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BEGINNING OF NEW SOCIO ECONOMIC REVOLUTION- CRITICAL APPRAISAL OF BLOCKCHAIN APPLICABILITY –A STUDY.

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Abstract
Whether it be societal decision making like voting or economic activities such as financial transactions, Centralisation is widespread in all-sphere, the emergence of 'Blockchain distributed ledger technology' is considered one of the technological breakthrough, to cautiously address the problem outcomes of centralization. Proponents contend that Blockchain will touch every major industry and will alter the way that people and society interact. The Blockchain revolution pushing the world into a new era, predicted on openness, merit, decentralisation and global participation. As per NASSCOM Avasant India Blockchain Report 2019,over 40+ blockchain initiatives are being executed by the public sector in India, with nearly 8% in execution Phase & around 92% in POC-Phase. This study explores some potential and existing use cases for Blockchain in several industries such as finance, healthcare, insurance, retail & ecommerce and media & entertainment. Further, the plausible potentiality of Blockchain along with its limitations, to address far reaching implications for value delivery and socio-economic development, is assessed employing SWOT-analysis. The paper covers applicability aspects of Blockchain with relevance to the future directives.

Key Words: Emerging Technology, Blockchain, Decentralisation, Socio-Economic Revolution, Value Delivery.

Introduction:

The advancement of human knowledge with time, bring forth new ideas, concepts and values for economic and social welfare of the society. Undoubtedly, Internet is one of such evolutionary concept of twentieth century that has impacted all lives. In same perspective way, among the 21^{st} Century inventions, the concept "Block Chain" is viewed as the one that would bring similar effect because of its potential usability in the days to come. Its core operational principles – such as decentralisation, transparency, equality and accountability – could play a significant role to cause drastic shift in the way economic transactions happen and social lives interact. This study explores some potential and existing use cases for Blockchain in several industries such as finance, healthcare, insurance, retail & ecommerce and media & entertainment. Further, the plausible potentiality of Blockchain along with its limitations, to address far reaching implications for value delivery and socio-economic development, is assessed employing SWOT-analysis. The paper covers applicability aspects of Blockchain with relevance to the future directives.

The organization of this paper is as follows; Section 1, Concept and Basic Mechanism of Blockchain, In Section 2, provide a short overview of Phases in block chain development, and how it can disrupt application perspective models. Section 3, describes the motivation and identifies several use cases in practice. Section 4, points the importance as well as challenges of Blockchain using Swot-Analysis. Section 5 concludes this paper.

Research Methodology

This study examines the effectiveness of blockchain from both financial and social perspectives, adopting a comprehensive approach that traces its evolution from inception to growth and future

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potential, including its strengths and limitations. The analysis is based on secondary data collected from the Scopus, Web of Science, and Google Scholar databases, primarily covering the period 2000–2025.

A three-step selection procedure was employed. First, key search terms such as *"blockchain use cases,", "blockchain application" "innovative technology,"* and related keywords were used to identify relevant literature, resulting in an initial pool of 49 research articles. Second, studies focusing exclusively on technical or technological aspects were excluded (12 papers). Finally, articles with limited relevance or minimal value addition to the research objectives were removed (13 papers). The remaining 24 papers were thoroughly reviewed, analyzed, and synthesized to develop the study's findings.

Section 1: Concept and Basic Mechanism of Blockchain

The Concept of 'Blockchain' was first introduced with emergence of first digital crypto currency 'Bitcoin' in 2008, where an individual (or group) under the name of Satoshi Nakamoto published a paper entitled "Bitcoin: A Peer-To-Peer Electronic Cash System", which is popularly known as Nakamoto's whitepaper [1]. This paper described the underlying technologies that support online transactions of the digital currency or electronic cash, directly from one party to another without going through any third party or financial intermediary. Although, digital payment & the idea of digital currency was of old origin and had been discussed much before in many research papers, this paper[1] catched eyes and drew attention of all, because of it's schematic revelation and systematic presentation for implementation of Peer to peer transactions. Further, the underlying technology that support Bitcoin holds vast usage potential beyond its initial purpose[13]. Blockchain technology is arguably the first ever innovation where "the end users are both at the centre as well as the periphery of the network. In fact, they are the network".

