FUSION OF ARTIFICIAL INTELLIGENCE IN BLOCKCHAIN

Abstract

The two breakthrough technologies of the Fourth Industrial Revolution (IR4.0) that have brought significant changes in the market are artificial intelligence (AI) and blockchain. Blockchain technology combined with AI promises to develop new business models powered by digitalization. Artificial Intelligence (AI) Machine learning technology is a complex decision-making process that affects daily activities such as financial services, medical care, entertainment media, transportation, and space exploration, to name some of the instances. On the other hand, AI is a self-learning process that uses self-learning and is based on the analysis and discovery of patterns in large amounts of data. Using supervised or unsupervised learning, it also assesses and makes decisions based on the examination of large amounts of data. The issues of AI are security, Resources are limited due to centralized architecture and resource constraints. Blockchain technology is a decentralized peer-to-peer network that securely saves transactions and information in immutable blocks. Blockchain's decentralized feature eliminates the need for a reliable third party intermediary. he fusion of AI and BC will result in scalable, secure high-level intellectual functioning, which will represent the new digital information paradigm. This article examines the developments in the integration of Artificial Intelligence with Blockchain, as well as the obstacles and concerns that arise when the two technologies are combined.

Keywords: Blockchain (BC), Artificial Intelligence (AI), Integration, IoT, Machine Learning, Privacy, Security, Supply chain, Business, Ethereum, Automation.

Author

M Nagarani
Research Scholar
Computer Science
Dr N.G.P College of Arts and Science
Coimbatore, India
prathirani94@gmail.com

I. INTRODUCTION

Blockchain and artificial intelligence have gained increased attention as cutting-edge technologies due to the crucial role they play in technological innovation and industrial change [4]. The technologies of the future include blockchain and AI. The potential for integrating these two technologies is becoming more and more of a focus for businesses and individuals as they both develop [1]. Artificial intelligence (AI) is a technology that can carry out difficult activities that call for human intelligence and has the potential to be more powerful than humans .As it encourages the integration of cutting-edge technology in the Fourth Industrial Revolution, AI is one of the primary forces behind industrial progress. such as Blockchain, Cryptocurrency , Cloud computing and Internet of Things (IoT). Undoubtedly, the enormous quantity of data produced by IoT devices, social media, and online apps has accelerated the development of AI, where the data is used to train machine learning algorithms. In a similar vein, blockchain is gaining popularity as a technology with several potential uses. Blockchain, the revolutionary technology that gained popularity with the creation of bitcoin in 2008 (Nakamoto, 2008), continues to change how we interact, track transactions, and automate payments, among other things. In fact, blockchain has created opportunities that allow for the trustworthy and secure direct movement of wealth between its users. Furthermore, because blockchain is a shared database that is synchronized across numerous sites, the checking of approvals and compliances can be made easier with the execution of smart contracts because each member of a distributed network can agree on such activities [2]. Blockchain technology and Artificial Intelligence both offer benefits, but each also has disadvantages. Artificial intelligence (AI) has challenges with interpretability and efficacy, whereas blockchain has concerns with energy consumption, scalability, security, and privacy. They can be connected to one another and benefit from natural integration as two distinct study topics. These two technologies can complement one another since they share requirements for data analysis, security, and trust [4]. Due to its capacity to provide secure data exchange services with traceability, immutability, and non-repudiation, blockchain has recently attracted a lot of interest. Despite the advantages of blockchain, a number of challenges have been experienced in the implementation of the technology, including poor flexibility, challenges with operational maintenance, finding weak coding in smart contracts, and detecting malicious conduct in blockchain historical data. The development of several commercial applications has been substantially accelerated by recent developments in artificial intelligence (AI). The limitations of blockchain might be overcome by incorporating AI into it. The phrase blockchain intelligence refers to the intelligent capabilities that AI has given blockchain. Following an analysis of the blockchain data, detection, and identification of potentially susceptible program codes in smart contracts, AI (such as machine learning) methodologies may help to capture the aberrant behaviors in blockchain [5]. When Ethereum was presented in 2013, it altered the game for blockchain technology by introducing new capabilities like smart contracts that allowed it to integrate more services and be more valuable to various companies and academic sectors [7]. Artificial intelligence (AI), an important branch of computer science, supports the research and development of ideas, techniques, technologies, and applications for replicating, extending, and increasing human cognition [13]. AI has been used in a variety of contexts, including autonomous driving, drug discovery, medical picture identification and healthcare [28-32]. A infinite database may be effectively mined using AI, which can also be used to build new settings and spot trends in data behavior. Blockchain effectively eliminates errors and fake data sets. The two technologies complement each other best because blockchain can reduce AI risk and AI can improve blockchain performance. The use of Blockchains to identify

intelligent applications in crucial sectors including healthcare, banking, electricity, government, and defense is now the subject of extensive research [16]. The blockchain is built on statistical and cryptographic concepts to improve data management security by enabling approved and audited change and processing of data from its inception to the end of data consumption [23].

