Blockchain for empowering Business Transformation with Cloud Environment: *Impact, Issues & Challenges*

P. K. Paul [1*], M. Daniel Rajkumar [2], Manoj Deva Yeddu [3], Suchismita Das [4], & P. S. Aithal [5]

[1*] Executive Director (MCIS), Asst. Prof., Department of CIS, & Information Scientist (Offg.), Raiganj University, West Bengal, India,
ORCID: 0000-0003-1140-3369; E-Mail: pkpaul.infotech@gmail.com

[2] Postdoctoral Researcher (PDFC), Poornaprajna Institute of Scientific Research (PPISR), Bengaluru, Karnataka, India, ORCID: 0009-0004-0885-4243; E-mail: mdr32000@gmail.com

[3] Asst, Professor, Department of Commerce & Management Studies, Adikavi Nannya University, Kakinada Campus, Andhra Pradesh, India,
ORCID: 0009-0007-5290-5505; E-Mail: manojdeva.y@gmail.com

[4] PhD CIS Scholar, Department of Computer and Information Science, Raiganj University, West Bengal, India, ORCID: 0009-0000-5006-3331; E-Mail: iamsuchismitadas29@gmail.com

[5] Director, Poornaprajna Institute of Management (PIM), Udupi, Karnataka, India,
Orchid ID: 0000-0002-4691-8736; E-mail: psaithal@pim.ac.in

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P. K. Paul [1*], M. Daniel Rajkumar [2], Manoj Deva Yeddu [3], Suchismita Das [4], & P. S. Aithal [5]

[1*] Executive Director (MCIS), Asst. Prof., Department of CIS, & Information Scientist (Offg.), Raiganj University, West Bengal, India,
ORCID: 0000-0003-1140-3369; E-Mail: pkpaul.infotech@gmail.com

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ORCID: 0009-0004-0885-4243; E-mail: mdr32000@gmail.com

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ORCID: 0009-0007-5290-5505; E-Mail: manojdeva.y@gmail.com

[4] PhD CIS Scholar, Department of Computer and Information Science, Raiganj University, West Bengal, India,
ORCID: 0009-0000-5006-3331; E-Mail: iamsuchismitadas29@gmail.com

[5] Director, Poornaprajna Institute of Management (PIM), Udupi, Karnataka, India,
Orchid ID: 0000-0002-4691-8736; E-mail: psaithal@pim.ac.in

ABSTRACT

Purpose: *Blockchain technology has evolved beyond its speculative roots as a cryptocurrency-based phenomenon to a basic layer of the infrastructure that is revolutionizing the way value is created, delivered and captured within organizations. Blockchain play a leading role in Digital Transformation and which is required for the purpose of business development. This paper illustrates the role and significance of Blockchain in Business sector with reference to Cloud Environment.*

Methodology: *This paper is purely based on existing works and publications. For conducting this work first of all the publications related to the Blockchain and digital business have been collected and then all the related and more connected and concerned works are analyzed properly.*

Findings: *Through this study it is observed about the blockchain technology including impact and role in business transformation, existing knowledge on uses of blockchain technology in digital business and transformation, emerging applications and utilizations of blockchain technology in digital business and transformation. This study also helps in understanding about the issues and challenges of Blockchain Technolgy in framing and utilizing modern business and organizations.*

Originality/ Value: *This paper is purely theoretical in nature but analyzed based on existing study. This is not an empirical study, but in this work impact of Blockchain in respect of cloud computing are studied and add a value addition in existing knowledge.*

Type of Paper: *Exploratory analysis.*

Keywords: Business Transformation, Business Informatics, ICT Applications, Business Applications, Cloud Computing in Business

