

Blockchain : A Potential Ingredient for Fourth Industrial Revolution

** Diptikant Satpathy*

Abstract

The business processes today are complex. With stricter compliance and policy requirements, more demanding customers, greater commercial competitions, geographically spread businesses, and vulnerable cyber security, today's business sees a lot more challenges than ever before to track and trace each aspect of the business process. Maintaining foolproof automated systems with transparency, security, reliability, traceability has big impact on the bottom line of the organizations. A distributed ledger technology called 'Blockchain' provides a viable solution to these problems. The technology started with its use in peer-to-peer online payment through a cryptocurrency called 'Bitcoin', but later it has been successful in finding its application in many other fields like banking, asset management, healthcare, travel, supply chain, logistics, identity management, etc.

This article discusses the high level working of blockchain technology with more focus on its applications in banking and financial sectors, supply chain management and identity management areas. Before taking a plunge into Blockchain implementation, one needs to evaluate its appropriateness. A 'Business Suitability Matrix' has been established to help decision makers. This may assist in formulating questionnaires, and the outcome of the exercise will supplement the business decision. A separate section has been added to determine Indian scenarios and the areas where Blockchain might come handy.

Keywords: Blockchain, cryptocurrency

I. INTRODUCTION

Often, I wonder, 'What is the identity of today's individual?' An immediate response comes to mind - the way Google perceives, Facebook portrays, and Twitter reacts to him or her. The journey of mankind from 'social groups' to 'social media groups' has been spectacular. From room-sized computers to nano-computers to virtual machines, from using typewriters to touchscreens, from carrying suitcase-load of currencies to use of finger print to make payments worth millions and many more in the list, the technological development over the last few decades has been nothing less than magical.

The rate and speed at which present-day innovations are taking place is faster than ever. The quantum of change that is happening in a day is probably more than it used to be over a year's time a few decades ago and it is going to be faster and faster. We are standing on the edge

of a technological revolution that will essentially change the way we think, live, work, identify ourselves, and interact with each other. The potential change that humankind is going to experience will be astounding.

While the first industrial revolution was about steam engine, the second and third revolutions were about mass production and information technology respectively. What might be the catalyst(s) for the fourth revolution - Big Data (BD), Artificial Intelligence (IA), Internet of Things (IoT), robotics or potentially Blockchain? The exponential growth witnessed in the field of Blockchain technology over the last couple of years has provoked many technocrats to term it as the new age business influencer and one of the drivers for the fourth industrial revolution.

Blockchain technology has already started to create a paradigm shift in social, legal, economic, and political arenas. It has so far been able to provide an innovative foundation for organizations that desire to be more

Manuscript received May 20, 2018; revised June 5, 2018; accepted June 10, 2018. Date of publication July 6, 2018.

* D. Satpathy is Senior Consultant with Infosys Ltd., Pocharam Campus, Hyderabad, Telangana, India - 500088.

(email: diptikantsatpathy@gmail.com)

DOI: 10.17010/ijcs/2018/v3/i4/131645

vigilant, transparent, and secure.

Blockchain is capable of positively impacting many industries. We will discuss three areas which have already begun to witness such imprints in manifest ways.

The article demonstrates the high-level working principles and key applications of Blockchain in areas of Banking and Financial services, Supply Chain Management, and Identity Management. Suitable use cases have been specified in different sections of the article to make it more reader friendly and informative.

This article does not aim to serve the purpose of a white paper, but is intended as an educational document on the subject.

Blockchain, as the name suggests, is nothing but multiple digital ledgers or records known as blocks connected with each other through a digital chain. As it is distributed across multiple computers, this is also known as distributed ledger technology (DLT). This peer-to-peer network sits on top of the internet and is an open source system to record transactions which cannot be removed but can only be sequentially updated with a timestamp. Hence, practically speaking, it does not let the historical trace and sequence of events to disappear at any time.

Blockchain technology started with the idea of a digital currency known as Bitcoin proposed by an individual or a group known by the pseudonym Satoshi Nakamoto. As per Satoshi Nakamoto blockchain is an open source, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way. The ledger itself can also be programmed to trigger transactions automatically [1].

“Announcing the first release of Bitcoin, a new electronic cash system that uses a peer-to-peer network to prevent double-spending. It is completely decentralized with no server or central authority.” – Satoshi Nakamoto, January 9, 2009, announcing Bitcoin on SourceForge [2].

This peer-to-peer network that sits on top of the TCP/IP was presented as part of a proposed platform for bitcoin, a virtual or crypto currency system. Bitcoin happened to be the first ever application of blockchain technology.

This comparatively new technology is considered to have the potential to cause major economic, political, and social transformations by:

- ❖ Promoting accessibility
- ❖ Ensuring auditability
- ❖ Warranting transparency
- ❖ Building trust and reputation
- ❖ Enhancing efficiency in transaction

Types of blockchain:

Blockchain technology can be broadly classified into the following three types:

- 1) *Public Blockchain*: Completely transparent, decentralized and accessible by anyone who is part of the consensus process. Examples of public blockchain are cryptocurrencies, such as Bitcoin, and Litecoin.
- 2) *Private Blockchain*: Semi-decentralized and permission controlled, for example, use of public domain data.
- 3) *Permissioned Blockchain*: Fully controlled and access permission oriented, for example, smart contract, trade contracts, loyalty programs, etc.

II. HOW DOES BLOCKCHAIN WORK

In a Blockchain system, multiple ledgers are replicated and maintained on as many databases. Each interested party is involved in the system and process. When one block or ledger is updated, all the other ledgers have to be consensually updated otherwise the chain breaks. Blockchain is a combination of three technologies [3]:

- 1) *Peer-to-peer Networking*: Like the way BitTorrent network works, a group of computers can connect with each other without depending on a central authority or central server, hence eliminating the chance of a single point failure.
- 2) *Asymmetric Cryptography*: Asymmetric cryptography is used to generate a set of credentials for individual account ensuring unique identity.
- 3) *Cryptographic Hashing*: Merkle tree or Hash tree data structure is used to record transactions, identify, and synchronize computers.

Each new transaction in the network is encrypted by hashes and in turn hashed into the on-going chain of hash-based proof-of-work [4]. This encrypted transaction on the chain is permanent in nature and it cannot be changed without modifying the proof-of-work.

The longest chain or main chain preserves the sequence of events, thereby preserving a consistent trail for future reference. Each node on the chain defends against attackers, and as long as it can do so, it remains integrated with the parent longest chain. Once its security is compromised, it will be detached from the parent and become an orphan block. These nodes can leave and join the longest chain at any time, but while joining back they

have to accept each time the longest proof-of-work chain as proof of activities that happened during their absence. With the joining of each new block, the main chain keeps growing. Each block contains a set of valid transactions that are hashed and encoded into a Merkle tree which is the heart of the technology. Fig. 1 shows a simplified conceptual Blockchain structure.

As per William Mougayar [34], Blockchain has three capabilities:

- ❖ Technical: Back-end database that maintains distributed ledger.
- ❖ Business: Exchange network for moving value between peers.
- ❖ Legal: A transaction validation mechanism, not requiring intermediary assistance.

Blockchain Process Diagram

Fig. 2 shows the simplified flow involved in a blockchain coupled supply chain management process:

- 1) Transaction completed between a supplier and a customer.
- 2) Transaction represented as 'Block' in the Blockchain and released online.
- 3) Block broadcasted and verified by miners.
- 4) Miners rewarded for verification service.

- 5) Block added to the blockchain as a permanent block.
- 6) Transaction process complete and record available for users.

III. MAJOR USES OF BLOCKCHAIN

Blockchain applications can be categorized mainly into two broad groups:

1) Use of Blockchain for Cryptocurrency: Major cryptocurrencies are Bitcoin (BTC), Ethereum (ETH), Litecoin (LTC), Zcash (ZEC), Ripple (XRP), and Monero (XMR).