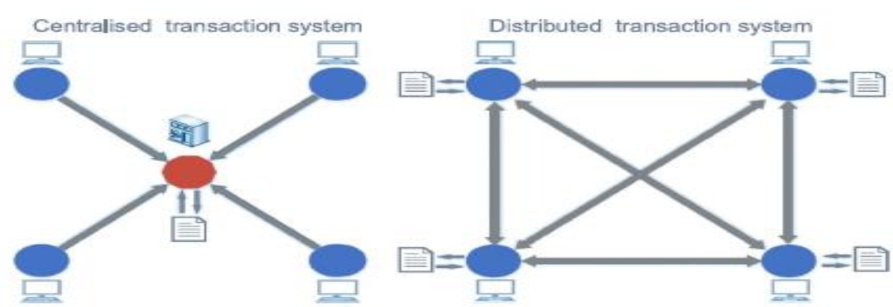

Fig. 1. Centralised and distributed transactional platforms: a single trusted authority manages the ledger as opposed to every member holding a copy of the ledger.

Blockchains are shared and distributed data structures or ledgers that can securely store digital transactions without using a central point of authority[14]. The ledger is a growing list of records clubbed into a block.It contains a list of all valid transactions that happen between different nodes over the network[12]. Blockchains run on digital networks, data transmission in such networks is equivalent to copying data from one place to the other[14]. In a blockchain network, every participating node maintains a synchronized copy of the distributed ledger, thereby ensuring transparency and data redundancy across the system. When a new transaction is initiated, it does not immediately become part of the ledger; instead, it is subjected to a verification procedure performed by miners or validators within the network [12]. These nodes are responsible for confirming the authenticity, validity, and compliance of transactions before granting approval for their inclusion in the blockchain.

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Once verified, transactions are aggregated into a block. Each block typically contains one or more validated transactions, a cryptographic hash uniquely representing the block's contents, the hash of the preceding block to maintain chain continuity, and a timestamp that records its creation. The cryptographic linkage between successive blocks preserves the chronological order and enhances the immutability of stored records.

The addition of a block to the ledger is governed by a consensus mechanism designed to achieve agreement among distributed participants. Various consensus protocols are employed across blockchain platforms, including Proof-of-Work (PoW), Proof-of-Stake (PoS), Proof-of-Burn (PoB), Proof-of-Authority (PoA), Byzantine Fault Tolerance (BFT), and Federated Byzantine Agreement (FBA) [8,9]. These mechanisms ensure that only transactions validated through collective agreement are permanently recorded. Moreover, the transaction validation framework is structured to mitigate security threats such as double-spending, balance insufficiency, and other malicious attacks [12]. Unlike traditional centralized access control systems, blockchain-based access control operates in a decentralized, consensus-driven, and cryptographically secured environment, resulting in significant differences in trust assumptions, governance models, and enforcement mechanisms [15].

1. In a blockchain network, every validated transaction is replicated across all participating nodes, ensuring collective record-keeping. The ledger operates as a write-once system in which previously stored entries cannot be altered or erased. Even system-level administrators lack the authority to revise historical records. This sharply contrasts with conventional centralized databases, where administrators typically retain full modification privileges. Through decentralized architecture, blockchain-based access control mechanisms maintain data permanence and resistance to tampering.
2. Governance within a blockchain environment is distributed among participating entities, preventing any single organization from exercising unilateral control over the network. Each member operates under the same predefined protocol rules, reinforcing structural parity. Such decentralization is essential in collaborative settings, as centralized authority could otherwise introduce risks of unauthorized alterations or biased decision-making without the awareness of other stakeholders.
3. Transactions recorded within a blockchain framework are visible to all authorized participants in the network, fostering openness in operations. This shared visibility enhances accountability and builds trust among involved entities by ensuring that activities can be independently verified.

