Table of Contents

Table of Figures

List of Abbreviations

1. **AI - Artificial Intelligence**
2. **BaaS - Blockchain as a Service**
3. **DAOs - Decentralized Autonomous Organization**
4. **HHS - Health And Human Services**
5. **ICO - Initial Coin Offering**
6. **IoT - Internet Of Things**
7. **IP - Internet Protocol**
8. **P2P - Peer To Peer**

Abstract

This document aims to explore Blockchain technology's disruptive potential through an evolutionary perspective with applications in business, and associated information security, socio-economic, legal and ethical perspectives. The first chapter defines the concept of disruptive technologies and what makes Blockchain disruptive. The second chapter narrates the four generations of Blockchain, their respective applications and potential in different industries, followed by constraints and challenges associated with the technology's adoption and usage. The final chapter serves as a natural conclusion to the document, briefly summarizing what was covered in the text, trailed by a narration on Blockchain applications beyond business enterprises, the way forward for Blockchain development, and ethical view points for consideration.

Chapter 1: Introduction to Disruptive Technologies & Blockchain

(Christensen, 2015) define a disruptive technology as “*a novel technology that creates new markets or upsets the status quo in current markets”*. With the use of APIs, disruptive technology changes a variety of products and services that were costly, difficult, or too complex into simplified implementations; transforming the business environment to accommodate all types of participants, large and small (Nambobi, 2021). Current disruptive technology trends revolve around Big data, Internet of Things, Artificial Intelligence, Blockchain etc.

Blockchain is not a single technology, but rather a collection of developing components with potentially unpredictable, and still under research, consequences. It can be described as a flexible database that allows for the creation of transaction entries, their vetting and validation, and storage in a tamper-proof ledger. Industry, economies, and society are forecast to be disrupted by the potential of blockchain’s unique amalgamation of characteristics; whether it be via consumer transactions, breaking down organization silos or enabling cross-enterprises’ collaborations; as highlighted in Figure 1 below (Treiblmaier, 2021).

Characteristic	Consumer Blockchain	Single organization Blockchain	Collaborating organizations on a blockchain
Decentralized processing network	• Increases speed of exchange and reduces time delays • Reduces price of exchange(if a fee is charged) • Improves quality, reliability and availability of services	• Increases speed of exchange between department/ divisions, which reduces backlog and overall costs • Improves availability, reliability and maintainability of services	• Increases speed of exchange, which reduces backlog and overall cost • Improves availability, reliability and maintainability of services
Distributed ledger	• Increases transparency(in the case of public blockchain) • Increases confidence	• Increases efficiency by standardizing data format across departments/divisions and ensure process integrity • Improves auditability because records are verified in near real-time	• Increases efficiency by standardizing data formats across multiple organisations,enabiling interoperability, and ensures process integrity • Reduce risk of fraud, error and invalid transactions across the group because records cannot be altered • Improves auditability because records are verified in near real-time
Digital Signature	• Reduce risk of fraud or theft	• Helps identify customers and participating departments/ divisions	• Helps identify customers and participating organizations
Programmable Logic	• Enables transactions criteria to be strictly enforced	• Enables new capabilities to be added to existing services and processes	• Enables new capabilities to be added to existing service and processes across the group • Enables collaborations criteria to be strictly enforced
Private vs. Public	• Public blockchain enables anyone to participate in any capacity	• Private blockchain restricts processing to members or employs of the organizations but opens up use to consumers	• Private Blockchain restricts participations to members of the group of organizations but opens up use to consumers

Figure 1: Value of a Blockchain

(Shelkovnikov, 2016)

Blockchain is defying norms of traditional businesses and business processes, pushing them to start thinking differently in terms of creating and delivering value to their customers. The groundbreaking decentralized, trustless, immutable architecture of Blockchain empowers P2P networks and threatens the shift in mediating power of institutions to disintermediated consumers (Shelkovnikov, 2016).

The technology is ripe for not just business potential but also associated career possibilities in the upcoming years including but not limited to - (Thiago Bueno da Silva, 2020) (Sumaira Johar 1, 2021).