II. OVER VIEW OF BLOCKCHAIN TECHNOLOGY AND ARTIFICIAL INTELLIGENCE

1. **Blockchain Technology:** Blockchain technology is a method of data storage that makes system manipulation, hacking, and deception difficult or impossible. It digitally stores the data. In cryptocurrency systems like Bitcoin, blockchains are renowned for playing a critical role in keeping a secure and transparent record of transactions. Blockchain is a sort of distributed ledger technology that stores data in a chain data structure. It is a novel distributed infrastructure and computing paradigm that leverages cryptography to guarantee data security and credibility as well as the distributed node consensus method to validate transaction data and further synchronize the whole network [4]. A particularly innovative and promising technology is blockchain. For a variety of applications, it lowers uncertainty, avoids fraud, and offers complete transparency. Blockchain is the ideal answer for practically any industry due to its public ledger and built-in security features [4]. In essence, a blockchain is a chain-like data structure that stores transactions that have been approved by the majority of nodes throughout the whole network [5]. The committed transactions on the blockchain are exceedingly difficult to change or falsify since they are kept at every node. Blockchain data is certified and auditable thanks to the integration of digital signature and asymmetric encryption, meaning non-repudiation of the transaction initiator. Blockchain technology have gone through two stages of development: blockchain 1.0 (also known as digital currency) and blockchain 2.0 (also known as smart contracts).

   Blockchain technology has mostly been applied to digital currencies like Bitcoin in blockchain 1.0. The introduction of blockchain has accelerated the growth of smart contracts. Several digital contractual agreements that have been approved by numerous parties make up a smart contract. When a certain circumstance is met, the smart contract's embedded contractual provisions will be triggered and automatically carried out [5]. The three primary forms of blockchains are public, private, and federated chains, and they are categorized largely according to their level of control and accessibility. Public blockchains with a decentralized architecture, like Bitcoin and Ethereum, let nodes to freely join or leave the network, maximizing decentralization [8]. The bulk of the blockchain architecture consists of the data layer, network layer, consensus layer, incentive layer, contract layer, and application layer. The data layer, which also covers the data structure, focuses on several technologies such as the hash function, digital authentication, Merkle tree, asymmetric encryption, and others. The block is the data layer's most significant structure [13].

   Block is made up of the blockhead and blockbody. The Merkle root, timestamp, and hash value of the most recent and preceding blocks are all contained in the block header. The two essential parts of the block body are the Merkle tree and transaction information. Each transaction is signed by the person initiating it, after which it is processed and validated by the miner. In the block, the verified transaction is

included. The hash value of each transaction is combined together in pairs to form the hash, and the resultant hash value is added together in pairs to generate the hash once again until the Merkle root, which is recorded in the block header, is reached. Any change to the information about each transaction stored on the blockchain has an influence on the Merkle root. This might lead to the blockchain being tamper-proof. Every block also carries a timestamp and the preceding block's hash value, which results in a chain that is chronologically ordered. The network layer is where P2P networks, data communication technique designs, and data verification methods are mostly located. There is no central server for the blockchain. All message transmission between nodes takes place using peer-to-peer networks. All nodes are constantly updating the blockchain. One node generates a fresh block and transmits it to the other nodes. Further nodes store a copy of the block after authentication. On the basis of this block, further blocks will likewise be constructed. This enables the bottom ledger to be maintained by all nodes. Numerous consensus algorithms are primarily part of the consensus layer. Which node is permitted to add fresh blocks to the main chain is decided by the consensus method. The three most popular consensus algorithms are PoW, PoS, and PBFT. Several incentive measures are primarily part of the incentive layer. The blockchain operates without a centralized server, therefore each node must actively participate for the network to be secure. The cost of service for each transaction and the associated compensation for each block's accounting privilege are now the two most often used incentive measures.

A number of scripts, algorithms, and smart contracts are contained in the contract layer, which supports the programmable aspects of blockchain. It is possible for it to be automatically executed without a third party using the pre-set criteria and circumstances. The basis for blockchain trust is this. The application layer is the last component. It includes applications for blockchain across various industries, such as banking, legal, audit, and healthcare [13]. Blockchain is a powerful alternative to the internet because of its design, which incorporates distributed ledgers with both public and private keys and also hash algorithms. An irrevocable distributed ledger is offered by BC for secure data storage. Furthermore, Blockchain is a tool for preventing the introduction of rogue IoT devices into the network. Aside from the economic impact of Blockchain on businesses in terms of operating costs, it may assist to reduce litigation bills associated with conflicts. A consensus mechanism is in place to guarantee transactions in order for a BC transaction to proceed without corruption. When faced with faults or adversarial situations, a consensus method will provide tracking and immutability while also enabling a stable BC. When BC is integrated with smart contracts, a level of reliability and security occurs due to autonomy and mobile infrastructure in attribute-based access control models assuring radio-frequency identification [26].The figure 1 illustrates the properties of the Artificial Intelligence and Blockchain.