1. INTRODUCTION :

Although blockchain's initial applications focused on financial services, the fundamental attributes of blockchain—decentralization, immutability, transparency, and programmability with smart contracts—have proven to be versatile for various business processes (Adeoye (2025).[1]). It explores blockchain applications in ten major sectors, ranging from financial services to public administration, detailing the processes of change and the organizational results that are being achieved in real-world use, and then looks at what factors are hindering and fostering the spread and speed of adoption to achieve these

benefits in various sectors. Digital Transformation is a process that restructures how organizations create value, manage information, and interact with different stakeholders. Most data-driven organizations use emerging technologies such as Artificial Intelligence, Big data analytics, cloud computing, and the Internet of Things (IoT). In this era, Blockchain has emerged as a transformative technology due to its well-designed architecture, privacy in record keeping, Transparency, Enhanced and most advanced security systems. It was initially developed to support crypto currencies. The blockchain technology emerged as a very prominent platform with applications in Agriculture, Education, Finance sector, Governance, Healthcare, Insurance sector, manufacturing, real estate, and Across Different Industries. In this Modern era, organizations continue to face various technological, organizational, Economic, Legal and Social challenges. Widespread adoption of enterprise blockchain is rarely a breeze, and so is knowing the obstacles as well as the use cases. Another constraint is integration complexity: most organizations have legacy systems which were never designed to interact with a distributed ledger, and the expenses of creating middleware to connect old and new infrastructure can be a significant part of the efficiency cost savings. This is exacerbated by regulatory uncertainty, especially within the financial services and cross-border trade sectors, where the legal nature of smart contracts, tokenized assets, and decentralized identity credentials remains unclear in different jurisdictions (Ahl et al. (2022) [2]; Akter et al. (2022). [3]). For organizations that do need to operate across borders, the advantages and value of adopting a shared ledger must be balanced against the compliance costs of reconciling it with the various, sometimes incompatible, national compliance regimes. Another barrier is the organizational one, as blockchain is more of an ecosystem-level benefit and will only be achieved through the combined efforts of several companies (Al Omoush et al. (2025). [4]; Alonge et al. (2025). [5]). Chain-of-custody, for instance, can only be truly effective if all the players in the chain are on the same platform and have established a shared data standard, and so blockchain projects are more likely to be effective as part of an industry or consortium than as a single corporate project. Typical stages of an enterprise blockchain implementation roadmap, from initial strategic evaluation through pilot testing to full integration and ongoing governance are depicted in Fig. 1.

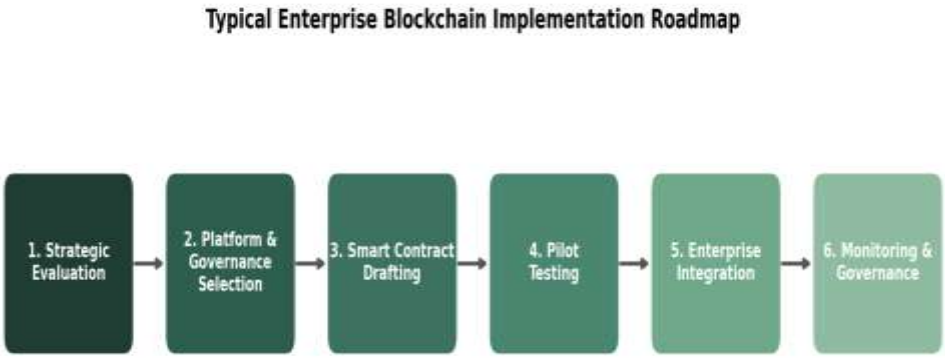

Fig. 1: Typical stages of an enterprise blockchain implementation roadmap, from initial strategic evaluation through pilot testing to full integration and ongoing governance

2. OBJECTIVE OF WORK :

The work entitled "Blockchain for empowering Business Transformation with Cloud Environment: *Impact, Issues & Challenges"* is a theoretical work and dedicated for revealing following—

(1) To learn aboout the basic of Blockchain Technology including impact and role in business transformation.
(2) To gather about the existing knowledge on uses of blockchain technology in digital business and transformation.
(3) To learn about the emerging applications and utilizations of blockchain technology in digital business and transformation.

(4) To understand about the issues and challenges of Blockchain Technolgy in framing and utilizing modern business and organizations.

