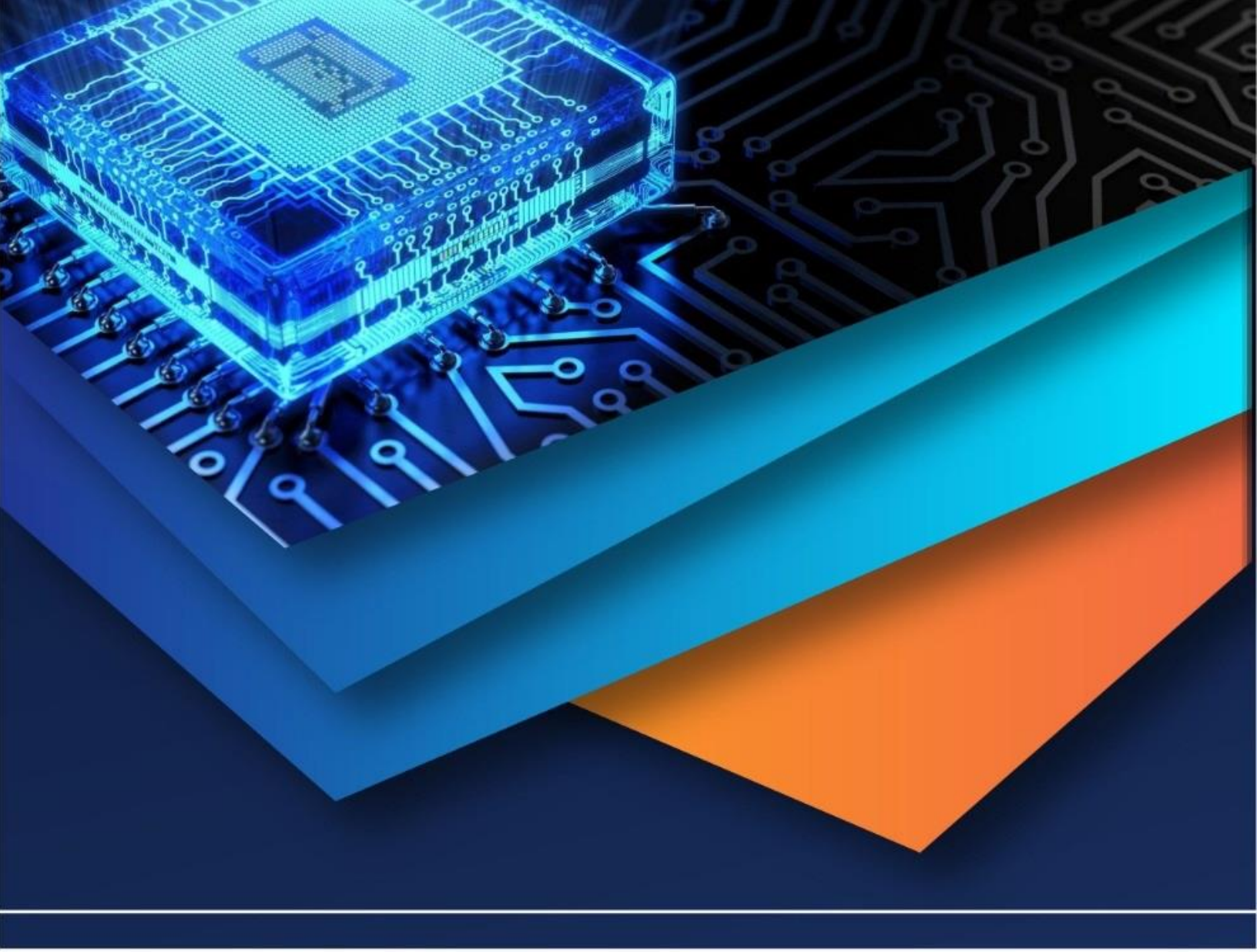
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Many sectors see the potential of blockchain, which can be beneficial in a variety of ways.
Banks are now employing this technology to speed up and lower the costs of payments and transactions.
The use of blockchain is not limited to the financial sector; it can also be used to give information.
This immutable ledger verifies that the commodity was produced using the proper procedure and resources, and that the process was approved.
The blockchain ensures that data is shared in a secure and efficient manner.
Furthermore, an immutable database of all messages exchanged by various connected smart devices is created. Another excellent use of blockchain is identity protection. Because it is deceptive, this technology allows users to create their own secure and trustworthy digital identity. People would be able to use their blockchain identities for a variety of things, from simple activities to apps, software, and signing digital signatures. Blockchain may be the solution to facilitating this step by providing a reliable source of high-quality transactional knowledge to smaller businesses and vendors. Furthermore, a store must ensure that goods in its supply chain are consistent.

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