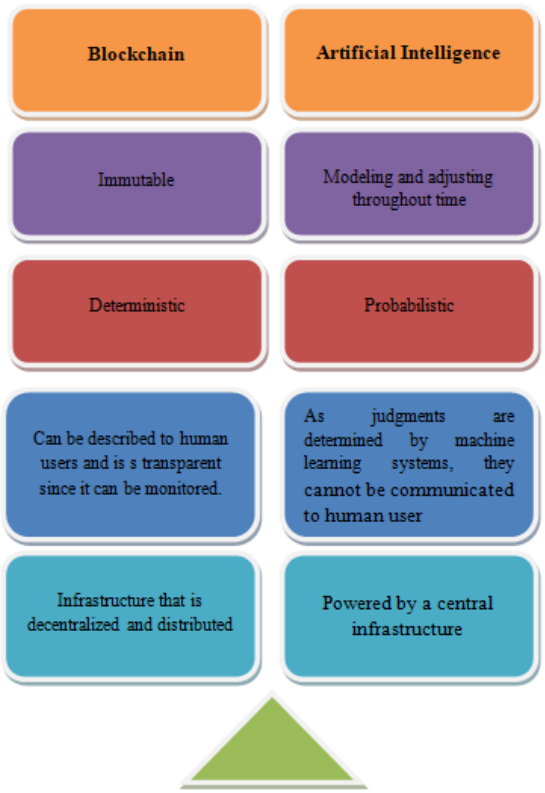

Figure 1: Properties of AI and BC

2. **Artificial Intelligence:** The study of creating computer systems that can replicate independent thought and decision-making processes is known as artificial intelligence (AI). AI exists to efficiently complete set tasks and make the best decisions feasible concerning actions [8]. A computer system called artificial intelligence (AI) analyzes fragmented or organized data, determines on an intelligent action based on that data to accomplish a certain goal, and responds to predetermined parameters in an actual or digital space. By automating, monitoring, and efficiently resolving problems, AI may help enterprises save time by identifying informative patterns that address difficult issues. Because of AI's adaptability, BC technology benefits from its use. In AI-based systems, BC can dependably monitor each stage of the decision-making and data processing process. Additionally, BC can improve the accuracy of the machine's observational justification [26]. Research in artificial intelligence has been predicated on the idea that, in theory, every component of learning may be so thoroughly characterized. The most recent technology Artificial intelligence (AI) research focuses on machine learning, deep learning, and reinforcement learning in disciplines such as computer vision, decision-making, and natural language processing (NLP). People are naturally motivated to actualize the metaverse by advances in artificial intelligence in the real world.

Typically, AI aids people and organizations in automating procedures and making data-driven judgments. For instance, the three essential components of artificial intelligence are algorithms, processing power, and data [14]. Artificial intelligence (AI) refers to a machine that performs a variety of tasks automatically, including learning, perceiving, reasoning, and problem-solving. Tele-surgery or robotic surgery is one such real-time mission-critical application that could benefit significantly from AI [15]. The discipline of artificial intelligence research describes itself as the study of "intelligent agents," or any technology that senses its surroundings and takes activities to optimize its chances of succeeding at some goal. Most AI systems in development today are primarily specialized expert systems that make judgments using a knowledge database [18]. Computer science's field of artificial intelligence (AI) is in charge of planning and carrying out activities that were first carried out by humans. However, these jobs are frequently well-defined and repetitious (Yang and Yu, 2021). AI was created to gather and recognize relevant information from a stockpile of data produced by occurrences. Smart surroundings have been a result of the development of AI. Artificial Intelligence (AI) refers to the study of developing machine systems capable of demonstrating intelligence akin to that of the human mind. It may be used to solve complicated problems automatically, without the need for human intervention [19].

III. APPLICATIONS OF ARTIFICIAL INTELLIGENCE

1. **Transportation:** Transportation AI will be used in driverless vehicles. In "autopilot" mode, an autonomous vehicle can use a self-driving vehicle to move between two points while utilizing a number of in-vehicle technologies and sensors, such as anti-lock hydraulic systems (brake by cables), adaptive cruise control, energetic steering (steer by wire), Global Positioning System, and warning drivers when making lane changes of anything in their blind areas. Utilizing radar and vision technologies, pre-collision systems were created, enabling vehicles to automatically stop in the event of an impending accident [15]. An all electric self-driving car called Project Titan has been under development by Apple. In addition to automobiles, AI systems will undoubtedly include trucks, flying cars, and personal robots.

2. **Home/Service Robots:** Vacuum cleaners were the first domestic robots sold on the market. Roomba is an iRobot robotic vacuum cleaner. Thanks to 20 years of advancements in artificial intelligence technology, the robots were able to create a three-dimensional vision of a house as they cleaned it and became increasingly adept at doing different types of cleaning. Robots will be used to transport goods, clean workplaces, and enhance security in many settings. household robots powered by AI that now prioritize human-robot interaction. Future developments in speech recognition and cloud-based machine learning will improve the support and communication that robots offer [15].

3. **Healthcare:** Popular uses in healthcare include automated clinical management, patient counseling and monitoring technology, healthcare system administration, and devices to help with surgery or patient care. Recent successes have raised the bar for AI in healthcare, such as leveraging social media to predict possible health hazards, machine learning to identify at-risk patients, and robotic surgery assistance [15].

4. **Education:** Through Intelligent Tutoring Systems (ITS), students may communicate with computerized interactive tutors in language, science, math, and other subjects. In particular, when combined with machine intelligence and crowd sourcing, By enhancing online learning, Natural Language Processing has allowed educators to triple the size of their educational settings while still accommodating each student's unique learning needs and preferences.. "Ozobot is a robot that uses color-coded patterns to dance or play while it teaches kids how to code and use deductive reasoning. By putting together robot blocks that can think, act, or sense depending on how each block is used, Cubelets helps youngsters develop their logical thinking skills. Dash and Dot from Wonder Workshop offer a variety of programming options. Children may study biology by teaching the robot to respond with the aid of the robot pet PLEO rb [15].

5. **Low-resource Communities:** AI has been used to create prediction models to assist government organizations in dealing with issues such as preventing lead poisoning in vulnerable children and effectively distributing food. Based on these first efforts, more may be done, particularly if businesses can engage with and inspire trust in these areas. To optimize the benefits of prenatal care, Predictive models are used by the Illinois Department of Human Services (IDHS) to identify pregnant women who are at risk of having a poor birth result. [15].

6. **Public Safety and Security:** For public security and safety, examples include enhanced surveillance drones and cameras, financial fraud detection algorithms, crime, and predictive policing [15].

7. **Employment and Workplace :** Artificial intelligence (AI) is expected to displace jobs in the near future, and it will also create new kinds of vocations. ex-ML engineers, ex-data scientists, ex-data engineers, ex-architects, ex-BI developers, ex-product managers, etc [15].