- Blockchain as a Service (BaaS) e.g. Azure, IBM
- IoT and Block Chain in tandem
- Block chain in Artificial Intelligence

Chapter 2: Business Potential & Challenges

2.1. Evolution of Blockchain Applications

Blockchain – a potentially revolutionary technology is disrupting traditional business structures across banking (Guo, 2016), finance, government, distribution networks (Kari Korpela, 2017) as well as rejuvenating current economic systems' infrastructure (R.Lakhani, 2017), through its distributed and automated applications (see Figure 2).

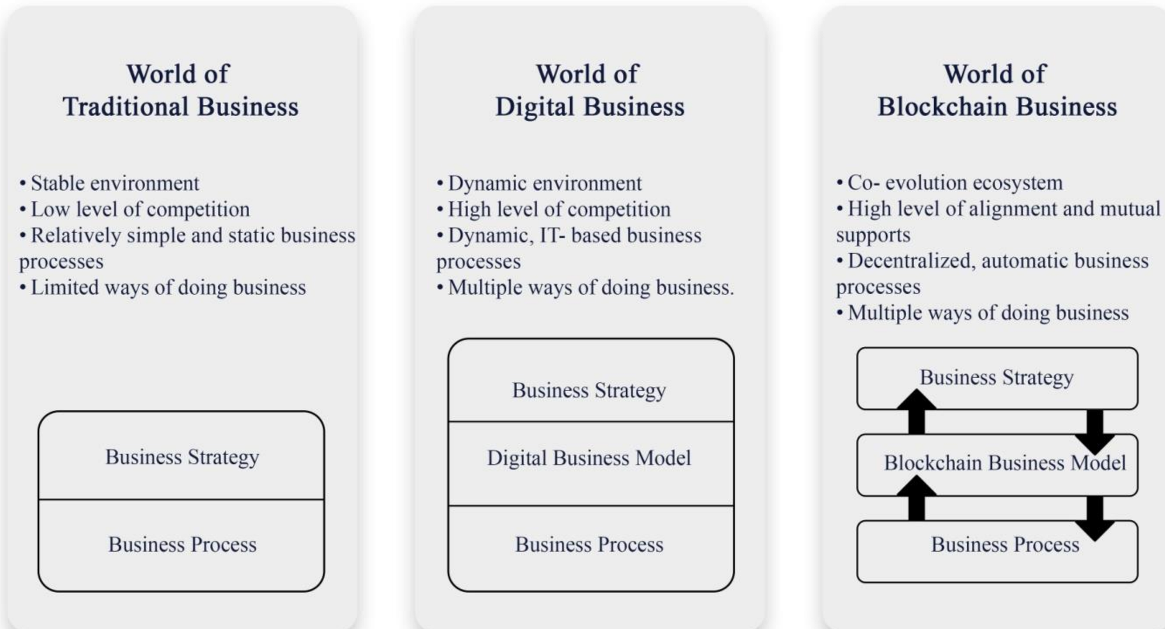

Figure 2: Blockchain's Impact on Existing Business Models

(Alain Yee Loong Chong, 2019)

The evolution spans 4 stages, beginning from Blockchain 1.0 in cryptocurrency format in 2009. Over 600 cryptocurrencies have been produced since the inception of the first cryptocurrency, Bitcoin (Shubhani Aggarwal, 2021).

Satoshi Nakamoto's groundbreaking work then transformed in 2010 into the form of smart contracts and financial technology (Nakamoto, 2010), in Blockchain 2.0 as part of the Ethereum and Hyperledger framework (Sukina Almekhlafi, 2021).

With Blockchain 3.0, the application range of the technology is no longer limited to financial and commodities' transactions but includes government, healthcare, science, academia, supply chain, access control, healthcare, insurance and more, acting as a general-purpose technology (Umesh Bodkhe, 2020) (Sukina Almekhlafi, 2021).

The present evolutionary stepping stone for the technology is Blockchain 4.0, still in its early stages of development. Artificial Intelligence (AI) will be a critical component of Blockchain 4.0, reducing the need for human administration and allowing labor and decision-making to be delegated to machines.