Blockchain by Satoshi Nakamoto was proposed as a platform for transactions through Bitcoin cryptocurrency during the year 2009. According to Wikipedia, there are around 1600 cryptocurrencies in circulation in the market today [5].

2) Use of Blockchain for all other purposes: Wherever a transactional data/record is involved (though this may seem a bold statement, this technology has the potential). Starting with banking and financial services, the utility of this technology extends to supply chain and logistics, healthcare industry, travel industry, e-governance, and many more applications. Fig. 3 shows the major

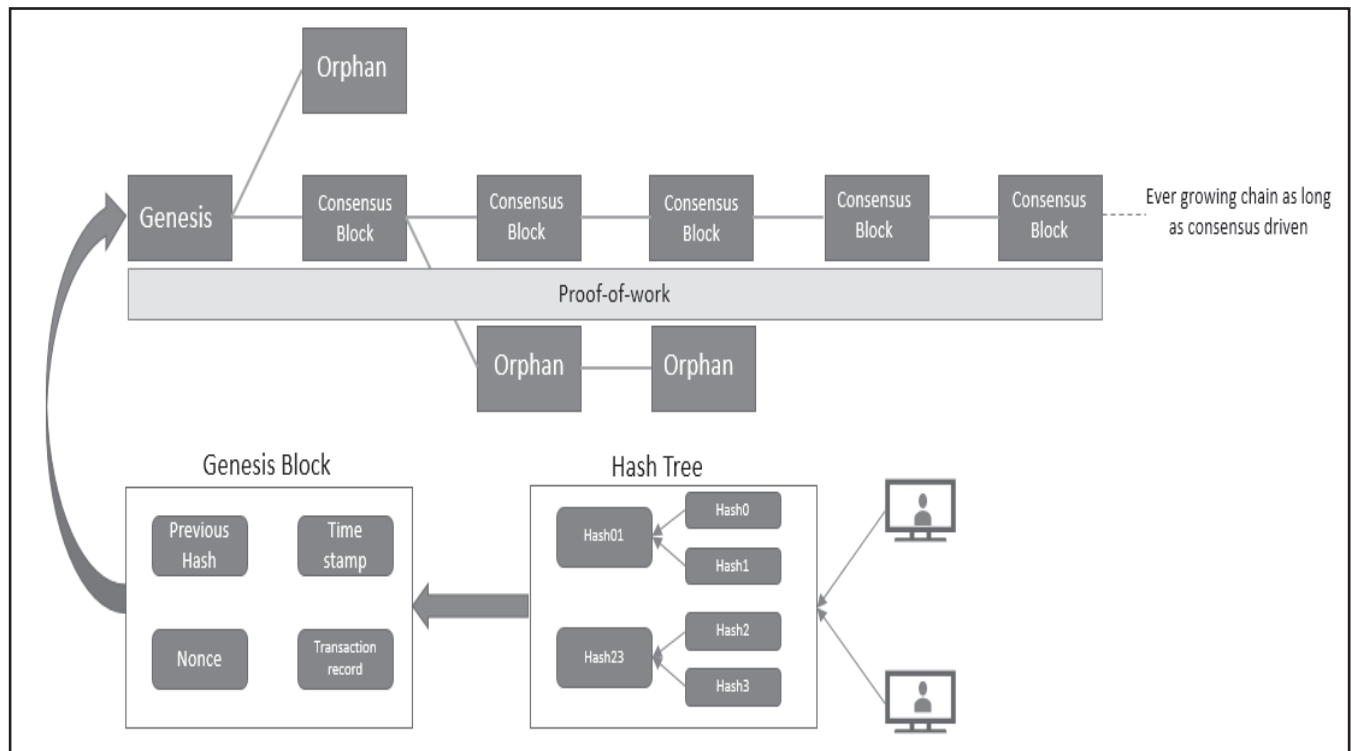


Fig. 1. Blockchain Structure

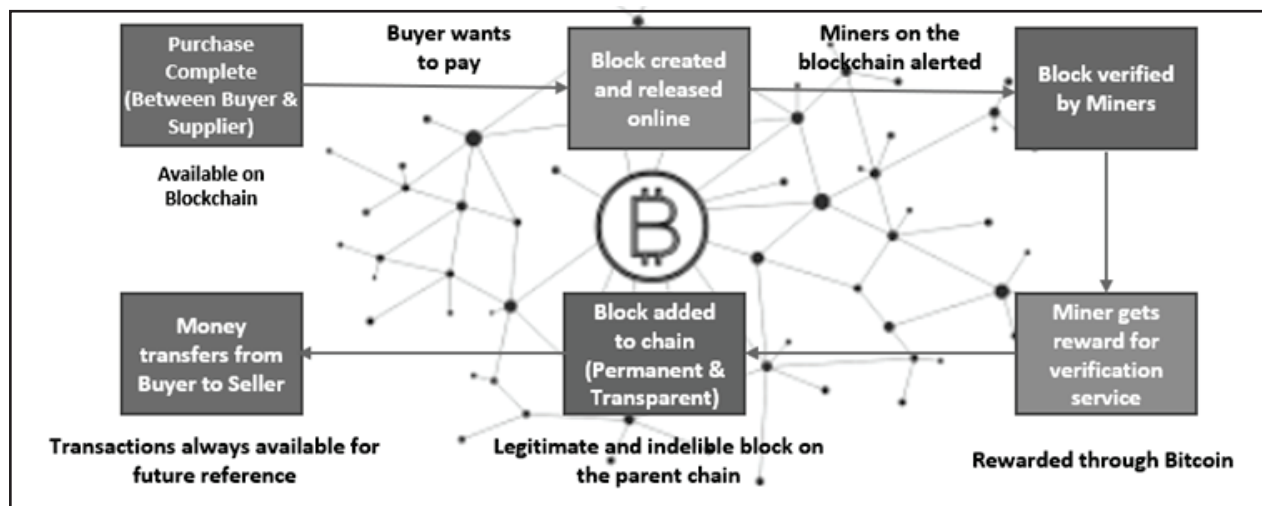


Fig. 2. Blockchain Protocol

applications of Blockchain.

IV. BANKING AND FINANCIAL SERVICES

Each business deals with financial transactions that are internal and external in nature, such as accounts payables, accounts receivables, inter-departmental transactions, etc. There is a need to maintain a lot of perpetual transactions spanning across past, present, and future records. Several ledgers are required to be in place for record keeping and tracking of financial transactions, mostly distributed across various units, departments, entities. The very nature of this work in business establishments poses the following challenges:

- ❖ It is a time-consuming and labor-intensive process.
- ❖ It is prone to human and system errors.
- ❖ It requires safekeeping of records.

A typical business organization deals with several financial transactions. The core functions can be broadly categorized as follows:

- ❖ Budgeting, cost management, and cashflow management
- ❖ Payments to supplies (transactions in the form of accounts payables)
- ❖ Transactions across units (inter-departmental or inter-unit transactions).
- ❖ Payments from customers (transactions in the form of accounts receivables).
- ❖ Payments to banks, financial institutions, and stakeholders.
- ❖ Transactions involving government and tax authorities.