3. METHODOLOGY :

This paper entitled "Blockchain for empowering Business Transformation with Cloud Environment: *Impact, Issues & Challenges"* is purely based on existing works and publications. For conducting this work first of all the publications related to the Blockchain and digital business have been collected and then all the related and more connected and concerned works are analyzed properly as per the objectives of the paper.

4. REVIEW OF EXISTING WORKS :

Similar to this work, some of them are consulted and reported here scientifically which are relevant, valuable and having significance in alphabetical order.

Gurzhiiet al. (2022) [6] present a comprehensive review consisting of 41 existing research papers to determine the blockchain's impact on digital transformation in various sectors. As a finding of this review, the researchers discuss the benefits offered by blockchain technology for innovative business models. They also talk about the challenges, including technical complexity, adoption barriers, and organizational readiness continues to control its deployment. This study consists of challenges, benefits, and new tech in digital growth, etc. As a conclusion of this study, the researchers state that successful blockchain needs the teamwork of governments, businesses, academia, and individuals, uses flexible plans etc. Hemamaliniet al. (2026) [7] explore the combination of AI, blockchain, and IoT on a cloud platform. This trio of technologies in a cloud environment gives major benefits like boosting security, privacy and data management. In this study, the authors proposed a robust architecture for data analysis and the transfer process to improve efficiency, productivity and quality of life. The researchers emphasize the blockchain's role in ensuring data integrity and privacy, AI's role in decision-making, and IoT's role in real-time data collection. This architecture applies to various applications like health care, logistics, smart cities and so on. Narayanan (2025) [8] proposes a blockchain-enabled integrated cloud architecture named Blockcloud to improve security, transparency and trust in regulated sectors, especially the insurance industry. The framework is a combination of Blockchain technology features with the cloud's scalable resources, including smart contracts, immutable audit logs, decentralized access control, and hybrid on-chain/off-chain storage. The author also mentioned that the Blockcloud architecture addresses various limitations of conventional cloud systems. This architecture also assists in automated claims processing, identity verification, fraud detection, and regulatory compliance, etc. In short, this study proves that merging blockchain with cloud technology assists insurance companies with a strong, flexible and safe system. Rena (2024), [9] reviews the role of blockchain technology in digital transformation and expansion of small and medium-sized businesses in India. This study also explains key features of blockchain technology and explores its uses across various sectors. The researcher also highlights the key obstacles, such as heavy energy use, environmental issues, policy-related regulatory issues and so on. The author suggests that a successful implementation needs policy support, economic stability and positive SME owners' attitudes, according to government reports, research articles and studies. The researchers also talk about how Indian small businesses can overcome the challenges with the help of government policies, the global economy, local markets, and owner mind-set.

Tian et al. (2024) [10] the researchers evaluate the factors responsible for the increasing adoption of blockchain technology and cloud computing for sustainable accounting among Chinese businesses. The authors had done literature review, surveys and case studies and point out the main factors and obstacles to using technology. The findings of this mixed-method approach were that company size, available resources, management support, organisational capabilities, and regulatory factors promote technology adoption. Industry type and profitability's impact is low, that affect reporting practices. They also highlight the requirement for the successful implementation of Cloud computing and blockchain technology in Chinese business. Saariet al. (2025) [11] investigate the successful scaling factors of Blockchain-based digital transformation using the TOE framework across traditional industries. This study emphasizes that blockchain technology is less critical than traditional collaboration, strategic alignment and ecosystem coordination, based on a multi-year case study in Finland from 2019-2023.

This study's findings identify best practice strategies and enabling capabilities through conducting 35 interviews with major stakeholders and finding the main theme of spotting growth steps. The findings about the blockchain-based digital transformation across industries require industry vision, collaborative work, government funding, and a complementary ecosystem and so on. Zhao et al. (2026) [12] highlight the importance of increasing the effectiveness of export companies' cloud-based information systems using Cloud computing, Blockchain, and Big Data. The researchers also state that the combination of Block technology and Cloud computing makes exporting data safer, easier to track, cost-effective and increases the speed of transportation. The authors have used the Technology-Organizations-Environment (TOE) framework to elaborate on the impact, transparency, regulatory compliance, and sustainability of blockchain on export companies' cloud-based infrastructure. The researchers also noted that integrating Big Data with the TOE framework enhances data storage, computing resource backup, and machine learning capabilities.