8. **Entertainment:** Pictures have altered entertainment using techniques from crowdsourcing, NLP, image processing, crowd sourcing, machine learning, social networks, and other platforms for sharing and viewing blogs, videos, and other online material. Platforms like WordsEye, which automatically creates 3D sceneries from natural language text, allow even casual users to apply their creativity [15].

9. **Agriculture:** Agriculture is a field where a combination of time, money, and effort yields the highest results. At the same time as AI is advancing, agriculture is now getting more mechanized. Agricultural robotics monitoring, predictive analysis, and other methods are all used by agro in a number of ways. Farmers might benefit greatly from the application of AI in agriculture [15].

10. **Astronomy:** Artificial intelligence (AI) devices may assist in the study of astronomical data, which includes the finding of new stars, far-off planets, and even dark matter [15].

11. **E-commerce:** AI can assist shoppers in locating relevant things in their preferred size, color, or brand.

IV. INTEGRATION OF ARTIFICIAL INTELLIGENCE AND BLOCKCHAIN TECHNOLOGY

Blockchain places a lot of emphasis on maintaining accurate records, checking them, and carrying them out, whereas AI supports in the selection, examination, and understanding of precedents and datasets, eventually increasing independent association [1]. Various kinds of blockchain and AI developments are merging together in an exciting way. AI is defined by machine learning. One of the most crucial criteria for machine learning is a massive informative gathering. The higher for informative index (data set), or the greater amount of a glimpse the computer can get from its own expertise, the better. There are several instances. For example, everyone uses Apple's Siri, which is clearly an illustration of artificial intelligence; as a consequence, Siri's programming foundation and genuine foundation benefit from every aspect of the interaction with both small and massive numbers of people around the world, and its learning is constantly improving. Similar things apply to Google, and something very similar applies to Cortona by Micro [1]. As a result of experience and improvement over time, machine learning keeps getting better. These characteristics demonstrate the power of machine learning, but they are only attainable when the system is fed a massive quantity of data or information. The accuracy of the data is equally as critical as the technology itself for the success of machine learning or AI. If these advancements are to truly take off, the ability of block chain technology to electronically encrypt data in such a way that it cannot be modified would meet the key security needs. All of these advances may benefit each other and pave the way for a future in which technology communicates safely with one another using blockchain technology and data is generated using AI and machine learning technology [1]. A platform for automated customer service built on machine learning, blockchain, and IoT is provided by Li et al. (2019), allowing small enterprises to deliver high-quality customer care without relying on outside vendors. Over time, this will raise consumer satisfaction levels and enhance the company's profitability. Furthermore, in a blockchain-based platform, consumer satisfaction may be forecasted using the LSTM machine learning algorithm.

The review corpus content analysis demonstrates that integrated AI and blockchain platforms have numerous applications for various business areas, some of which are generic (such as management and marketing) and thus applicable over all industries, while others are industry specific (such as e-commerce and healthcare). One of the 10 issues addressed is e-commerce. The other nine are accounting and finance, medical care, intellectual property rights, leadership, advertising, efficient production, social media, logistics, and transportation [2]. AI and blockchain are the major technologies driving the digital transformation tsunami. The confluence of these technologies has the potential to enhance present business processes and establish new company models that can behave as independent economic agents making autonomous judgments. Blockchain may improve business process transparency, trust, privacy, and security (Mao et al., 2018), whereas AI can find patterns in data and optimize business operations (Salah et al., 2019). These two technologies are designed to be complimentary, and their full potential can only be realized if they are combined (Sandner et al., 2020).

Numerous business cases involving AI and blockchain integration have arisen in recent years. The combination of AI with blockchain results in a highly trustworthy technology-enabled decision-making system that contributes to the development of a safe ecosystem for data exchange and transactions. Specifically, blockchain enables frictionless information access to AI models and aids in commercial decision-making [2].

The combination of AI with blockchain technology has also resulted in the introduction of decentralized autonomous business models, which provide better flexibility, agility, and cost-effectiveness to businesses. For example, Lee et al. (2019) provide a cyber physical system (CPS) for the manufacturing industry that enables self-optimizing, self-adjusting, and self-confguring production systems and addresses the shortcomings of traditional manufacturing processes. CPS has set the groundwork for sophisticated production systems that may influence every functional aspect of the production chain, including design, manufacturing, supply chains, customer service, and support (Lu, 2017). AI and blockchain, together with IoT hardware support, can also make supply chains more resilient and durable by allowing items to be traced in real time across the supply chain (Alonso et al., 2020). Furthermore, these technologies have the potential to facilitate the flow of products, information, and financial resources throughout supply chains (Rodrguez-Espndola et al., 2020). As a result, it is evident that the convergence of AI and blockchain may occur in various dimensions. The integration of these technologies may benefit products, services, and business models, as the convergence can digitally alter industrial organizations to drive the advancement of their business and lead the way into a new digital era (Makarius et al., 2020).

The integration of BC and AI is the confluence of two of the most sophisticated technologies, capable of presenting a wide range of options. Artificially intelligent blockchain is used in self-driving vehicles and smart city transportation. The marriage of blockchain with AI has the potential to improve ML and supply financial goods to AI. The blockchain offers a safe authentication technique [15]. On the one side, blockchain has flaws in terms of security, scalability, and efficiency. On the other hand, AI has its own set of challenges in terms of trustworthiness, explainability, and privacy. Blockchain will provide AI with trustlessness, privacy, and explainability; in turn, AI might help with the creation of a machine learning system on blockchain technology for better scalability, individualization, and governance. Blockchain thinking could result in new consensus models such as the use of demurrage principles to transfer brain currencies such as ideas and potentiate intellect, as well as self-mining ecologies and intelligence proof.