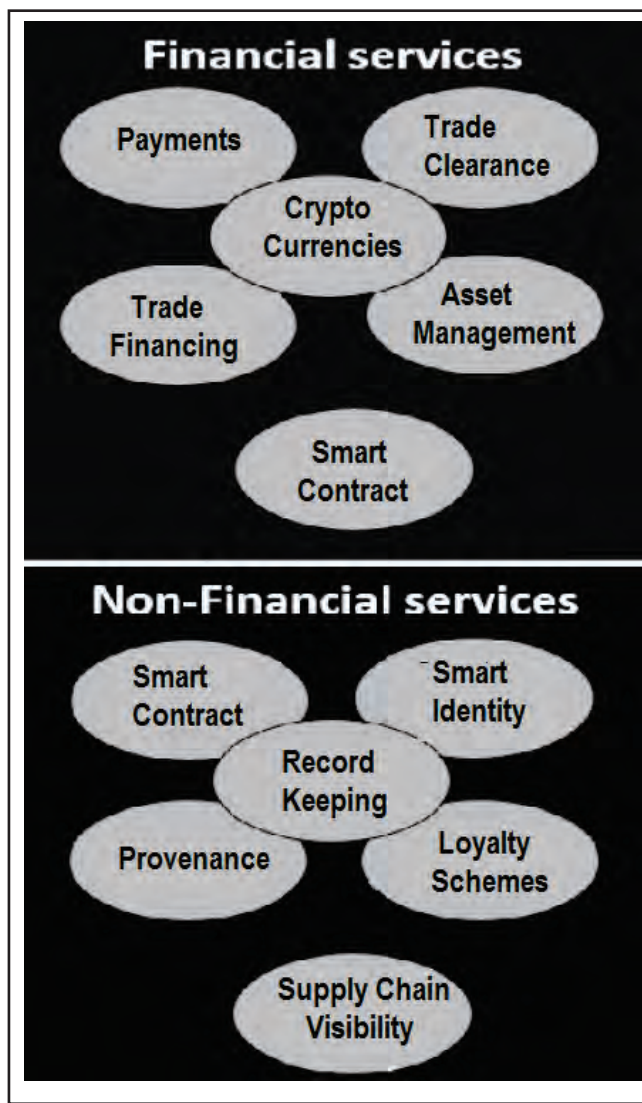


Fig. 3. Major Applications of Blockchain

All these transactions not only involve multiple ledgers for current and future periods but also need a huge amount of past records to be maintained. Depending on the size of the organization, quantum of transactions and involvement of multiple entities, record-keeping becomes more and more challenging.

The settlement of financial transactions needs a lot of human interventions, and is also prone to error. Any flaw in the financial system may imperil the survival of an organization.

V. SCOPE OF BLOCKCHAIN IN FINANCIAL SECTOR

As discussed earlier, the use of blockchain was originally established by the pseudonym *Satoshi Nakamoto* through the first cryptocurrency called **Bitcoin**. Hence, appropriately enough, most of the initial developments have gained traction and have taken place in the financial sector. Despite being a nascent technology, most of the major financial players, regulators and central banks have shown keen interest and have been dedicating their resources to pilot projects and prototypes.

More interestingly, most of the projects are corroborated by multiple establishments. An organization can use blockchain in the following ways:

- 1) Use of cryptocurrency for payments and other financial transactions (which is increasingly going to be a proven area)
- 2) Use of Blockchain for regular payments, internal transactions, and record keeping
- 3) Clearing and settlement activities (for banks, stock brokerage firms)
- 4) Stake-holder identity verification (e.g. KYC)
- 5) Asset digitization and digital asset management
- 6) Commercial papers (e.g. digital contract)

A radical shift is on the way into the turf of Escrow systems in today's trade and this has been possible through '*blockchain Smart Contract*'.

A. Smart Contracts: A Digital Platform for Agreement and Guaranteed Execution

Smart contract is a computer protocol to enable automatic transaction, verification, and authentication based on negotiated terms. This term was first proposed by Nick Szabo in 1994 [6].

With Blockchain, trade contracts are embedded in digital code and stored in transparent and shared databases. Once agreed and accepted, they are protected

from deletion, tampering, and revision. Each aspect such as agreement, process, task, and payment has a digital record and signature that can be identified, validated, stored, shared, and later retrieved. The role of intermediaries like lawyers, brokers, and bankers is eliminated to a great extent. Individuals, organizations, machines, and algorithms spontaneously execute and interact with one another with little friction. This is the immense potential of Blockchain smart contract which can facilitate self-execution and self-enforcement.

Blockchain has the capability to automate monetary transactions based on the negotiated terms and conditions in the contract digitally signed earlier between various parties. This has made the complete digitization of trade possible.

Smart contracts can be very effectively used in a supply chain and logistics application pertaining to cross-border trades.

In a typical brick and mortar industry such as the auto industry, there is a long and complex chain of suppliers, OEMs, whole sellers, distributors, retailers, and customers. There are payments which can be regulated and completed once shipments are delivered. In turn, the

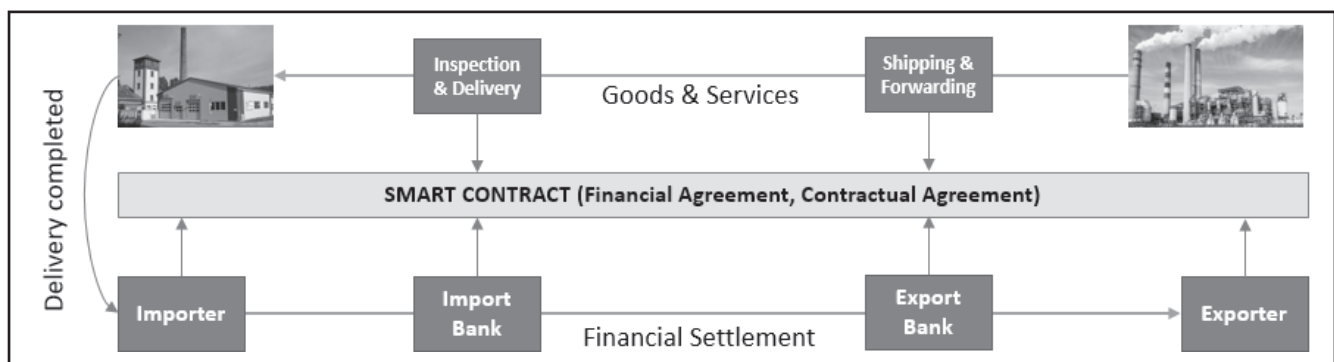


Fig. 4. Smart Contract Process Flow

trigger for payment can be prompted through the application of GPS, RFID, mobile, and smart devices.

In the service industry, most of the stakeholders in the supply chain are generally better positioned on more matured IT platforms. This provides an edge over other industries as far as the use of Blockchain is concerned. Also, the supply chain is less complex in these industries.

However, irrespective of the nature of the industry, the starting point is the creation of smart contracts. The members involved in the process are buyer or customer, seller or supplier, banks, shipping and logistics company, inspection company, customs, and other agencies. There are terms and conditions embedded in the contract, which becomes active when conditions are met through online consensus. Automated payments will be released once trading parties agree that the contractual agreements have been met. The complete process is automatic, and hence frictionless.

Fig. 4 shows the smart contract process flow. We had earlier discussed about '**digitizing payments**' (financial transactions) through cryptocurrency using Blockchain. Smart contracts will help with '**digitizing trade**' making use of Blockchain.

In Fig. 4, a typical supply chain involving all the major stake-holders like shipping and logistics companies, agents, and suppliers have been brought onto the Blockchain platform to make the process smooth and frictionless.

B. USE CASES IN FINANCIAL SERVICES

Cryptocurrency, Banking, Stock Markets, Smart Contracts

The following are a few examples of application of Blockchain in banking and financial services (Fig. 5).

❖ **ABRA** is a mobile app which allows investors to buy, store, invest, and transact multiple cryptocurrencies (about 25 cryptocurrencies such as Bitcoin, Ethereum, Ripple, Bitcoin cash, Litecoin, Dash, etc.). A bank account, American Express card or cash can be used to add Bitcoin to the crypto-wallet [7].

❖ **Bank Hapoalim blockchain project:** Israel's largest bank, Bank Hapoalim Ltd., and the largest aerospace defense company, Israel Aerospace Industries (IAI), are collaborating on using Blockchain technology in a bid to meet cybersecurity and information security challenges [8].