The growth of blockchain technology from its birth to the present is depicted in detail in Figures 3 and 4.

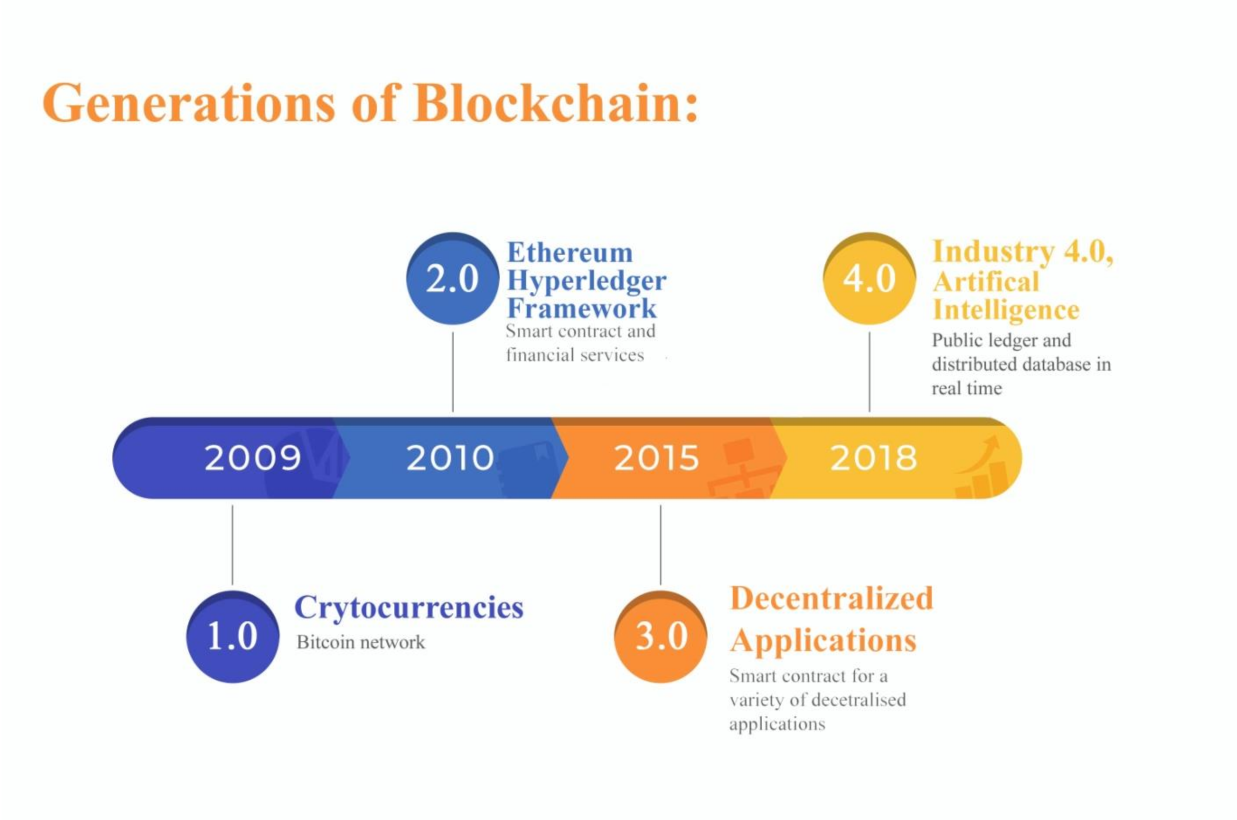

Figure 3: Generations of Blockchain

(Umesh Bodkhe, 2020)

We explore the business value and associated challenges of each blockchain evolution and format turn by turn in this chapter.