5. BLOCKCHAIN APPLICATIONS IN DIGITAL BUSINESS TRANSFORMATION: A CONTEMPORARY OVERVIEW :

Blockchain technology has wider impact in diverse areas in business and industries and this trend and application are rising rapidly and some of them are scientifically placed here (refer Table: 1 as well).

Financial services and payments—The financial services industry is the most developed use case for blockchain, as the industry's core function (transfer and verification of value) is a direct match for what blockchain does. Traditionally, cross-border payments have relied on correspondent banking networks and settlements taking days, but are now being reconfigured to settle within a few minutes, all with independent verification. Trade finance, which has long suffered with documents like letters of credit and bills of lading that are handled in paper form, now has access to the same documentation in electronic (e) form, with all parties having real-time visibility and fewer transactions and fraud risk (Amroni et.al. (2025) [13]). Tokenizing assets—representation of equity, debt, or real assets on a distributed ledger—has also reduced issuance costs, fractionalized ownership, and enhanced settlement efficiency with blockchain. Several jurisdictions are investigating so-called 'blockchain adjacent' central bank digital currencies, expanding blockchain's scope beyond the private sector, into monetary policy infrastructure as well. Together, these movements are a sign of a transition from blockchain as a payment infrastructure to blockchain as a financial market infrastructure.

***Supply Chain and Logistics*—**One of the most predominant enterprise blockchain applications is SCM, which involves multiple parties with a high level of trust and traceability. Current supply chains are characterized by disjointed and isolated records held by manufacturers, logistics providers, distributors and retailers, resulting in lost proof of origin and raising the risk of counterfeiting and fraud. Blockchain offers a shared, single, immutable ledger that is accessible to all authorized users, which can help mitigate reconciliation issues and facilitate full transparency. It's especially important in food safety, luxury products, and pharmaceuticals, where authenticity and compliance are critical (Aoun (2021) [14]). With blockchain, drug serialization is used to fight against counterfeit drugs, and sources of contamination in food chains can be known within minutes instead of days, reducing public health risk and recall expenses. Customs documentation and cross-border trade compliance are also improved, with blockchain eliminating duplicate paperwork and providing regulators with clear records and a history of transactions, instead of having to reconcile transactions later on, thus reducing administrative costs and the time goods are held up awaiting clearance.

***Healthcare Sector*—**The use of blockchain in the healthcare industry revolves around interoperability and data security. Patient records are usually spread among provider systems, which causes conflict in care coordination and data inaccuracies when the patient transitions between providers. Blockchain-based health information exchanges enable the sharing of records with a clear and visible history of access, and maintain access-controlled, decentralized sensitive record data, consistent with HIPAA or even India's Digital Personal Data Protection Act. Given the public health implications of counterfeit medicine, drug supply verification is a natural application of blockchain in healthcare, and blockchain has also been explored for the management of clinical trial data, reducing opportunities for data manipulation and selective reporting and enhancing public trust in clinical trial results. This type of verifiable record keeping is also becoming relevant to cross-border insurance claims and medical tourism as health systems become more and more cross-border (Ariyib (2024). [15]).

Human Resource Management—While less impactful in terms of size, blockchain has a conceptual impact in relation to HR applications. In verifiable credentialing, the academic and professional records of a candidate can be directly checked on the fly using a tamper-proof record, without the need for a third-party verification service or direct contact with the institution. It applies to decentralized identity more generally: individuals have portable, self-sovereign digital identities that can be selectively shared with employers, institutions, and government services without having to re-verifier, thus easing the friction of onboarding for organizations with global or gig-economy operations, and minimizing the administrative process of onboarding a large, distributed workforce at scale.