❖ **Nasdaq** is working with Chain.com to offer technology for processing and validating financial

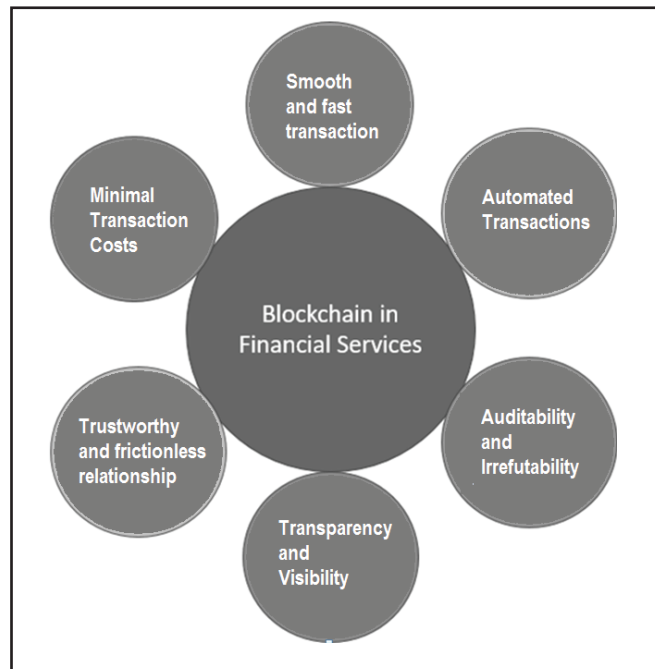


Fig. 5. Advantages of Blockchain in Finance

transactions. Chain.com is a blockchain service provider [9].

❖ **Bank of America, JPMorgan, the New York Stock Exchange, Fidelity Investments, and Standard Chartered** are testing Blockchain technology as a replacement for paper-based and manual transaction processing in such areas as trade finance, foreign exchange, cross-border settlement, and securities settlement [10].

❖ **Barclays** has launched several Blockchain initiatives involving financial transactions tracking, compliance and combating fraud [9].

❖ The shipping and transport giant **Maersk** has started Blockchain solutions for streamlining marine [11].

❖ **The Bank of Canada** is testing a digital currency called CAD-coin for interbank transfers [10].

❖ **Æternity blockchain** is into creation of smart contracts which allows execution of a credible transaction with interference of a third party such as Escrow agents or a bank. It uses a novel hybrid Proof-of-Work (PoW) and Proof-of-Stake (PoS) algorithm to create smart contracts [11].

❖ **Augur** has been into Blockchain based predictions markets. It lets users create prediction markets on the future outcome of derivatives and other financial instruments in a trustless manner in a decentralized ecosystem [12].

❖ With an aim to reduce transactional costs and make

money transfer faster, German businessman **Radoslav Albrecht** has started an online bank. It will use cryptocurrency Bitcoin to enable international money transfers [13].

To conclude this section, we say that the use of Blockchain in financial services offers the following benefits:

- ❖ Minimal transaction costs without any intermediaries involved.
- ❖ Automated financial transactions and verification (e.g. making use of smart contract).
- ❖ Transparency and clarity through no updateable cryptographic codes.
- ❖ Auditability and irrefutability through permanent trail with timestamps and signatures.
- ❖ Trustworthy and frictionless supplier-customer relationship through digitally binding terms and contracts.
- ❖ Cross-border payments with reduced cost and time.

VI. SUPPLY CHAIN MANAGEMENT

Supply chain management has traditionally been a cross-functional activity involving the movement of material and information, which spans across suppliers through manufacturer to customers. It encompasses all the major touch-points in a typical business organization.

Globalization has made access to best technologies involved in manufacturing or production process easier and smoother. This makes supply chain process in an organization even more critical as this provides scope for direct bottom-line impact.

Major areas of modern supply chain management are:

- ❖ Customer relationship management
- ❖ Forecasting
- ❖ Inventory management
- ❖ Shipping and logistics
- ❖ Procurement
- ❖ Material and production planning
- ❖ Analytics and data management

Best-in-class Enterprise Resource Planning (ERP) products fulfill most of the existing requirements. However, with more and more stringent compliance-related checks and regulations, existing ERP platforms fall short of accomplishing business goals.

A. Challenges Around SCM

Globalization and shrinking geographical boundaries pose a great deal of challenges in terms of quality, cost-effectivity, and **timely delivery** of product and services.

The fast-changing market and technologies coupled with highly demanding customers and strict compliances make it necessary for the organization to be well-informed and up-to-date about each touch point on the supply chain.

- ❖ **Gem stones** (such as diamond) companies have to ensure that the product has not come across any conflict zone throughout its journey (example: De Beer, USA).
- ❖ **Garment manufacturers** have to ensure that child labour or any other form of exploitation was not involved in the manufacturing process (in the famous case of Walmart sourcing clothing from Bangladesh).
- ❖ **Food products** giants such as Walmart and Whole Foods need to track their products, to ensure that it was organically grown and proper standards of hygiene were maintained.
- ❖ **Electronic products** need to be tracked throughout the lifecycle for adherence to environmental norms.

B. Scope of Blockchain in Supply Chain Management

Blockchain, described as a distributed ledger in the previous sections, has been extensively tried in financial services, which is just one of its multiple dimensions. The sector which has witnessed the second-highest blockchain applications is probably the supply chain industry.

- ❖ **Traceability** through Blockchain of materials, starting from the origin through the manufacturing process to delivery to the final customer (cradle-to-grave), to guard against counterfeiting and to comply with strict regulations in certain industries such as nuclear, aerospace, diamond, etc.
- ❖ **Visibility and transparency** in a supply chain can be achieved in industries such as food processing. Starting from the source, exact tracking of shipment to avoid spoilage, and counterfeiting is possible using blockchain technology.
- ❖ Blockchain helps to tackle **pilferages and counterfeiting**, hence improving efficiency, and to adhere to stringent environmental norms. Fig. 6 is a diagrammatic representation of the Blockchain and supply chain process.

The real use of Blockchain in major supply chain processes is integration with existing ERP systems. ERP systems typically create configurations, build products, compute costing, do sourcing and procurement, perform shipments, create invoices. Hence, integrating with ERP will benefit business with improved transparency and reduced cost of tracking and reporting.

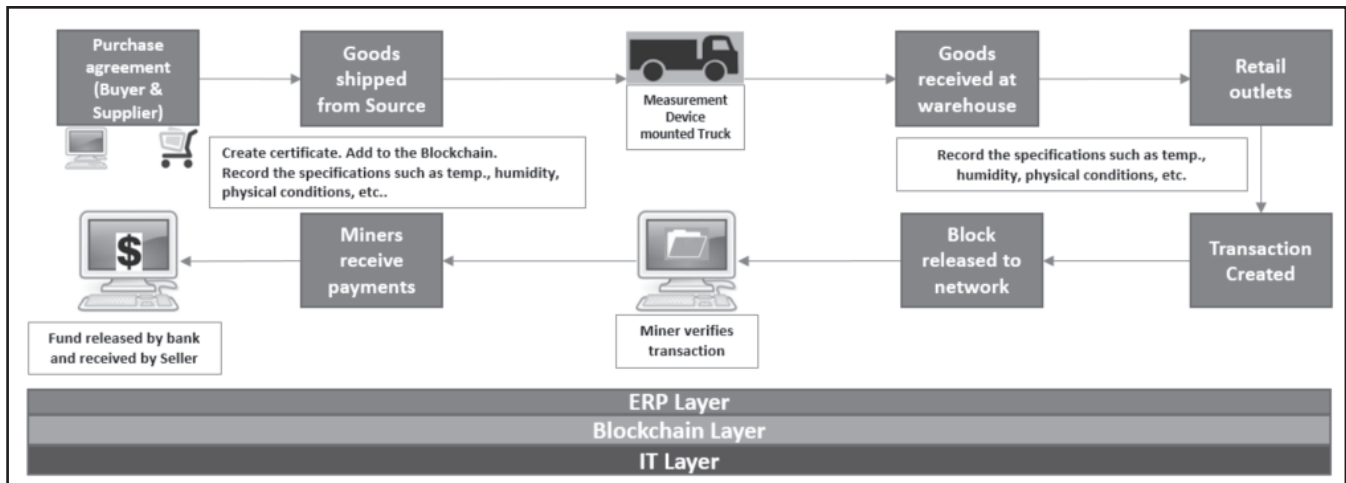


Fig. 6. Blockchain Platform – Supply Chain Application

Finlync is considered to be the world's first blockchain-agnostic integrator which can integrate SAP ERP system to distributed ledger technology Hyper Ledger Fabric. Similarly, Skye has developed products which help in integration of SAP with blockchain [14].