Table 2
Overview of blockchain types-description-example infrastructures

Type	Description	Examples (Daniels, 2018; Voshmgir, 2019)
Public Permissionless	No entry boundaries for reading, writing and validating. Everyone can become user, node and can develop applications on top. Sometimes referred to as "true blockchain".	Bitcoin, Ethereum
Public Permissioned	Open for reading, boundaries in becoming a validator/node. Open for use, but network control remains with selected validating nodes. Sometimes open for building external applications on top.	Neo, Ripple
Private Permissioned	Boundaries for reading, boundaries in becoming a validator/node. Access granted through owners, network control with selected validating nodes.	Hyperledger, Corda (both can support Public Permissioned as well), consortia blockchain initiatives like R3 and B3i
Private Permissionless	Boundaries for reading, open for validating. Non-existent, although some argue to have set up a model like this. (Daniels, 2018)	None

Source : [12]

Section 2: Phases of Block Chain Development:

This may be discussed under three progressive phases of development in Blockchain technology,i.e, Blockchain 1.0,Blockchain 2.0 and Block Chain 3.0.

Blockchain Generations based on it's Usage[18, 22, 23]:

Type	Description	Examples
Blockchain 1.0	Currency	Cryptocurrencies like Bitcoin. Was first introduced in 2009.
Blockchain 2.0	Contracts	Financial services, crowdfunding, Bitcoin prediction markets, smart property, smart contracts. Was introduced through the release of NXT in 2013.
Blockchain 3.0	Justice, efficiency and coordination applications beyond currency, economics, and markets	Digital Identity, Intellectual Property Protection, Governance Services, Elections. Solutions within these areas of applications are starting to take form.

Blockchain 1.0: Digital Currency Era

Blockchain 1.0 denotes the foundational phase of distributed ledger technology, primarily associated with the development of decentralized digital currencies. Its earliest practical application was the creation of a peer-to-peer electronic payment system that enabled direct value exchange over the internet without dependence on centralized financial intermediaries [16]. This innovation laid the groundwork for what is often characterized as the "Internet of Money," facilitating secure and transparent financial transactions through cryptographic validation and distributed consensus mechanisms.

The introduction of Bitcoin in 2009, following the publication of the seminal white paper by Satoshi Nakamoto, marked the operational emergence of blockchain technology [16]. Bitcoin demonstrated that a decentralized ledger could reliably record and verify transactions across a global network while maintaining transparency and resistance to manipulation. The success of Bitcoin subsequently encouraged the development of numerous alternative crypto currencies (altcoins), thereby expanding the scope of decentralized digital asset exchange across international markets.

Blockchain 2.0: Smart Contracts and Decentralized Markets

Blockchain 2.0 represents a significant progression from crypto currency-based transactions to programmable and automated contractual systems. While the first generation focused on decentralizing currency and payment infrastructure, the second generation extended blockchain applications to broader asset classes and digital market structures [24].

A defining feature of this phase is the emergence of smart contracts—self-executing digital protocols embedded within blockchain platforms that automatically enforce predefined terms once specified conditions are fulfilled [24]. Platforms such as Ethereum facilitated the deployment of decentralized applications (DApps) and introduced innovative governance structures, including decentralized autonomous organizations (DAOs) and decentralized autonomous corporations (DACs). Through these advancements, Blockchain 2.0 expanded its relevance to financial services, crowdfunding mechanisms, tokenization processes, and blockchain-based market ecosystems, thereby enhancing efficiency, transparency, and automation in economic transactions [24].

Blockchain 3.0: Expansion Beyond Financial Systems

Blockchain 3.0 reflects the transition of distributed ledger technology beyond purely financial applications into diverse industrial and societal domains. This stage conceptualizes blockchain as an enabling infrastructure capable of transforming governance systems, healthcare management, supply chain operations, digital identity frameworks, and broader socio-economic coordination mechanisms [16].