Generation	Example	Advantages
Blockchain 1.0	Bitcoin	• Lower transactional cost in comparison to other electronic payment channel • Secure and transparent with tracking cash, so counterfeiting is not possible • There is finite supply of Bitcoin, just like gold markets. • Relative anonymity in transactions
Blockchain 2.0	Smart contracts and ethereum	• Smart contract are accurate and records all terms and conditions to minutest explicit detail • Terms and condition of the contract are fully visible to all transactional involved peers • Smart contracts are interpreted ,thus the scriptes are executed live on the server, thus transactions execute fast • Businesses are now paper-free, thus smart contract allow go- green initiative. • It eliminates a vast change of intermediares as only transaction parties are involved in the contact
Blockchain 3.0	Convergence towards decentralized Apps	• No single point of failure as there is no single node controlling the transaction • No central authority owing the DApps Network, even if any intruder tries to manipulate data, it is not possible as the app does not lie on any particular Internet protocol(IP) addresses, hence trust on the system is enhanced • The transactional speed is increased about 100 times is distributed environment system
Blockchain 4.0	Seamless integration with industry 4.0 and Artificial intelligence	• Artificial intelligence (AI) will be an essential part of the platform • Provide automation and integration of different execution platforms as a single coherent unit

Figure 4: Blockchain Evolution: Comparison

(Abhishek Srivastava, 2018)

2.2. Blockchain 1.0: Cryptocurrencies

Distributed digital currencies based on peer-to-peer technology allow users to conduct financial transactions with anyone, anywhere in the world instantly. These exchanges are protected via multi-layered security protocols without the need of a centralized intermediary, drastically reducing, if not, eliminating any transaction costs.

2.2.1. Applications

Cryptocurrency and blockchain-based digital payment networks have a huge edge to become shareholders in this fast-developing market.

PayPal, the world's largest online payment company began accepting Bitcoin as a form of digital payment from online consumers in 2014 with services extended to its global e-commerce customers as well. SBI Remit, Japan's largest money transfer company, has been using the blockchain based payment system called Ripple. Banco Santander has launched a mobile app for cross-border payments using Ripple's xCurrent. Customers of Santander use this app to execute digital payments in Euros and US$ within a day. (Mohammad Hashemi Joo, 2019). In addition, cryptocurrency is a profitable investment category for reducing portfolio risk and has been found to outperform traditional investments in terms of average daily returns (David Lee Kuo Chuen, 2019).

2.2.2. Potential & Constraints

Protection of personal information, lower or no transactional costs architecture and safety against chargeback fraud are few of the many characteristics of blockchain based cryptocurrencies which make them an attractive payment mode. For example, using a credit card to make a $100 purchase costs $3.37 compared to $0.61 for a Bitcoin transaction. Credit cards are 5.5 times more expensive than Bitcoin transactions in the long-term (Hayes, 2016).

Merchants are protected against chargeback fraud due to the swiftness of the transfer. A cryptocurrency transaction is typically verified in 10 to 30 minutes, but a bank transaction may take several days to complete (Seaman, 2014). The retailers have time to double-check the transaction before delivering the products or services in this instance. Blockchain transactions in contrast, are immutable until the seller and the buyer agree otherwise.

While it is also inflation-resistant, cryptocurrencies are volatile in nature with their prices controlled by multiple parties. This vulnerability makes it difficult for cryptocurrencies to obtain credibility from authorities as well as customers. Most government organizations do not accept cryptocurrencies, including Bitcoin, as legal currencies (Fields, 2018). A number of financial and cryptocurrency-based organizations have tried to seek SEC accreditation, as well as SEC approval for a variety of Bitcoin and currencies derivative products. However, SEC has denied all the ETF registrations and inquiries (Fields, 2018).

The risks associated with cryptocurrencies go beyond price fixing. Hackers and other criminals often target exchanges that convert conventional money for cryptocurrency (Neil Gandal, 2017) with vulnerability of other types of fraud overshadowing the cryptocurrency exchange network. Between 2011 and 2014, fraudulent operations defrauded approximately $10 million in Bitcoin deposits from naive cyber consumers (SMU, 2015).

2.3. Blockchain 2.0: Smart Contracts

Based on the "smart contracts" theoretical concept of (Szabo, 1996), Russian programmer Vitalik Buterin introduced the Ethereum Framework in 2013 serving as the primary foundation of executing blockchain based smart contracts, opening up an infinite suite of possibilities for platform and blockchain agnostic applications. (Buterin, 2015) (Hamilton, 2019) (Swan, 2015). Smart contracts are electronic contracts with terms of transactions encoded within their architecture allowing autonomous execution and self-sufficient resources distribution, based on inputs from off-chain services that collect real world data and push it onto the blockchain's decentralized network. (Bhuvana R, 2020) (Swan, 2015) (Valentina Gatteschi & Santamaría., 2018).