ERP giants like Microsoft, Oracle, and SAP are already spending considerable amount of resources in developing middlewares for supply chain industry.

C. Use Cases in Supply Chain Industry

Provenance, Visibility, Transparency, Traceability

❖ **United Parcel Service (UPS)** is mainly into logistics business and is a supply chain solution provider. UPS is developing blockchain standards for freight industry through Blockchain in trucking alliance (BiTA) [15].

❖ **Driscoll's** supplies berries to American super markets such as Walmart, Stop & Shop, Whole Foods, etc. They are working with IBM for establishing the provenance of their food products. They are planning to create certificates for their products starting from their origin and track them through the supply chain till the shelf. In case of any contamination, counterfeiting or damage, the product lot can be tracked back to the harvest-point through use of barcoded crates and GPS enabled vehicles [16].

❖ **Provenance** is a blockchain-based project to enable traceability through certifications and information availability at each point in a supply chain [17].

❖ **Hijro** which was previously known as Fluent, is a US-based company and is into blockchain framework for collaborating on prototyping and proof-of-concept [18].

❖ **SKUchain** uses Hyperledger Fabric to create blockchain framework for tracking of material across the

supply chain [19].

❖ **Blockverify** is a blockchain based anti-counterfeit solution. This has been introduced into diamond, pharmaceuticals, luxury, and fashion industries [20].

❖ **Tracr** is the blockchain platform used by the Anglo-American diamond company De Beers, the world's largest diamond manufacturer. It has recently announced that it has started using blockchain technology to track its gem stones from mines to the end customers in a bid to verify authenticity and ensure that the stones are not mined from conflict zones.

“The Tracr project team has demonstrated that it can successfully track a diamond through the value chain, providing asset-traceability assurance in a way that was not possible before,” De Beers Chief Executive Bruce Cl [21].

❖ **Walmart-IBM blockchain** aims at creating a blockchain for freshness and food safety [22].

VII. IDENTITY MANAGEMENT

Identity management is a process which deals with *identification* and *authentication* of an individual or a group of individuals using physical (hard IDs) or virtual (digital IDs) means.

As the world fast becomes 'a globalized place', one of the biggest challenges faced by many countries has been authenticity of its nationals.

Organizations have long been struggling to authenticate user identities and managing access to their critical resources. Many of the corporates are investing millions of dollars to build robust identity management systems. Organizations not only spend enormous

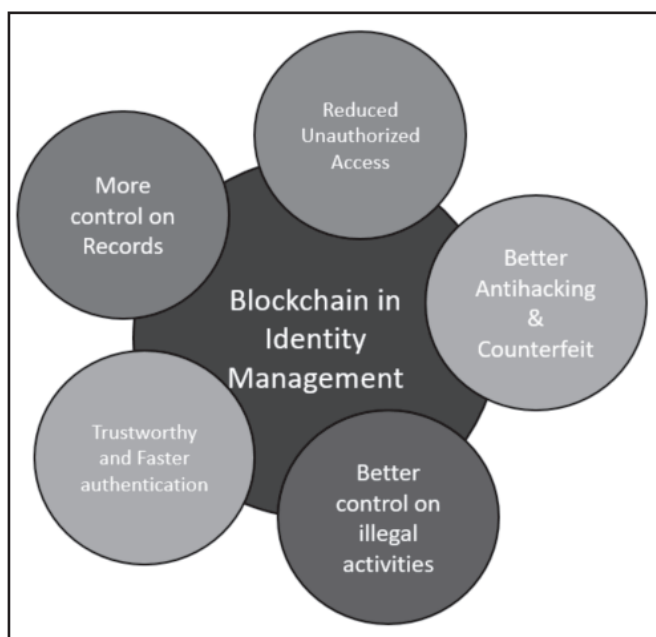


Fig. 7. Advantages of Blockchain in ID Management

amounts of resources to authenticate user identity (e.g., KYC), but also invest equal amounts to protect data from theft.

Currently, multiple identification certificates are issued for multiple purposes such as health cards, voter ID cards, social security cards, passports, tax cards, driving licenses, ration cards, residency cards, and many more. All of these are prone to hacking and exploitation, rendering personal information compromised.

The main challenges in this area of identity management are as follows:

- ❖ Failure-prone traditional ID systems
- ❖ Fast changing global landscape
- ❖ Vulnerable cyber security
- ❖ Ever increasing userbases
- ❖ Complex user authentication process

Advent of blockchain in this area shows a lot of promise. It has the potential to create a global and borderless platform which can see passports no longer needed by immigration agencies.

VIII. BLOCKCHAIN APPLICATIONS AND USE CASES

In the list of use cases, there are a few big and governmental projects, a few startups, a few open-source projects.

❖ **Bitnation or cryptonation** is a "voluntary nation" that records vital data, identity and other legal events

using blockchain technology. Bitnation was founded in 2014 using Ethereum smart contract technology [23].

❖ **Democracy.Earth** is an open source software and peer-to-peer network and a decentralized democratic governance protocol [24].

❖ **Followmyvote.com** is a blockchain-based secure online voting platform that will ensure greater voting transparency [25].

❖ **E-Residency** is a new digital nation program for global citizens, powered by the Republic of Estonia to provide access to non-Estonians to services such as banking, medical, taxation, company formation, etc. [26].

❖ **ConsenSys** is a global formation of technologists and entrepreneurs building the infrastructure, applications, and practices that enable a decentralized world [27].

❖ **ID2020 Digital Identity**, a tool built on blockchain, is jointly developed by Microsoft and Accenture. This is supposed to be used for identity management [28].

❖ **Civic App** is a downloadable app on mobile phones. It uses blockchain technology and enables users to authenticate and verify user information in real-time and also helps in identity verification [29].

❖ **SecureKey and IBM Blockchain** is an identity management system in Canada. This is built on IBM blockchain which is in turn built on HyperledgerFabric [30].

❖ **MONI** is a Finnish startup aimed at developing unique identity for asylum seekers in Europe [31].

Advantages of Blockchain application in Identity Management:

- ❖ Better control of data
- ❖ Reduced unauthorized access
- ❖ Improved anti-hacking and anti-counterfeit security
- ❖ Faster access and authentication
- ❖ Money laundering and illegal financial activities
- ❖ Combat antisocial activities

Many estimations state that there is still a considerable amount of global population not covered under any identity management systems. This makes them lose out on benefits such as healthcare, education, government benefits, etc.

With the ever-growing world population, it is becoming more and more sensible to make use of blockchain technology which can help provide a more robust and cost-effective platform.