Blockchain-AI technology is growing and maturing. Blockchain is facilitating sustainable development in a variety of ways, such as boosting supply chain efficiency and transparency. In addition, the technology encourages and incentivizes circular economies, reduces information asymmetry in resource management, improves monitoring, improves disaster preparedness, and enables geospatial platforms. Because both technologies deal with data and value, the Blockchain-AI connection is unavoidable. Due to its decentralized ledger, blockchain provides a trustworthy platform for safe data storage and delivery. Whereas AI assists in data analysis and produces insight that may be used in decision making [27].The figure 2 shows the Benefits of Artificial Intelligence and Blockchain integration.

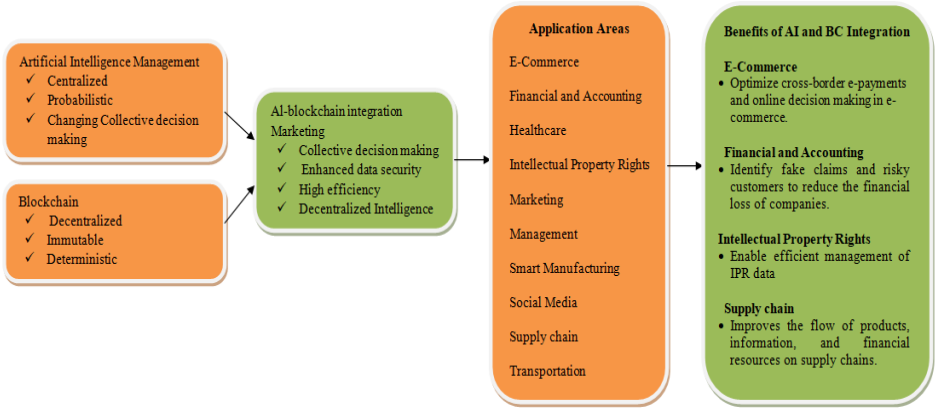

Figure 2: Benefits of AI and BC Integration

V. USE CASES OF ARTIFICIAL INTELLIGENCE AND BLOCKCHAIN

Combining blockchain with AI may speed up work completion, increase cyber security procedures, and enable the creation and organization of enormous databases [9]. The following domains and regions provide some major use cases where the power of AI/ML with blockchain is evident [11].

1. **Automation in Manufacturing:** In order to offer transparency, development, security, and enforcement checks during the production process, businesses are now depending on smart contracts and bitcoin blockchain-based procedures. The machine learning prediction algorithms are utilized to create flexible plans rather of the traditional set computer maintenance timetables. Additionally, quality assurance and product testing have gradually moved toward automation [11].

2. **Food and Logistics:** By enabling transparency and accuracy, ML and Blockchain are helping to solve supply chain issues in the food business. Blockchain technology has made it feasible to trace food sources and manage the related financial activities. In recent times, IBM and Twiga Foods announced a blockchain-based microfinancing plan for food merchants. But the work would not have been completed without the application of ML methods. IBM scientists purchase data from mobile devices, evaluate it, and then use ML algorithms to determine credit ratings and forecast creditworthiness [11].

3. **Energy and Utilities:** The goal of blockchain is to encourage energy transactions in the utility and energy industries. For instance, the energy-based company IOTA has offered peer-to-peer blockchain energy development and consumption. Micro grids for smart energy are also quickly gaining popularity as a technique to provide sustainable energy sources. A New York-based firm called LO3 Energy likewise makes use of blockchain-based technology to empower regional communities to produce, save, and exchange energy [11].

4. **Smart Computing Power:** With all of its encrypted data, a blockchain would need a substantial amount of computing power to run on a laptop. For instance, the "brute force" approach employed by the hashing algorithms that create Bitcoin blocks comprises painstakingly listing all potential candidates for the solution and checking if each one satisfies the problem's statement before making a decision. AI gives the United States the potential to go away from this and approach tasks in a very much more intelligent and cost-effective way. If given the right training data, a machine learning-based system may theoretically improve its abilities in "real-time."[9].

5. **Creating Diverse Data Sets:** Blockchain technology, in contrast to computing-based initiatives, builds suburbanized, transparent networks that can be accessible by anybody, anywhere in the world, in the case of a public blockchain network. Blockchain networks are currently being used in numerous industries to promote decentralization, even if blockchain technology serves as the cryptocurrency industry's central ledger. Singularity NET blends blockchain with AI to produce decentralized, intelligent AI and blockchain networks that can house many types of data. Making an API of APIs available on the blockchain would enable AI agents to communicate. As a consequence, different algorithms might be created using different knowledge bases [9].

6. **Data Protection:** AI uses knowledge to learn about the world and what is happening in it. The knowledge that AI is given determines its capacity to evolve over time. On the other hand, blockchain simply enables the storing of encrypted data on a distributed ledger. It enables the construction of completely secured databases that are accessible to those who have permission to do so. We have a backup mechanism for very sensitive and valuable individual personal data when we combine blockchains with AI. The right combination for managing massive databases is created by the development of artificial intelligence applied to big data and the security provided by blockchain technology [9]. The financial sector or healthcare information is too sensitive to leave to the algorithms of a single corporation. Consumers may gain significant benefits from personalized recommendations while safely preserving our sensitive data by putting this data on a blockchain, which can be accessed by an AI but only with permission and after following the proper procedures.