2.3.1. Applications

Smart contracts can empower Decentralized Autonomous Organizations (DAOs), encoding decision making terms of agreement within the blockchain and self-managing participants and resources. (Valentina Gatteschi & Santamaría., 2018). Recently, IBM has successfully adopted smart contracts for shipment tracking and facilitation of trade finance. (Chang & Chen, 2020) Project Lighthouse is allowing users to execute their crowdfunding and assurance contracts from a Bitcoin wallet. Between January and June 2018 alone, smart contracts based crowdfunding initiatives raised $6.8 billion.

Cryptokitties is a digital collectibles game where players trade creatures called cryptokitties similar to trading cards. It has achieved wide scale success; with cryptokitties trading from less than $100 to a whopping $100000+ figures. TronToken is another smart contract project for digital entertainment content distribution, and one of the largest blockchain-based operating systems in the world, raising $70 million in its Initial Coin Offering (ICO) alone. (Gustavo A. Oliva, 2020).

Smart property can allow transferring ownership rights and transactions of vehicles, homes, stock shares, copyrights, etc on the blockchain; held as a digital asset with a private key by the owner. (Swan, 2015) Financial organizations too, are increasingly adopting smart contract platforms Hyperledger, R3 Corda, Ripple, Wave, as well as Ethereum itself.

2.3.2. Potential & Constraints

Smart contracts' dynamic nature opens a whole new world of opportunities in terms of cost and time efficiency along with making trust-based contracts possibly a mechanism of the past. Hence, it has massive interest for global enterprises.

Hyperledger is testing an enterprise sensitive data sharing and exchange platform for supply chains, assets lifecycle, airlines/travel agencies' record keeping, bond derivatives' transactions along with numerous other financial applications. Similarly, R3 is focusing on trade financing, insurance contracts, healthcare record keeping etc. SWIFT, a major banking payment network is using R3 in proof of concept trials for a blockchain based payment gateway since 2016. VISA too is investing heavily to study cross-border DLT based B2B transactions (Douglas S. Hamilton, 2020). Augur and Gnosis have developed very sophisticated prediction markets. (Shuai Wang & Rui Qin, 2018).

Ripple is facilitating financial transaction between different traders; Wave's potential lies in e-documents submission and transmission to eliminate transaction costs. All these frameworks have wide scale applicability to supply chains and industrial pilots.) (Shuchih E. Chang, 2020).

Other prospective domains under exploration and development include smart contracts for copyrights protection and royalty payments, smart identities with individuals' personal, financial, medical, legal and other data all pushed onto blockchain infrastructure. People this way can have unique personal identifiers with no need to share IDs and other information at the time of opening up bank accounts, signing policies, etc., enabling simplified citizen and customer experiences. It can transform record-keeping and archiving, with all the world's information ecosystem becoming a blockchain. (Swan, 2015) (Víctor Santamaría & Fabrizio Lamberti, 2018).

Third party vendors such as Azure and IBM are offering businesses Blockchain-as-a-Service (BaaS), empowering their clientele to harness the expertise and platforms of the tech giants and set up their own blockchain infrastructures, drastically bringing down initial investments for enterprises.

Smart contracts and applications come with their fair share of constraints and challenges, particularly in terms of their legality and enforcement in the absence of an intermediating authority. A "code law" will need to developed as binding or different legal frameworks and licenses which can service different applications. Moreover, if blockchain replaces current technologies as the ultimate storage lingua franca, end of life planning, longevity and preservation protocols as well as accessibility will demand much attention and study before it ready for mainstream adoption. (Swan, 2015).