Fig. 7 shows the major advantages of blockchain in identity management process:

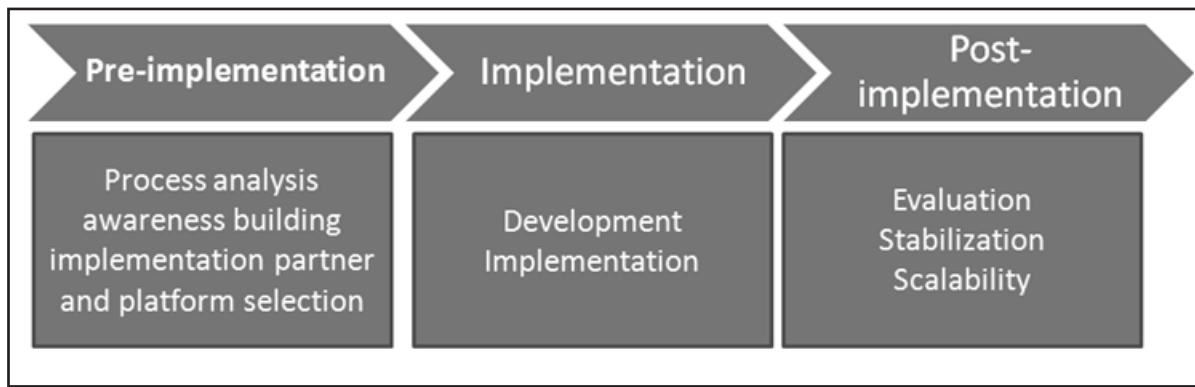


Fig. 8. Blockchain Implementation Cycle

IX. BLOCKCHAIN IMPLEMENTATION

Blockchain implementation process is comparable with any software implementation cycle in an organization. Depending on the complexity and scope, the duration may be six to eight months.

The following are the milestones or phases of a typical blockchain implementation project:

1) *Pre-implementation stage*: The following activities are part of this phase:

In-depth process analysis and discovery, awareness building, implementation partner selection, technology platform selection.

This foundational phase is the most important of the whole life-cycle. The success of the project is very much dependent on the solemnity of this phase. This is the longest phase in the whole process.

A proposed '*Business Suitability Matrix*' as discussed in the next section can be used to formulate the right set of questionnaires before embarking on the journey of blockchain implementation.

2) *Implementation stage*: The infrastructure development and implementation materialize during this phase. The identified business process is integrated to the blockchain system. User training, testing, validation are the key steps of this phase.

3) *Post-implementation stage*: Evaluation and stabilization of the process are key features of this stage. Depending on the success factors, the future roll-outs (scalability) are decided during this phase. The diagrammatic representation of blockchain implementation cycle is given in Fig. 8.

X. BUSINESS SUITABILITY MATRIX

Amidst all the hype, it is prudent to carefully evaluate

whether the technology is suitable for a specific business or organization.

The matrix called 'Business Suitability Matrix' (Fig. 9) may be referred to identify if blockchain is suitable for the business.

There are three segments in the 'Business Suitability Matrix'. Each segment comprises of 10-12 factors. Each factor can be framed into a question, eventually a set of questionnaires will be formulated.

The first segment refers to 'Low value proposition'. If the evaluation falls in this segment, then the organization should not go for blockchain application.

'High value proposition' segment is the best case for blockchain application. However, it is worth noting here, that there will be no 100% fitment and the blockchain technology or business process may need to be tweaked to align the business processes and vice versa.

The middle segment is the one in which most of the businesses and organizations evaluating blockchain application will fall.

After undertaking a proper study using the above matrix, an appropriate segment of the business can be identified for initial implementation. Depending on the outcome, rest of the business can be integrated gradually. It is always better to go for a pilot project rather than the final one.

XI. CHALLENGES AND DOWNSIDE : MENTAL BLOCKS AND OBSTACLES

Whenever a new technology is introduced, and once it is in use, it is natural to face challenges. Some of the factors arise from the product, technology & platform, and some arise from the resistance to change. Today Blockchain is besieged by many limitations and challenges. Those challenges can be broadly divided into the **Technological and Situational** categories.

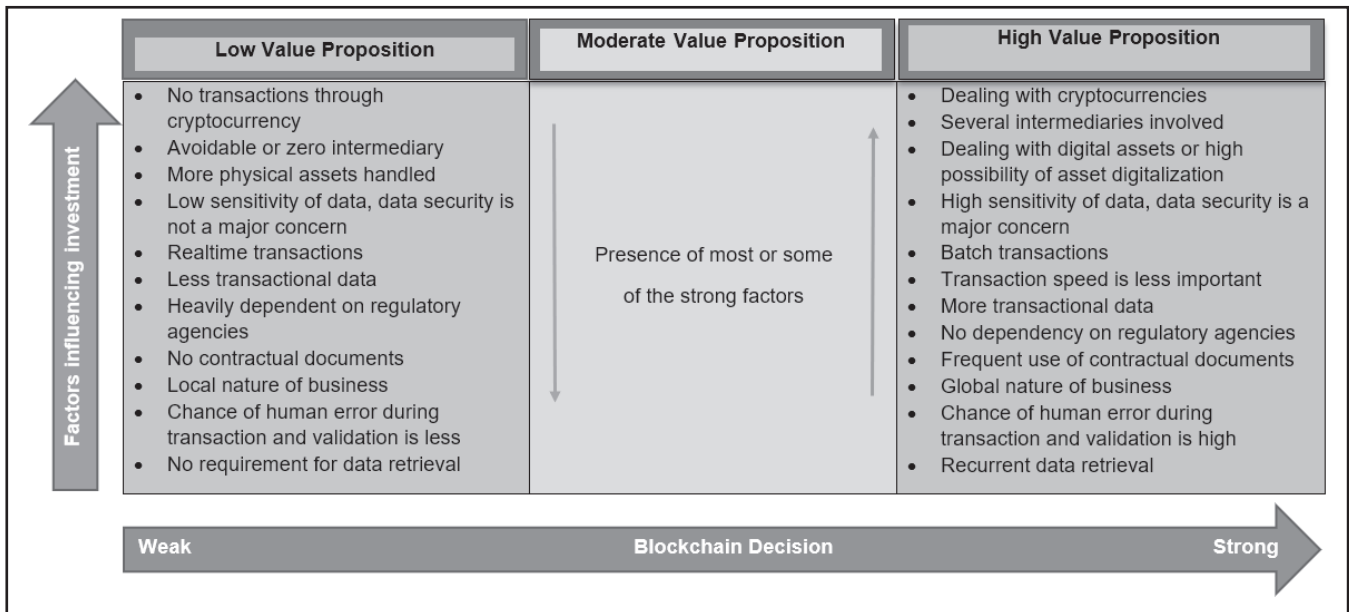


Fig. 9. Business Suitability Matrix

A. Technological Factors

1) *Extrinsic technological limitation*: These are the challenges due to existing technologies.

❖ *Compatibility*: Blockchain has not yet fully proven compatibility with existing technologies such as ERP systems, databases etc. This is an inherent problem of any new product or technology as existing systems may not work well with the new one.

Most of the IT giants like IBM, Microsoft, Oracle are already working towards developing Blockchain technologies which will be compatible with their existing products (ERP systems), and databases.

2) *Intrinsic technological limitation*: These are related to the limitations arising from the technology itself.

❖ *Standardization*: Absence of central administrator and multiple teams working on developing Blockchain have hindered standardization. This impedes Interoperability of Blockchain between various other platforms.

❖ *Latency*: Blockchain suffers from latency due to the time lag between the entry and verification of a block (or transaction). This is a result of the miners' verification process.

❖ *Intensive CPU usage*: Bitcoin mining is hugely CPU intensive due to the excessive number of hashes the system does at any point of time.

❖ Both high storage space requirement and excessive computational power consumption make Blockchain very expensive.

❖ Security concerns still surround Blockchain products.

Existing apprehensions around security issues of the technology must be suitably addressed before the technology picks up speed.

❖ *Unproven Scalability*: Currently Blockchain platforms like Bitcoin, Ethereum work on a consensus mechanism to verify transactions. Bitcoin has a maximum limit of 7 transactions per second which is very less as compared to existing systems like SWIFT which can achieve few thousands per second. However, hyper ledger fabric can clock 10,000 transactions per second.