Marketing and Customer Relations—Blockchain's transparency attributes solve two ongoing marketing issues: advertising fraud and loyalty program fragmentation. By utilizing blockchain-based loyalty tokens, which are digital assets that can be transferred and used by customers with other brands, the customer value perception can be expanded and customer engagement can be increased (Beshley (2022). [16]; Erica et al. (2024). [17]). For advertisers, the blockchain-based ad-verification systems provide an audit trail of clicks and impressions, allowing spend to be correlated with real impressions and clicks, not ad fraud. This transparency also applies to consumer trust, as sourcing statements like "ethically sourced" or "carbon neutral" can be independently verified, not assumed to be true because the origin is unknown.

Manufacturing and Industrial Operations—In the manufacturing sector, blockchain can be used to ensure quality control and track the origins of components, especially in industries that have multiple, long and intricate supplier chains like the automotive and aerospace sectors. If a defect is discovered, manufacturers can determine the exact batch and supplier that caused the defect, which helps to limit the scope of the recall and minimizes costs. Smart contracts can also trigger supplier payments upon meeting delivery milestones, reducing administrative burden associated with invoice reconciliation (Faruque (2024). [18]; Florek-Paszkowska& Ujwary-Gil (2025). [19]).

Real Estate and Asset Management—Blockchain-based land registries eliminate intermediaries in real estate, such as lawyers and escrow agents, as well as jurisdiction-specific registries, which typically cause title verification delays; they also produce tamper-proof ownership records, minimizing disputes and fraud, especially in real estate markets where paper land registries can be easily manipulated (Habib et al. (2022). [20]). Real estate tokenization also introduces fractional ownership, which enhances liquidity in the asset class which is known for its high transaction costs.

Energy and Utilities—Blockchain can facilitate peer-to-peer energy trading, especially as more distributed renewable energy (such as solar) is being generated at homes. Smart contracts enable automatic settlement based on metered production and consumption data, enabling the direct trading of excess capacity from producers to consumers in close proximity without the use of a centralized utility, thereby contributing to grid decentralization and the movement towards distributed energy resource management.

Government and Public Sector Services—Government blockchain apps are geared towards minimizing administrative hassles and the potential for administrative corruption when storing information. As mentioned above, land registries are applicable to public administration as well. In addition, Blockchain has also been experimented with for public benefit distribution, for voting systems, for which the security and auditability of the system are still in debate, and for public procurement, where an immutable record of bidding and contract award allows for better public accountability. The increasing volume of Blockchain Technology in across business functions are depicted in Figure-2Illustrative adoption maturity of blockchain applications across business functions, ranging from mature/scaled deployment (financial services, supply chain) to early/pilot-stage adoption (government, real estate); whereas Figure-3 depicted Approximate distribution of enterprise Blockchain.

Table 1: Summary of Blockchain Applications and Transformation Outcomes by Business Function

Business Function	Representative Blockchain Application	Transformation Outcome
Financial services & payments	Cross-border payments, tokenized assets, CBDC pilots	Faster settlement; lower intermediation cost

Business Function	Representative Blockchain Application	Transformation Outcome
Supply chain & logistics	Provenance tracking, customs documentation, pharma serialization	End-to-end traceability; reduced counterfeiting and recall scope
Healthcare	Health information exchange, drug verification, clinical trial data	Improved interoperability and data integrity
Human resource management	Verifiable credentials, decentralized identity	Faster, tamper-proof credential verification
Marketing & customer relations	Loyalty tokens, ad-verification, sourcing claims	Reduced ad fraud; enhanced customer trust
Manufacturing	Component traceability, automated supplier payments	Narrower recall scope; lower reconciliation overhead
Real estate & asset management	Blockchain land registries, asset tokenization	Reduced title disputes; improved liquidity
Energy & utilities	Peer-to-peer energy trading via smart contracts	Grid decentralization; automated settlement
Government & public sector	Identity management, procurement, benefit distribution	Reduced corruption risk; increased accountability

Concurrently, multiple enablers are fast driving the adoption where these barriers are manageable. Cloud-based options for blockchain-as-a-service have reduced the technical hurdle to entry, allowing companies to experiment with blockchain without building up internal expertise (Hameed, K., et.al. (2024). [21]). No regulatory sandboxes have been established to test tokenization of products and blockchain-based settlements in a controlled environment before they are rolled out on a larger scale; better interoperability between platforms minimizes the chances of the technology of today becoming the restriction of tomorrow.