7. **Data Monetization:** The validation of information is another controversial breakthrough that could be possible by integrating the two technologies. For big businesses like Facebook and Google, monetizing acquired data is a significant source of income. Data is being used against us when it is left up to third parties to decide how it is used to make money for corporations. Blockchain enables the United States to protect our knowledge cryptographically and use it in the way we typically do business. Additionally, this protects the privacy of our personal information while allowing the U.S.A. to legitimate knowledge in person if we choose to [9].

It is vital to understand this in order to combat biased algorithms and generate diverse data sets in the future. The same holds true for AI applications that need human understanding. AI networks will need to purchase data from data providers directly through data markets in order for AI algorithms to learn and improve. This will make the entire process much more honest than it is now and prevent tech companies from taking advantage of its people. A knowledge market of this kind will also make AI accessible to smaller businesses. The cost of creating and maintaining AI is absurdly high for

businesses that don't provide their own information [9]. Through commercialized knowledge marketplaces, they will be able to get privately owned data that would otherwise be prohibitively expensive.

8. **Financial Sector:** In addition to the financial sector, AI and blockchain have a number of less significant but nevertheless significant application cases. AI has the potential to improve supply chains' efficiency and transparency in the transportation industry as well as other sectors. Artificial Intelligence and blockchains are transforming the financial services industry in a variety of ways, including the introduction of trust, the reduction of friction in multi-party transactions, and the acceleration of transaction speeds. Take, for example, the loan application process. Applicants consent to provide blockchain access to their data. Faster closures and higher customer satisfaction can be achieved by combining data trust with automated application assessment methods [17].

9. **Logistics and Supply chain:** Supply chain AI algorithms can assist in identifying supply chain bottlenecks and inefficiencies by analyzing data on the blockchain, allowing businesses to streamline their operations. Contrarily, blockchain technology may support ensuring product transparency and traceability as it moves through the supply chain. Typically, it achieves this by maintaining a record of the legitimacy and ownership of logistical papers and ensuring visibility to those engaged in following the movements of commodities [33].

   Completely Autonomous Systems: Vendors, transporters (such as trucks, trains, and aircraft), warehouses, customs, insurers, consolidators, buyers, and other parties are all involved in today's supply chains and logistics systems. A piece of information concerning a shipment may be found in any of these plays, such as the preliminary final step, prior step/next step, arrival/departure time, product condition, etc. As a result, whether mistakes are made or impoverished individuals are involved in a process, serious problems will arise. The major challenges affecting logistics and supply chains stem from a lack of accountability in procedures, insufficient coordination among parties, and the inclusion of potentially untrustworthy partners. Problems include delayed hand-offs, malevolent persons stealing products or money, missing documents or data, fraudulent or counterfeit items, weather delays, and so forth [11].

   Supply chains across sectors are changing as a result of the automation and intelligence that AI and blockchains are bringing to transactions, the increased trustworthiness and sharing of data, and the digitization of formerly paper-based processes. For instance, tracking carbon emissions data at the product or component level may give manufacturers more clarity and insight into their decarbonization efforts. [17].

10. **Medical Care:** Another sector where combining blockchain and AI has huge promise is the healthcare sector. The potential for improving telemedicine using AI simply has been prior demonstrated. AI algorithms can assist in identifying patterns and abnormalities in patient data by evaluating medical data stored on the blockchain. This enables physicians to treat and diagnose patients with greater accuracy. As a method of storing patient data, blockchain technology may assist safeguard confidentiality and privacy—two factors that are crucial in the healthcare sector [33].

AI has the potential to improve practically every area of healthcare, from bringing therapeutic discoveries to light and supporting user requests to detecting insights from discovering trends and patient data. Blockchain technology enables the secure exchange of sensitive patient data, such as electronic health records (EHR), across healthcare providers [17].Individualized Medicine Silos could be opened, blockchain combined with self-sovereign identification and medical data could be freed, and AI and ML could provide new possibilities. To quickly diagnose a patient, a clinician may, for instance, utilize an automated medical assistant (AI / ML medical bot) to search the patient's Personal Health Record (PHR), current vitals and symptoms, and associated community health data. The doctor will utilize the advice from the bot to create a unique healing plan that is suited to the patient. Due to security problems, a lack of PHR ownership, segmented public health data, application bias, and unreliable data, as well as the undeveloped and untrained nature of medical bots, such an approach is currently not practicable [34].

11. **Transportation:** Autonomous Vehicles on Demand-There has been a lot written and talked on the self-driving future. In numerous instances, autonomous cars will play the streets and pick up passengers as needed. Before this is conceivable, however, a number of significant obstacles must be overcome, including: safe identities, secure identification, interference protection for cars, real autonomous vehicles (level 5), and enormous bias-free datasets. The fusion of Blockchain technology (immutability, ultra security, decentralization, and intelligent contracts), self-reliant identities, impartial big data, and AI / ML will address these issues [35].

    - Blockchain technology can prevent remote bus hacking, verify that the appropriate passengers pick up and pay for transportation, protect identities, give individual interests priority, and allow networks to get stronger over time. There would probably be a bot assistant for every car and every person to communicate for planning, paying, rerouting, and automobile preferences. Through the use of smart contracts, these systems will communicate with one another and share knowledge in order to construct future drives depending on machine and human input (i.e., efficiency, cost/time, vehicle use) and preferences. Combining a decentralized automobile, human identity (private key encryption), and biometrics (facial recognition, fingerprints) can reduce the success of hacking by reducing single points of failure. For barrier categorization and avoidance as well as culturally and gender-appropriate human contact, mutual, impartial huge data sets will be necessary [35].