By integrating cryptographic architectures, peer-to-peer networking, distributed computing, and consensus algorithms, Blockchain 3.0 provides a secure and transparent foundation for organizing institutional and economic activities in real time across global networks [16]. In this advanced phase, blockchain functions not merely as a tool for digital currency or automated contracts but as a foundational technological framework that supports decentralized innovation, cross-sectoral collaboration, and systemic reconfiguration of traditional organizational models.

Section 3: Key Dimensions of Blockchain Applications

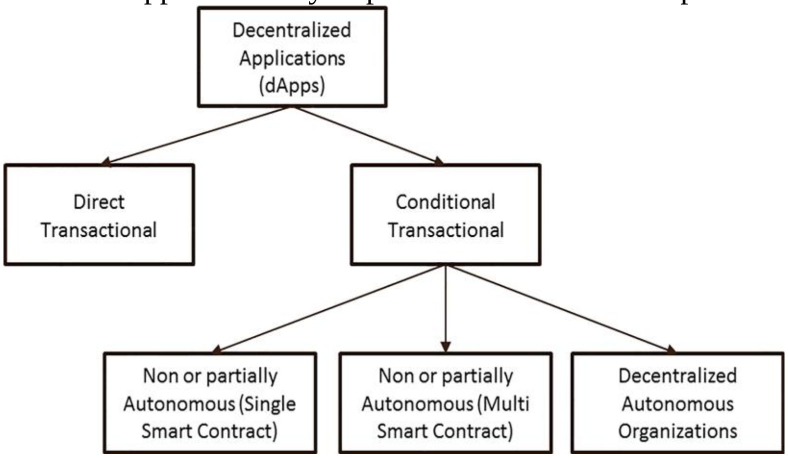
Supply Chain Management : Blockchain technology has increasingly been adopted to enhance transparency and traceability within complex supply networks. For instance, collaborative initiatives between IBM and major global retailers demonstrated how distributed ledger systems can track agricultural products—such as pork sourced from China and mangoes imported from Mexico—across multiple supply chain stages. The system integrates data from farmers, processors, logistics providers, distributors, and retailers into a shared digital ledger.

By enabling real-time access to authenticated information that would traditionally remain siloed, participating firms are better positioned to identify contamination sources, reduce recall time, and improve food safety standards. Building on these early implementations, companies including Walmart, Unilever, and Dole Foods partnered with IBM to establish broader blockchain-based frameworks tailored specifically to the food industry. These initiatives highlight blockchain’s capacity to strengthen accountability, reduce information asymmetry, and enhance operational efficiency in global supply chains.

Internet of Things (IoT) and Energy Systems: Blockchain also presents transformative potential when integrated with Internet of Things (IoT) ecosystems, particularly in decentralized energy markets. A notable experimental initiative emerging from the MIT Media Lab’s Digital Currency Initiative involves the development of a “transactive” solar microgrid. In this model, community members equipped with smart meters can exchange electricity directly with one another through blockchain-enabled platforms, thereby minimizing reliance on centralized utility providers[11].

The smart meters generate verifiable consumption and production data, which are recorded on a distributed ledger and linked to automated digital payment mechanisms. This structure allows energy access to be managed through programmable financial arrangements, potentially enabling collateralized micro-financing for solar infrastructure. The broader objective of such pilot projects is to deploy scalable, modular energy systems in regions facing infrastructural limitations. In doing so, blockchain-integrated microgrids may function not only as decentralized energy solutions but also as catalysts for localized economic development.

Decentralised Autonomous Organization (DAOs): Many of the DAOs are build on top of existing block chains, through external applications by implementation and development of smart contracts.



Source :[12]

Transport and delivery industry: The transportation and logistics sector represents a significant application domain for blockchain technology. Within such a framework, multiple stakeholders—including transport operators, insurance providers, regulatory authorities, and clients—can function as independent nodes within a distributed ledger network. Each participant operates a dedicated server capable of maintaining a complete copy of the blockchain, thereby ensuring transparency, redundancy, and data integrity across the ecosystem. Access to the network is governed through cryptographic authentication mechanisms, where each authorized participant utilizes a unique private key to validate identity and initiate transactions. This structure enhances security by preventing unauthorized access while preserving accountability.