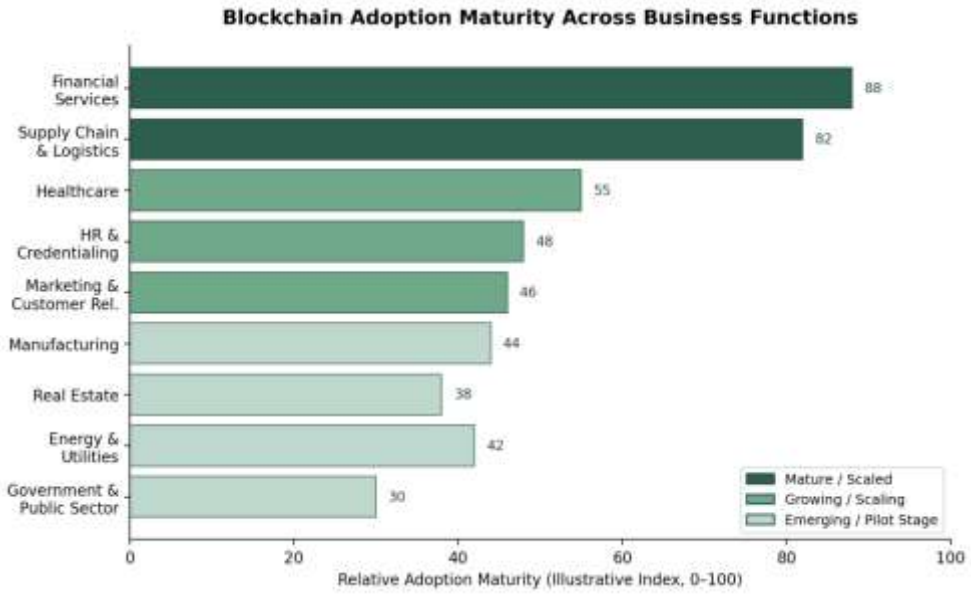

Fig. 2: Blockchain applications across business functions, ranging from mature/scaled deployment to early/pilot-stage adoption (government, real estate).

Instead of further improvements in the blockchain technology itself, future adoption is likely to rely more on the evolution of the ecosystem around the blockchain, in terms of regulatory clarity, data standards and governance models, and the extent to which these documented benefits can be realized at scale (Joel et. al. (2024). [22]).

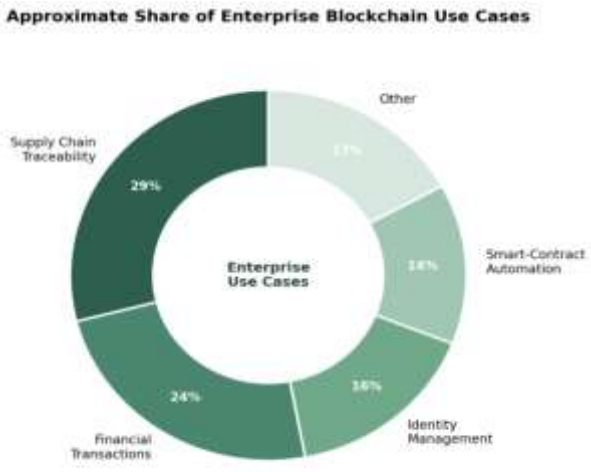

Fig. 3: Approximate distribution of enterprise blockchain use cases, with supply chain traceability and financial transactions together accounting for more than half of reported implementations