12. **Life Sciences:** With increased openness and traceability throughout the drug supply chain, the use of AI and blockchains in the medical goods industry has the potential to greatly improve clinical trial success rates. Data integrity, automation of trial participation and data collection, patient monitoring, permission management, and data openness are all made feasible by integrating strong data analysis with a decentralized clinical trial architecture [18].

13. **Social Network Analysis:** Only a limited amount of study has taken into account the blockchain's built-in social networking capabilities. Numerous publications conducted psychological assessments to predict personality. Based on the findings, a number of academics created several models that made it possible to identify the traits that define a

person's personality. With the use of these models, it is now possible to comprehend the relationships that underpin interpersonal interactions, work performance and satisfaction, and personality and mental illnesses. Social networks are a wonderful place to do personality study on a particular group since they have millions of users and a wealth of information [18].

VI. BENEFITS OF ARTIFICIAL INTELLIGENCE AND BLOCKCHAIN TOGETHER

It is up to business owners to look at ways to implement the two in order to profit from deeper insights, increased efficiency, and accountability.

1. **Improving Security:** Data in a blockchain is highly secure. Blockchain is perfect for the storage of very private personal information, such as customized evaluations or medical records. There is still another way to increase safety. Even if the blockchain is secured at the core, implementations and other layers may still be exposed. Future device breaches and the development of blockchain applications can be detected with the help of ML [11].

2. **Data Market Management**: Large companies like Google, Facebook, and Amazon have access to enormous amounts of data that might be helpful for AI operations, but much of this information is exclusive to these large companies. With the use of a blockchain, startups and small businesses will compete against these industry giants by having access to the same data pool and even the same AI [11].

3. **Optimizing Energy Consumption:** Data mining is one of the biggest problems in the current world since it requires a lot of energy. Google has nevertheless demonstrated that MI can resolve the problem. They were able to cut the amount of energy needed to cool their data centers by 40% by teaching the DeepMind AI. A similar idea might be used to mining, which would bring down the cost of mining equipment [11].

4. **Automation:** By lowering the need for human engagement, boosting production, and enabling improved data integrity, blockchains, AI, and automation may bring value to multi-party business operations. The use of AI models in blockchain-based smart contracts could, among other things, suggest that out-of-date products be recalled, that stock be reordered, paid for, or purchased based on predetermined thresholds and events, that disputes be settled, and that the least harmful shipping method be used. [17]. The study by Rajagopal et al. [36] set out to investigate how AI and blockchain technology would affect an automated service. The researcher decided to use a secondary data gathering strategy to get relevant data and information about the study subject. In a manner identical to this, the resources employed quantitative techniques to make it easier to understand the data. Additionally, this study will help readers understand how effective AI is in controlling automated activities.

5. **Augmentation:** A competitive edge for blockchain-based business networks comes from AI's capacity to evaluate, investigate, and correlate data at breakneck speed and in-depth. Blockchain enables AI to develop by providing access to enormous quantities of information from both inside and outside the company, enabling more useful insights, greater control over utilization of data and model sharing, and creating a more transparent and accurate data market [17]. opes et al.'s [37] proposed an architecture that makes use

of blockchain technology as a ledger for robotic control and third parties, or oracles, to handle data. They showed how to engage without using AI systems for image processing, how to securely record events, and how smart contracts may be used to control robots. Since the suggested architecture is simple to integrate, modify, maintain, and expand to other domains, it may be utilized in a variety of scenarios, including manufacturing, network management, and robot control.

6. **Authenticity:** Utilizing the electronic record offered by blockchain technology, the basic structure of the AI and the data source from which it draws may be better understood, addressing the difficulty of explainable AI. As a result, faith in data and, by consequently, AI-generated recommendations is increased [17]. When a blockchain distributes and stores AI models, especially when paired with AI, data security may be improved. Li et al. [38] proposed a blockchain-based data security framework for artificial intelligence in 6G networks. Following that, they discussed two AI-enabled 6G-related applications: autonomous cars and indoor location. They demonstrated the effectiveness of blockchains in data security using an indoor navigation system case study. The integration of blockchain and AI is being developed in order to examine and enhance the degree of intelligent service.

VII. CHALLENGES AND ISSUES

In this part, will discuss the issues and obstacles associated with the integration of blockchain with artificial intelligence.

1. **Scalability:** The effective implementation of smart blockchain applications depends on the scalability issue. Decentralized apps (DApps) on the blockchain must utilize the infrastructure already in place. It is impossible to deploy a system as a large-scale application if its performance and scalability are insufficient. Based on the idea of upholding data secrecy and decentralization, the scaling limits of blockchain are primarily three in nature and include consistency problems, network latency, and performance restrictions. The majority of nodes must agree on the transactional information in order to guarantee the security of the blockchain. One-sidedly focusing on scalability lowers the distributed network's need for consistency, which will split the blockchain in two. The network latency between nodes will restrict the system's potential to scale because the blockchain is a peer-to-peer distributed network, especially those with greater delays. Another barrier is the restriction of transaction performance on the scalability of the blockchain, which is also the main factor preventing the implementation of blockchain applications. Blockchain transactions must be executed in parallel to maintain security and long-term consistency, which makes it challenging to boost transaction throughput [4].