Smart contracts are also not configurable with APIs; data first needs to be injected, using off-chain "Oracles" with strong governance mechanisms ingrained; otherwise there is no reliability of the information injected and they can be the weakest link. Their immutability becomes a challenge when buggy code cannot be modified if hacked or new information needs to added. In that case new contracts from scratch have to be built, making their scalability highly problematic, along with being dependent on strengths of different consensus protocol. As all the transactions conducted through blockchain are public and technically available "forever", it is theoretically possible for individuals' private information to be hacked in a deanonymization attack; all the while, violating GDPR's "right to be forgotten" clause too. (Víctor Santamaría & Fabrizio Lamberti, 2018) (Fei-Yue Wang, 2018) (Shafaq Naheed Khan, 2021).

A major recursive calls attack on a DAO let the hackers transfer amount of worth $50 Million to a subsidiary account in 2016. It was reversed by the Ethereum community only by implementing a hard fork. (Fei-Yue Wang, et al., 2019). Consequently, threat of criminal activities also remains a challenge (Fei-Yue Wang, 2018).

2.4. Blockchain 3.0 & 4.0

Decentralized applications are the future. Blockchain 3.0 made the technology adoption prospects ubiquitous to all industries. While many aspects of its sophisticated architecture and its amalgamation with other technologies such as AI, are still heavily researched and under development in Blockchain 4.0, there is no doubt that Blockchain is here to stay.

2.4.1. Applications

Chemical Industry

Both blockchain technology and its use are quickly evolving. AB InBev (a global beverage company), APL (a large ocean carrier), Kuehne + Nagel (a large logistics company), and Accenture have formed a consortium to test blockchain technology with actual product shipments across various locations in order to rethink the freight and logistics operating model. This blockchain application has reduced manual data entry by 80% while also simplifying data revisions, streamlining inspections, and lowering the risk of customs' fines. The approach is expected to save billions for international trade communities (Accenture, 2018).

Governments

The public sector is also opening up to the mass appeal of blockchain around the world. The Department of Health and Human Services (HHS) in the United States has created Accelerate, a contract billing management tool that incorporates blockchain, artificial intelligence, machine learning, and process automation. This facilitates over 100,000 contracts, valued at $25 billion, spread across 50 systems to be better managed by opting for record link to unstructured data, instead of self-storage. It is the first federal application to be certified as having the authorization to operate by a designated approving authority. Accelerate has been able to replicate contract information across the entire bureaucracy (Ross, 2018).

Estonia's e-identity, e-healthcare, and e-governance are all supported by the e-Estonian initiative (Estonia, 2020). 98 percent of Estonians make tax filings online and 99 percent of their health data is digitized and kept on blockchain (Adegboyega Ojo, 2017) (Clare Sullivan, 2017).

Other examples are highlighted in Figure 5 below –

Use Cases	Representative Countries	Focus
Medical and healthcare	China, United States, Switzerland, Phillippines, Japan, Brazil, etc.	Supply chain, Internet-of-Things, etc.
Financial applications	(Almost) All	Cryptocurrencies, asset management, etc.
Critical infrastructures	South Korea	Asset management, optimization, etc.
Blockchain city	Malaysia	Cryptocurrency, data management
Asset management	Georgia, Sweden, Switzerland	Land registry, property transactions, etc.
Education	Japan, Malta	Certificate management
Data management	Phillipines, Australia	Cloud data management

Figure 5: Blockchain Use Cases Adopted by Governments and the Focus of Blockchain Applications

(Clavin, 2020)

Energy

The energy sector may use blockchain in a variety of ways, from energy trade to IoT device management and energy resource management (Merlinda Andoni, 2019) (Muhammad Baqer Mollah, 2019). The representative areas of blockchain usage in the energy sector are shown in Figure 6.

Areas	Blockchain Usage	Benefits
Energy trading	Transaction management	Real-time and peer-to-peer exchange
Smart energy	IoT management, resource management	Secure asset management
System protection (SCADA)	Data and service protection	Intrusion tolerance

Figure 6: Blockchain Use Cases in the Energy Sector

(Clavin, 2020)

Japan is funding a project to develop a system for measuring and controlling self-consumed renewable energy. Energy may be transferred locally without needing to be transported to a central point after the transactions are completed (Corporation, 2020). The initiative uses the cryptocurrency side of blockchain technology.