In this configuration, designated stakeholders—such as transport agencies, insurers, and road authorities—may perform the role of validators. Their responsibility includes verifying and confirming freight transportation services (FTSs) or related transactional records before they are permanently recorded on the ledger. Through this consensus-based validation process, blockchain can reduce disputes, minimize fraud, streamline documentation, and improve trust among interconnected actors in the logistics chain[5].

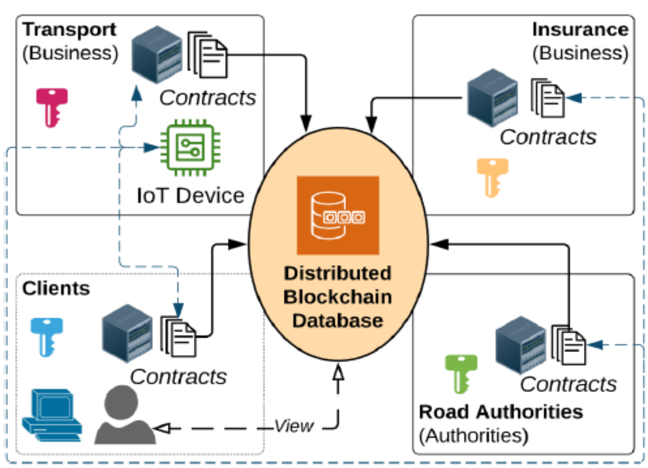


Figure 5. The 4-peer transport use case scenario

Source [5]

Gaming and Integrated Casino Ecosystems: Within the gaming and integrated casino entertainment (ICE) sector, blockchain-enabled smart contracts provide a mechanism for automating operational processes while maintaining transparency and fairness. Smart contracts allow predefined rules governing bets, payouts, rewards, and compliance procedures to be executed automatically once specified conditions are met.

Importantly, while blockchain enhances procedural transparency, sensitive financial details can be managed through privacy-preserving mechanisms rather than being publicly exposed on the ledger. This balance between automation, auditability, and confidentiality strengthens user trust while supporting regulatory oversight and fraud prevention within digital gaming environments.

Automotive Industry: In the automotive sector, blockchain applications can be broadly classified according to two foundational functions: record management and transaction facilitation.From a record-keeping perspective, blockchain serves as a static registry for vehicle identity, ownership history, maintenance logs, and certification records. It can also support digital identities and smart contract frameworks that automate warranty claims, leasing agreements, and service contracts.From a transactional standpoint, blockchain operates as a dynamic registry that enables payments infrastructure, including mobility-as-a-service (MaaS), toll payments, electric vehicle charging settlements, and usage-based insurance models. Together, these applications improve traceability, reduce administrative inefficiencies, and enhance trust across automotive value chains[4].