2. **Security and Privacy:** Landing, security, and privacy protection are significant concerns when it comes to the problems of blockchain applications. Information sent between blockchain system nodes is open and transparent since it serves as the Internet of Value's infrastructure and may contain sensitive data that its users may not wish to make public. Because of this, the ability to safeguard user privacy will determine whether blockchain technologies can be widely used. Information concealment and identity confusion are often used techniques for protecting privacy on blockchains. The use of privacy protection signature technologies like group signatures and ring signatures combined with

identity obfuscation technology, which partially anonymizes the user's identity on the blockchain, makes it impossible to identify the actual user. To guarantee identity security, the supervisor may occasionally see user information using the supervisor's private key [4]. Information concealing successfully safeguards the user's transaction privacy by conducting transactions without disclosing any personal information and ensuring the veracity of the outcomes. Examples of such technologies are zero knowledge proof and secure multiparty computing. However, the system's efficiency suffers as a result of the increased calculating procedure, necessitating more development for practical applications. A challenging issue is how to utilize artificial intelligence algorithms judiciously to increase the poor efficiency. In addition, it is evident that the current method has to be redesigned for the use of artificial intelligence algorithms in distributed environments. Public blockchain ledgers provide secure and genuine data processing, but all readers have open access to the data that has been gathered. This might lead to concerns about privacy infringement. Furthermore, ubiquitous sensing devices used in the Internet of Things (IoT) constantly record the private and delicate information of users, and publishing this data to open ledgers may raise privacy issues. By enabling encryption and allowing just a small number of users access to the ledgers, private blockchain ledgers may protect data privacy. However, these private blockchain systems would restrict access to and exposure of the enormous volume of data that AI may need to consume in order to execute accurate decision-making and analytics [18].

3. **Data Collaboration between On-Chain and Off-Chain Storage:** Both conventional information systems and blockchain systems have their own limitations as methods of data storage. Both traditional information systems and blockchain technology are necessary for data exchange and trustworthiness. On the one hand, blockchain must increase performance through off-chain storage and processing services. The key is to secure the relevance and consistency of the data on the chain and the data off the chain, which calls for an efficient integration of blockchain technology and conventional information systems. Additionally, data and the advancement of artificial intelligence are inextricably linked. The application of artificial intelligence is still plagued by a number of issues, including bad data quality, data monopolies, data misuse, and others. Blockchain involvement offers these issues fresh development prospects. Blockchain and artificial intelligence can only be successfully applied to the actual economy by properly fusing the data on the chain with the data off the chain [4].

VIII. TECHNICAL ENHANCEMENT

Artificial intelligence has the potential to significantly advance several fields. Here are a few of these: Security, Efficiency, Trust, Better Management, Privacy and New Markets and Storage [9].

1. **Security:** With the help of AI, blockchain technology becomes safer by facilitating the implementation of secure applications in the future. The growing use of AI algorithms to identify whether cash transactions are fraudulent and should be prohibited or investigated is a great example of it.

2. **Efficiency:** AI may help do calculations more quickly and effectively to lighten the stress on miners, which lowers latency in the network and accelerates up transactions. AI can help to reduce the carbon footprint of blockchain technology. The expense placed on miners as well as the energy utilized would be reduced if AI machines took over the work that they currently perform. Blockchain data may be processed using AI's data pruning algorithms, which automatically remove information that won't be required in the near future as blockchain data continues to increase at a rapid rate. Even brand-new, incredibly effective decentralized learning models like federated learning or groundbreaking data-sharing schemes can be offered by AI.

3. **Trust:** The iron cast records of the blockchain are one of its distinctive qualities. People can clearly trace the system's cognitive process when AI is included. As a result, bot trust grows, boosting machine-to-machine communication and enabling them to share data and coordinate major decisions.

4. **Better Management:** With time and effort, human professionals get better at cracking codes. Machine learning-based mining techniques may eliminate the need for human knowledge since, given the right training data, they may almost immediately become more skilled. As a result, AI also helps to govern blockchain networks better.

5. **Privacy and New Markets:** Securing personal information always leads to its sale, creating information markets and model marketplaces. Simple and secure data sharing in markets increasingly advantages smaller businesses. Blockchain privacy may be further improved by employing "Homomorphic encryption" methods. Only homomorphic algorithms let operations to be performed directly on encrypted data.

6. **Storage:** Blockchains are perfect for keeping extremely private, sensitive data that can be valuable and practical when intelligently analyzed by AI. A excellent illustration of such is smart healthcare technology that provides precise diagnoses based on medical records and scans.

IX. CONCLUSION

Blockchain and AI technologies are developing quickly, bringing up previously inconceivable new ways to deal with data. In practically every industry, they are bringing about a drastic transformation and setting the pace for innovation. Blockchain and AI are state-of-the-art technologies on their own, but when coupled, they have the potential to be genuinely transformative, provided that this integration is supported by a problem-centric thinking strategy. Each of them has the potential to increase the capacities of the others, enabling improved monitoring and accountability. Blockchain technologies, which include decentralized, self-sovereign identities, strong consensus procedures, and extremely secure, unchangeable ledgers, offer a significant potential to improve and rebalance AI/ML systems. Additionally, by utilizing Blockchain-based technology, we will be able to envision a better future as the Internet moves away from human-human interactions and toward more bot-bot interactions. In the not-too-distant future, it will be dominated by an interoperable Blockchain network built on numerous distributed-ledger technologies and capable of storing many digital currencies. It may also be federated to manage different components of remote applications. As a result, Machine Learning and Blockchain are a logical match, because incorporating them into effective and stable systems will revolutionize the world. The future

work will focus on the Transparency and openness and Complex Cryptography. This article examines the integration of Artificial Intelligence and Blockchain, as well as the issues that may arise as a result of the integration of these two technologies.

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