The Brooklyn Microgrid project is an early example of an open-source and scalable platform for the energy sector. Customers (neighbors) in the local Brooklyn market have been autonomously trading in near-real time (siemens, 2018).

Environment

Blockchain applications are being utilized by environment-focused enterprises too. Clean Water Coin, which uses a blockchain network to gather funding for clean-water initiatives. Other emerging projects, such as Poseidon, are attempting to tokenize carbon credits and natural capital assets in an effort to reduce carbon emissions (cleanwatercoin, 2018).

Plastic Bank is a social venture that offers a monetary incentive in the form of a cryptographic token in return for collecting ocean recyclables such as plastic containers, cans, and bottles and depositing them (IBM, 2018).

Gain forest is an example of "crypto-conservation," in which smart contracts are used to motivate farmers in the Amazon to protect the rainforest. The preservation of a piece of woodland is verified using satellites, which then activates a smart contract utilizing blockchain technology (Dr Celine Herweijer, 2018).

2.4.2. Potential & Constraints

The promise of Blockchain is not limited to the list above. Researchers, industrialists, governments, and enthusiasts, alike have all jumped on the Blockchain bandwagon.

Education & Development

The immutable record creation process of blockchain networks is well-known in the education and development sector, and it may be useful in keeping track of all activities and researches across multiple learning institutions and research companies (P. Ocheja, 2018). The blockchain may also be used to maintain track of the course's students have taken and the degrees and certificates they have received (Y. Xu, 2017), ensuring that no one can fake a certificate or degree. It can also assist in doing research in a secure way, since the blockchain network can be used to store and preserve intellectual property. Because the network validates the blockchain using timestamps, the intellectual property would be protected and preserve its origin on its own. This platform may also be used by researchers to keep their study secure and retain its integrity throughout the process. In the case of research articles, (M. S. M. Pozi, 2018) proposes a blockchain platform that maintains account of the contributions made by the authors based on the editing.

Health Care

The healthcare business is one of the areas where blockchain might be used to build a transparent infrastructure for storing and analysis of healthcare data (T. Nugent, 2016). It may also assist in the creation of novel medications as well as a more cost-effective healthcare diagnostic. Aside from patient diagnostics and medical records, the blockchain may assist in evaluating data generated by intelligent devices, tracking the origin of medications, and keeping track of drug adverse effects, among other things. Additionally, pharmacies may use the blockchain technology to preserve supply chain data traceable between the manufacturer, customer, and vendor (Archa, 2017). From submitting a quote to claiming expenditures, blockchain can enhance the state of the art in the medical insurance industry by providing a transparent process and reducing fraudulent requests.

Wide Scale Adoption: Information Security, Socio-Economic & Legal Challenges

Despite the seemingly boundless potential of Blockchain, the marriage of decentralized applications with industry is a tricky one. In Figure 7 below, we have summarized some hurdles that are felt industry wide when it comes to Blockchain adoption.

Technical	Information Security	Social	Organization	Government/Legal	Energy
Lack of storage capacity for a large amount of data	Shared data among multiple peers	Needs to be more "convenient"	Cultural and trust concerns to adopt blockchain	Does not have any legal quotes to follow	Energy- intensive validation processes (e.g. PoW)
Blockchain software is still in its infancy-being developed and refined	Limited cryptocurrency key protection	Knowledge Gap - lack of knowledge & skillsets	Unknown cost of operating blockchain	Identifying responsible actors	
Limited transaction capacity	Information is likely to be manipulated and put to inappropriate use – cyber-attacks & illicit commerce	Hesitant social adoption of technology	Challenges in finding the ROI	Regulatory barriers associated with data protection	
Lack of production-ready network	Fit-for-purpose authentication and communication protocols	Uncertainty around adopting the technology and participating in a shared network	Encouraging organizations to adopt technology and participate in a shared network	Ownership of records	
Lack of maturity of AI technologies	Selfish mining		Difficulty in identification of use cases	The implication of the distributed storage nature for the	
Deficient architecture - system speed & scalability			Poor visibility of market short term and long term potential	Service level agreements	
Potential for information decay					
Maintenance costs					

Figure 7: Challenges to Blockchain Adoption

(Ichikawa et al, 2017), (Banafa, 2017), (Pirtle et al, 2018), (Mackey et al, 2019), (Upadhyay, 2020)

Chapter 3: Reflections

In this article, the disruptive potential of Blockchain technology across different industries is explored, through the lens of evolutionary stages of Blockchain and associated information security, legal, technical and other challenges.