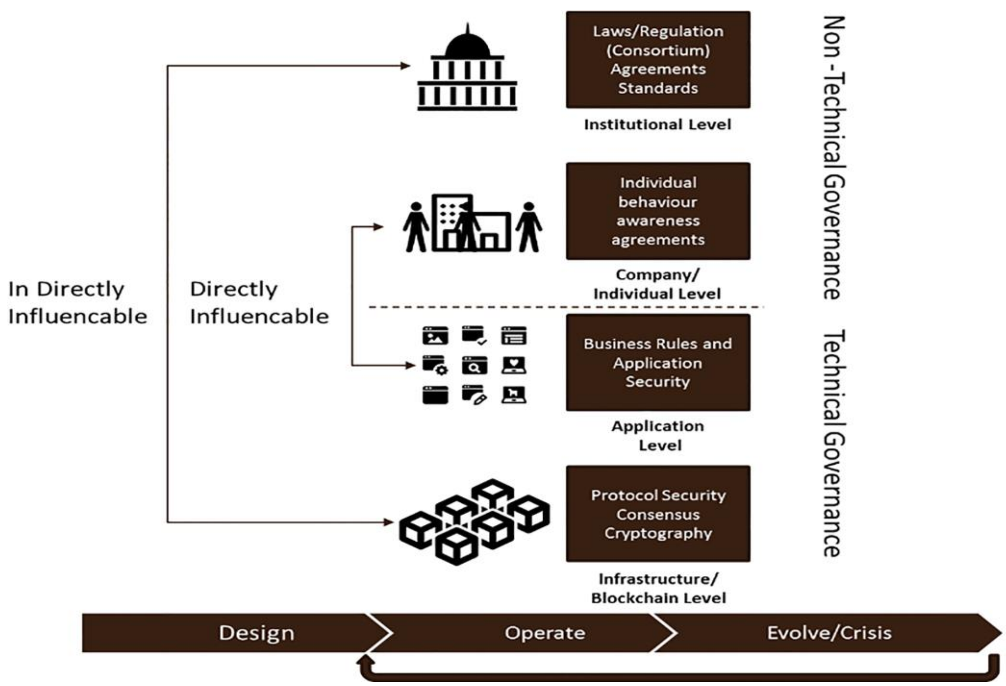
Blockchain within the symbIo Te Ecosystem: In IoT-integrated environments such as the symbIoTe framework, blockchain facilitates decentralized coordination among interconnected devices and service providers. For example, a hypothetical technology firm operating in Spain developed an intelligent routing system designed to optimize traffic flow in urban areas[3].By leveraging sensor-generated data and blockchain-based verification mechanisms, drivers can be guided toward routes that minimize congestion and reduce emissions in environmentally sensitive zones. Such systems are particularly relevant in metropolitan regions located near industrial areas, where air quality monitoring and traffic regulation are critical. Blockchain ensures that sensor data remains tamper-resistant and transparently verifiable, thereby enhancing environmental governance and collaborative urban mobility.

Smart Contract–Enabled Crowdsourcing: Blockchain-powered smart contracts also demonstrate strong potential in organizational crowdsourcing models. In enterprise environments, proposals or project tasks can be encoded within smart contracts that automatically execute predefined outcomes once completion criteria are verified.In large corporate settings, including enterprises with several hundred employees, this mechanism promotes transparency in performance evaluation, ensures accountability in collaborative projects, and minimizes administrative intervention. Automated execution reduces delays, mitigates disputes, and fosters trust among contributors[6].

Vehicular Networks and Reputation Systems: Blockchain-based architectures have also been proposed for vehicular communication networks. In such systems, decentralized ledgers record interactions among vehicles and infrastructure nodes while integrating reputation-based evaluation mechanisms[20].By assigning and updating credibility scores to message senders, the system can assess the reliability of transmitted information, thereby improving network security and reducing the risk of malicious data dissemination. This decentralized reputation framework enhances trust, strengthens communication integrity, and supports safer intelligent transportation systems.

Governance Framework : The integration of blockchain technology into governance systems has the potential to substantially strengthen transparency, accountability, and institutional integrity. By recording decisions, transactions, and procedural actions on an immutable and time-stamped distributed ledger, blockchain enables the creation of verifiable audit trails that can be independently reviewed by authorized stakeholders. This reduces the scope for discretionary manipulation, information asymmetry, and opaque administrative practices.

Furthermore, blockchain can facilitate clearer allocation of roles and responsibilities by embedding governance rules within programmable smart contracts. Such automated protocols ensure that predefined procedures are executed consistently, thereby minimizing human error and reducing opportunities for corruption or undue influence.Decentralized validation mechanisms also enhance trust in institutional processes by distributing verification authority across multiple nodes rather than concentrating control within a single entity. As a result, governance decisions become more transparent, traceable, and resistant to unauthorized alteration. In the long term, the adoption of blockchain-based governance frameworks may contribute to improved regulatory compliance, strengthened public confidence, and more participatory administrative ecosystems.