❖ *Maturity of legal and regulatory contributors* has to emerge along with the journey of technology. These two factors are equally significant in determining the success of the blockchain. This can be achieved through proper steps taken by authorities who see value in it.

B. Situational Factors

❖ From introduction to maturity of any technology, there have to be inevitable situational factors, a few arising out of inertia of existing systems.

❖ The use of cryptocurrency requires every involved party that does monetary transactions to adopt it, donning the role of agencies and institutions that have long handled, verified, and regulated such transactions. Hence, opposition to implementation of Blockchain is apparent. This is ostensible and can only be overcome with more use of technology.

❖ Users will need to gain more awareness to change their outlook and understand how to implement and utilize the

new functional capability of cryptocurrency. The players involved in and driving the blockchain technology such as vendors, service providers, and development partners have a significant role to play in making Blockchain technology more affordable, scalable, and cost-effective.

❖ Why will an Escrow agency or a clearing house allow the Blockchain to flourish as it is clearly going to end its dominance? Similarly, it is going to face stiffer road blocks from credit card agencies, banks, and financial regulators.

To overcome the technological shortcomings, an *ultra-high speed, antifragile, lower cost network* is required. This will be accomplished with more and more players adopting the technology. With each passing day, Blockchain is seeing improvement in terms of safety, security, and efficiency.

Situational factors will be subdued with use of the technology by major industry players. This technology can take a clue from the application cycle of ERP products. These obstacles will take time before permitting the entry of Blockchain.

XII. ADOPTION AND FUTURE OF BLOCKCHAIN

There is a significant distance to be covered before the industry can witness a wide-spread application and use of Blockchain. Strategically selected and appropriately evaluated business areas must be chosen for the initial implementation to minimize risk.

A change in mindset and a cooperative atmosphere involving all the parties will be essential to overcome the initial shortcomings and realize the full potential of the novel technology.

Consolidation and standardization of Blockchain providers will happen sooner than later. There are currently around 1600 crypto currencies in circulation, and the number is growing upwards. However, for cryptocurrencies to be successful, stronger and stable coins are essential. Multiple teams across the world are working on numerous projects at the same time, hence making standardization difficult.

Policy and governance are two key challenges and are areas of concern unaddressed yet. Security issues still surround the coin market due to frequent unfavorable news such as hacking of exchanges dealing with coins. Technological, governance-related, organizational, and societal barriers against the implementation and uses of Blockchain technology all have to be removed first.

For real success, shortcomings of the technology

must be outweighed by its tangible benefits. Currently, most of the application of Blockchain is happening in the area of financial management. This technology has the potential to equally contribute to other areas like supply chain, healthcare, identity management, travel industry, etc. Hence, more and more organizations can leverage the benefits of Blockchain.

With wider use, improved Blockchain technology can gel well with existing ERP systems and traditional databases. The aim of the technology developers to make Blockchain a real success.

XIII. INDIAN USE CASES

A. Scope of Blockchain in Identity Management

India has been facing the menace of chronic problems such as corruption, terrorism, counterfeiting and data theft, financial frauds, money laundering, informal economy, rigged polling, etc. Bulk of the problems can be attributed to absence of efficient identification management system. Blockchain can be of great value in all these grey areas.

The Indian Prime Minister Narendra Modi has recently acknowledged the potential of Blockchain technology and has emphasized on the application and adoption of this technology. It is significant because so far the Indian government and the regulatory agencies have been hawkish on the use of cryptocurrencies, and the application of Blockchain technology.

The flagship Aadhaar number project has been witnessing many hurdles due to cyber attacks, forged documents, etc.

B. Use of Blockchain in India

Jioco being developed by Reliance is a Blockchain smart contract based supply chain, and logistics platform. This is also a cryptocurrency being initiated by the company [32].

The state of Andhra Pradesh has started implementing Blockchain technology in managing land records and vehicle registration process through two key pilot projects. For creating land records, the government has partnered with an Indian Blockchain startup called **ZebiData** [32].

FinTech Valley Vizag has partnered with **Covalent Fund** to create **Velugu Core**, a pioneering India-focused Blockchain stack. This in turn aims at creating an app which will help users to access government data freely and digitally available on Blockchain platforms [32].

Looking at the pace at which court cases related to land disputes in India are moving forward, digitalization of land records on Blockchain seems to hold promise. Digital India Land Records Modernization Programme (DILRMP) is an initiative by the Indian government to digitalize all the land records in a decentralized way [32].

e-Governance coupled with Blockchain has the potential to address many issues in the Indian context.

❖ **Mahindra group** and **IBM** are jointly working on developing Blockchain solution for lowering operational costs [32].

❖ **YES bank** has implemented smart contracts based vendor financing for **Bajaj Electricals** which helps vendor financing from banks without physical documents and manual intervention [34].

❖ **Blockchain Foundation of India (BFI)** has been founded to promote Blockchain technology in the country [32].

Vizag has also partnered with KPMG to launch a BFSI use case repository program to identify Blockchain and other technology solutions to common problems in the banking, financial services, and insurance sectors [34].

Another important area with strong potential to make use of Blockchain technology is **Aadhaar card** and **UIDAI** [32]. In India, there are multiple identity cards, depending on the purpose, but in a country with more than one billion population, it is very difficult to create, maintain, retrieve, and update the data. The Aadhaar card initiative, which is unique in nature aims at creating a single instrument which has the potential to eliminate multiple cards. This can be and is very well used for efficient KYC for banks, telecom companies, government agencies, etc. to pass on the benefits to the card holders.

However, the biggest challenge here is data security and data maintenance. Many a times there is news of infringement on the UIDAI. The possible answer can be Blockchain. The features and functionalities of Blockchain such as decentralization, traceability, auditability, and security can be utilized by the Aadhaar system. Data privacy and its vulnerability to hacks can be addressed effectively. Banks, telecoms, government agencies, etc. can independently verify the identity (with or without the consent) of the individuals.

Election commission can use the data which can be linked to electronic voting machines (EVMs) to verify the details. Voter registration, verification, and vote counting can be performed. Chance of rigging can be eliminated, thereby making elections more fair and

transparent.

❖ **India Post** is another potential area which can make use of Blockchain to improve its tracking, delivery, efficiency, and service levels.

Cryptocurrency in India

Bitcoin and other cryptocurrencies are not recognized as legal tender in India, but users are allowed to use cryptocurrencies for payments.

Reserve Bank of India (RBI) is contemplating on having its own cryptocurrency due to regulatory and volatility challenges posed by global cryptocurrencies such as Bitcoin.

Coin Exchanges in India

Cryptocurrency exchanges are also known as 'Coin Exchanges'. Unocoin, Zebpay, Coinmama, LocalBitcoins, Bitcoin ATMs, VirWox, and Mycelium Local Traders are some of the coin exchanges in India. Most of them trade with Bitcoin only [33].

Blockchain Platform Providers

Microsoft, IBM, Deloitte, SAP Cloud blockchain, R3, Accenture, Infosys, Oracle are among the leading Blockchain service providers.

XIV. CONCLUSION

Based on our discussion in this article, we can conclude that Blockchain has traveled a good distance so far, but has still to cover much.

Blockchain is a hype or reality?

A lot of parallels are being drawn between blockbuster TCP/IP or HTML technology and Blockchain. TCP/IP and HTML proved to be an overtly disruptive technology which replaced the less efficient 'Circuit Switching' technology. Blockchain may not be disruptive, but is foundational in nature. TCP/IP completely changed the peer-to-peer messaging, and HTML made internet indispensable; similarly, Blockchain shows promise in peer-to-peer financial transactions and information sharing.

Blockchain is in a developmental stage. How long it will take to become a domiciliary name will depend on the early success stories, its sustainability, the extent to which it can stand up to its claim of irrefutability, and also its technological and infrastructural viability.