In the final component of our research, we reflect back on the birth of blockchain, its growth today and its intersection with society, now and in the future.

3.1. Blockchain: A Look Back

Blockchain's innovation lies in its ability to empower individuals through disintermediation via a decentralized distributed network. The evolution of different blockchains may be divided into four generations. The first generation of blockchains was enabled by Bitcoin, the second and third by programmable smart contracts, allowing business logic to be included into a decentralized system with far ranging applications. The fourth generation of blockchain and, its combination with AI, IoTs, cloud computing etc. are still under research and development (Caradonna, 2020). Blockchain technology is continuously maturing. There are multiple view points on the pace and promise of its progress, the products/businesses which will emerge as a result of them, and the conceivable implications of their use.

3.2. Blockchain Beyond Business: Socio-Economic & Ethical Perspectives

3.2.1. Social Enterprises

Blockchain's potential has largely been explored for the purpose of investment, profitability, and process optimizations. However, social science researchers, think tanks, international development organizations and other public sector stakeholders have also applied it to, "greater good" social initiatives for promoting the interests of the poor, preserving the environment, provisioning of basic social services, or facilitating community development; particularly in terms of transparency, auditability, security, and decentralization (E. Werker and F. Z. Ahmed, 2008).

(R. R. Mukkamala, 2018) discovered that implementing blockchain technology may assist social enterprises in building and strengthening trust relationships with social investors and sponsors. Furthermore, blockchain technology's applicability may easily be expanded to social enterprises' other activities, such as donations/products collected from corporations, foreign relief agencies, or the government. In such situations, blockchain technology can be used to give digital receipts, assist in supply chain product monitoring, auditing, and regulatory compliance.

3.2.2. Way Forward

(Zambrano, 2017), (Solomon Anzagra, 2020) have identified certain prerequisites and actions that can be taken to support blockchain development.

In addition to financial resources, it needs to be reinforced with the right infrastructure and infostructure, capacity development, policy and regulation, and institutions. Agile policy frameworks can make the technology more accessible and enable nations towards becoming place for pilots and prototypes, boosting expertise and competitiveness.

In particular, the authors recommend to -

(1) Formulate Blockchain specialists' groups

(2) Invest in advanced STEM research organizations and graduate programs

(3) Create dedicated blockchain research organizations, laboratories, incubators, and consultancies

(4) Invest in pilot programs and initiatives to encourage people to trust Blockchain technology and bridge the digital divide amongst various sections of society

(5) Augment current platforms by incorporating blockchain-based services for more sustainable investments and lower barriers to entry

(6) Develop national strategies and governance protocols for use of blockchain

(7) Establish international interoperability standards based on multi-stakeholder involvement

(8) Form cross industry and cross country/regional strategic alliances and collaborative platforms by identifying critical use-cases

3.2.3. Final Words – The Philosophical & Ethical Challenge

From a socio-political and philosophical point of view, in the non-digital age, society needed trustworthy third parties for large scale collaboration. In the future, we will have multiple ecosystems with checks and balances. As a result, the idea of trusting an algorithm or technology may be difficult to convey, explain, and implement to the masses.

Finally, it remains critical, from both ethical and technical viewpoints to educate the users, politicians, and decision-makers on the technology's potential in order to make informed decisions about how to mobilize this disruption towards positive scientific and social developments, while curtailing its implications towards privacy, theft, energy and the environment. We can only decide how we wish to control and use technology after we understand its potential, the possible consequences of its usage, and the human elements of its consumption. When a society is confronted with a novel technology, it must make judgments about how to manage it; for that education is critical (Caradonna, 2020).

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