Energy Sector:[14]Blockchain supports decentralized energy ecosystems by enabling peer-to-peer (P2P) trading, IoT-based monitoring, electric vehicle charging systems, and decentralized marketplaces. For example, the Brooklyn Microgrid project demonstrates how blockchain allows households to trade surplus renewable energy directly within a community network. Such systems enhance transparency, automate settlements, and reduce reliance on centralized utilities.

Cloud Computing:A Secure Authentication–Management Scheme (SAMS) integrates blockchain to verify mobile devices accessing cloud resources. This framework improves trust in Mobile Resource Management systems by ensuring authenticated device identity through decentralized validation[19].

Satellite Networks: To improve authentication reliability in Low Earth Orbit (LEO) constellations, blockchain-based access verification protocols have been proposed. By combining identity-based encryption with distributed ledger technology, these systems enhance security and reduce unauthorized access [21].

Identity Management: Blockchain offers solutions to digital identity challenges, including identity fraud and lack of documentation among vulnerable populations [17]. By enabling secure, tamper-resistant digital identities, blockchain can strengthen cyber security while supporting social inclusion.

Academic Certificate: Project Digital Certificate is one of the brainstorming matter as issues of fake certificates are also came to exist in many parts of the countries. E-Certificates through block chain are secured and verifiable [15,21]

Medical Record: Information relating to medical history, allergies and other medical reports may be Stored through blockchain technology [10]. This may be very advantageous to patients as well as healthcare providers if used in appropriate way.

Section 4: SWOT Analysis: The objective here is to point out the most relevant potentiality of Blockchain with its constraints.

Positive	**Negative**
Internal Strengths	Weaknesses
-Open, globally accessible, and verifiable ledger system -Decentralized trust architecture -Tamper-resistant structural design -Collective validation of transactions -Cryptography-based security framework -Reduction of excessive digital surveillance -Mitigation of censorship and protection of fundamental rights -Enhanced safeguarding of personal information -Distributed governance mechanisms -Efficient management of IoT ecosystems -Rapid and cost-efficient value transfer -Elimination of traditional intermediaries -Process automation via smart contracts -Operational transparency -Support for advanced data analytics -Immutability of stored records -Non-repudiation of recorded transactions	-Data mining and analytical complexity challenges -Resource inefficiency and excessive computational consumption -Vulnerabilities related to cryptographic mechanisms -Unsustainable levels of energy usage -Risk of restrictive or distortionary government intervention -Potential displacement of traditional employment roles -Difficulties in decentralized protocol governance -Concerns regarding autonomous system misuse or loss of control -Exploitation by criminal actors -Scalability and performance limitations -Possible erosion of user privacy -Absence of centralized recourse in case of credential loss -High volatility of cryptocurrency markets
External Opportunities	Threats
-Strategic differentiation through simplified blockchain integration and IoT adoption	-Perception of insecurity or reliability concerns

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-Expansion into emerging decentralized markets (e.g., asset sharing, storage leasing) -Access to large-scale, multi-actor heterogeneous data within blockchain networks	-Limited external participation leading to information gaps -Potential regulatory resistance toward blockchain and smart contracts -Requirement of medium- to long-term investment commitment -Incompatibility with certain existing operational processes -Continued customer preference for direct human interaction

Section 5 : Conclusion

Blockchain technology extends far beyond its initial role as an enabler of financial services and offers potential solutions to a wide range of challenges, particularly those related to trust, transparency, and security. Its decentralized and cryptographically secured structure positions it as a promising tool for overcoming long-standing issues associated with data integrity and institutional reliability. In this regard, blockchain may be viewed as a transformative mechanism for strengthening trust-based systems. Nevertheless, several limitations and structural vulnerabilities remain unresolved and require further scholarly attention. In particular, comparative evaluation of private or permission block chain models versus public blockchain architectures within the proposed framework warrants deeper investigation. Issues relating to scalability, governance, interoperability, and regulatory alignment continue to present practical constraints. Moreover, substantial research opportunities exist in underexplored dimensions of blockchain technology. With systematic development, refinement of protocols, and effective implementation strategies, blockchain has the potential to expand across diverse industrial sectors and progressively influence everyday socio-economic interactions.

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