Blockchain evolution may probably follow the ERP path which started with many fragmented ERP products and vendors, but gradually consolidated to a few major, successful, and efficient products.

A bigger success factor is how much value all involved parties see in it. Involvement of more, and more diverse entities will not only help the technology to become more viable but also more effective and successful. This technology must overcome all the shortcomings, especially latency and computational power consumption. It may take time but surely it has got the potential to be a perfect ingredient for the fourth industrial revolution.

None of the recent internet-based technological innovations have caught our imagination like Blockchain has done. Today, we depend on Google to search stuff on internet, tomorrow we will probably depend on Blockchain for security, authenticity, and validation.

It is not a disruptive technology, but rather an enabler for creating a paradigm shift in the business world. It may not upfront replace any technological platform, but aid the existing ones without disturbing the business processes to a great extent.

Blockchain is in a nascent stage and it will take time to come to the mainstream. In conclusion, we can safely say that it cannot be overlooked. Once the big companies and government agencies start using and promoting it, sooner or later everyone will become in one way or another part of the Blockchain world.

ACKNOWLEDGEMENT

The author would like to convey his heartiest gratitude to Prof. (Dr.) Dilip Kumar Das, EFL University, Hyderabad for his thorough review and suggestion for necessary changes. He is indebted to Mr. Srikanth Sripathi, Senior Industry Principal, Infosys Ltd. for his review and useful suggestions.

REFERENCES

[1] S. Nakamoto, "Bitcoin: A peer-to-peer electronic cash system," 2008. [Online]. Available: <https://bitcoin.org/bitcoin.pdf>
 [2] Blockgeeks, "What is Cryptocurrency: Everything you need to know [Ultimate Guide]," [Online]. Available: <https://blockgeeks.com/guides/what-is-cryptocurrency/>. Accessed on: June 15, 2018.

[3] C. Dannen, *Introducing Ethereum and Solidity*, 2017. Brooklyn : Apress. doi: 10.1007/978-1-4842-2535-6
 [4] M. Iansiti, and K. R. Lakhani, "The truth about blockchain," 2017. [Online]. Available: <https://hbr.org/2017/01/the-truth-about-blockchain>
 [5] Boulton, C., "Get ready for blockchain's big business breakout," 2018. [Online]. Available: https://www.cio.com/article/3249705/emerging-technology/blockchain-is-poised-for-a-big-business-breakout.html#tk.cio_rs
 [6] Smart Contract, (n.d.). [Online]. Available: https://en.wikipedia.org/wiki/Smart_contract
 [7] ABRA, (n.d.). [Online]. Available: <https://www.abra.com/>
 [8] S. Solomon (n.d.). Bank Hapoalim, IAI to join forces on using blockchain for cybersecurity, 2018 [Online]. Available: <https://www.timesofisrael.com/bank-hapoalim-iai-to-join-forces-on-using-blockchain-for-cybersecurity/>
 [9] C. Mulligan, J.P. Rangaswami, S. Warren, and J. Z. Scott, "These 11 questions will help you decide if blockchain is right for your business," 2018. [Online]. Available: <https://www.weforum.org/agenda/2018/04/questions-blockchain-toolkit-right-for-business>
 [10] L. Shin, "Canada has been experimenting with a digital fiat currency called CAD-COIN," 2016. [Online]. Available: <https://www.forbes.com/sites/laurashin/2016/06/16/canada-has-been-experimenting-with-a-digital-fiat-currency-called-cad-coin/#51d04e5046a4>
 [11] AETERNITY, (n.d.). [Online]. Available: <https://www.aeternity.com/>
 [12] AUGUR, (n.d.). [Online]. Available: <http://www.augur.net/>
 [13] Bitcoin.com, (n.d.) [Online]. Available: <https://news.bitcoin.com/bitcoin-loans-priced-big-macs-radoslav-albrecht-cryptofinance/>
 [14] Finlync, (n.d.). [Online]. Available: <https://www.finlync.com/distributed-ledger-blockchain-sap>
 [15] C. Boulton, "Get ready for blockchain's big business breakout," 2018. [Online]. Available: https://www.cio.com/article/3249705/emerging-technology/blockchain-is-poised-for-a-big-business-breakout.html#tk.cio_rs
 [16] M. Knowles, "Blockchain: Dole and Driscoll's on board," 2017. [Online]. Available: <http://www.fruitnet.com/eurofruit/article/173170/blockchain-dole-and-driscolls-on-board>

- [17] Provenance, "Blockchain: The solution for transparency in product supply chains," 2015. [Online]. Available: <https://www.provenance.org/whitepaper>
- [18] Hijro, (n.d.). [Online]. Available: <https://hijro.com/> Accessed on: June, 15, 2018
- [19] Skuchain, (n.d.). [Online]. Available: <http://www.skuchain.com/>. Accessed on: June, 15, 2018.
- [20] Blockverify, (n.d.). [Online]. Available: <http://www.blockverify.io/>. Accessed on: June, 15, 2018.
- [21] Reuters, "De Beers tracks diamonds through supply chain using blockchain," 2018. [Online]. Available: <https://www.reuters.com/article/us-anglo-debeers-blockchain/de-beers-tracks-diamonds-through-supply-chain-using-blockchain-idUSKBN1IB1CY>. Accessed on: June, 15, 2018.
- [22] Mike Knowles, "Blockchain: Dole and Driscoll's on board," 2017. [Online]. Available: <http://www.fruitnet.com/eurofruit/article/173170/block-chain-dole-and-driscolls-on-board>
- [23] Wikipedia, "Bitnation," (n.d.). [Online]. Available: <https://en.wikipedia.org/wiki/Bitnation>
- [24] Democracy.earth, (n.d.). [Online]. Available: <https://www.democracy.earth/>
- [25] Followmyvote, (n.d.). [Online]. Available: <https://followmyvote.com/>
- [26] Republic of Estonia E-Residency, (n.d.). [Online]. Available: <https://e-resident.gov.ee/>
- [27] Consensus, (n.d.). [Online]. Available: <https://new.consensus.net/>
- [28] ID2020, (n.d.). [Online]. Available: <https://id2020.org/digital-identity-1/>
- [29] CIVIC, (n.d.). [Online]. Available: <https://www.civic.com/>
- [30] Securekey, "IBM and SecureKey technologies to deliver blockchain-based digital identity network for consumers," 2017. [Online]. Available: <https://securekey.com/press-releases/ibm-securekey-technologies-deliver-blockchain-based-digital-identity-network-consumers/>
- [31] MONI (n.d.). [Online]. Available: <https://moni.com/>
- [32] S. Balaji, "India's blockchain revolution goes beyond banks into land records and private firms," 2017. [Online]. Available: <https://www.forbes.com/sites/sindhujabalaji/2017/12/28/indias-blockchain-revolution-goes-beyond-banks/#307ada984123>
- [33] "Buy Bitcoin in India," (n.d.). [Online]. Available: <https://www.buybitcoinworldwide.com/india/>
- [34] W. Mougayar, *The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology*, Wiley, 2016, pp. 10.

About the Author



Diptikant Satpathy is a Senior Consultant in Enterprise Resource Planning with Infosys Ltd. in Manufacturing and Planning domain. Previously he was a Senior Manager in Supply Chain and Manufacturing in Tata and Jindal Steel respectively. Overall, he has more than 12 years of experience in steel manufacturing, supply chain, and ERP consulting domain. He has presented a few research and conference papers at the national level. He has about seven years of Manufacturing and Planning consulting experience in discrete and process industries with clients in Asia (Malaysia, China), Europe (Hungary, France), North America (USA), and South America (Brazil). His research interest is mainly focused on customer Centric Supply Chain Management, and application of Information Technology in Supply Chain Management. He holds a Masters degree in Business Administration and a Bachelor's degree in Metallurgical engineering. He qualified for NET (UGC) in Management in 2017. He is a certified lead auditor for ISO 9001:2000.