***Cross-Cutting Transformation Patterns*—**There are some patterns when it comes to these functional uses. Where one party cannot be trusted by others, as in supply chains, cross-border finance and credential verification, blockchain has the most value, but in systems that are single-organization, where a centralized database might do the job for a comparable cost, that's not the case. Additionally, blockchain projects are more likely to succeed as part of a larger ecosystem redesign rather than specific deployments, and need to be adopted collectively by suppliers, customers, and regulators (Kitsantas (2022). [23]). Lastly, each sector has a different degree of adoption maturity: financial services and supply chain traceability are scaled and relatively more mature, whereas healthcare, real estate and government applications are mostly still at pilot stage and are limited by regulatory uncertainties and lack of interoperability standards. Blockchain-enabled digital business transformation is thus more a process than a wave of disruption – and a process that varies by function and context, reflecting the level of existing multi-party friction, regulatory readiness, and digital infrastructure (Korolyuk et. al. (2024). [24]).

6. BLOCKCHAIN DRIVEN CLOUD COMPUTING FOR ENHANCED BUSINESS TRANSFORMATION :

Cloud computing and blockchain technology are both the latest emerging technologies in this era. In the business sector, the combination of these technologies can bring evolution. Cloud computing enables access to and deployment of computational resources, whereas blockchain technology provides a secure, transparent, and decentralized transaction system to the business sector. Businesses can choose cloud computing for running blockchain-empowered applications and blockchain for providing security to the cloud's data (Ariyibi et. al. (2024). [15]), (Beshley et. al. (2022). [16]). Due to the growing demand for blockchain-driven cloud computing technology in the business sector's enhanced transformation and development, perception of Concept/theory, importance, positive outcomes, implementations, challenges and prospects has become very essential to know. These are discussed in this study.

6.1 Theory of blockchain-empowered cloud computing and organizational need:

Blockchain-driven cloud computing offers the combination of scalable computing resources with secure, decentralised, transparent financial or data transactions. The key difference between traditional cloud computing and blockchain-empowered cloud computing is that traditional cloud computing relies on a central service provider for data and computing resources management, for which data breaches

and unauthorized access threats can happen; on the other hand, blockchain-enabled cloud computing solves this issue by storing data in decentralized nodes through cryptographic techniques. The network checks every piece of data first, so that no one can change the saved data later. Therefore, the business sectors benefit from secure cloud platforms to stay safe and secure while developing and transforming the business with the help of emerging technologies. organizations need to develop their business processes through emerging technologies to support the digital transformation of their business. Blockchain-enabled cloud computing supports the digital transformation of the organisation sector with its secure, transparent, decentralized transaction process and collaboration among its stakeholders. It makes organizational work faster by transforming it into digital work, speeds up tasks, and protects shared data between its stakeholders (Erica et.al. (2024). [17]). Moreover, this helps organizations cut costs, enhance service quality, and respond faster to increasing market demand. This trustworthy combination of emerging technologies helps drive innovations in business sectors.

Positive outcomes for business growth: Blockchain-driven cloud computing offers numerous benefits to the business sectors. They are as follows-

- **Strengthen Data Security:**Blockchain's robust security protocols enhance cloud data security and prevent data breaches.
- **Enhanced Transparency and Trust:**The blockchain's transparency feature helps prevent fraud and increases people's trust in the transaction system.
- **Budget management:** Blockchain technology assists in budget management by eliminating the middleman(Faruque et. al.(2024). [18]), (Florek-Paszkowska & Ujwary-Gil (2025). [19]).
- **Peak performance:** Blockchain technology helps decrease errors and automate tasks to get smooth operations.
- **Decentralisation:** Blockchain provides a decentralised Cloud system that helps with data storage and the decision-making process for enhancing data security, preventing data loss and handling errors.
- **Streamlined ownership tracking:** Blockchain technology's decentralised, secure, and transparent features enable real-time tracking of vehicles, goods, and services, improving logistics and transportation businesses.
- **Uninterrupted services:** Cloud computing enhances blockchain by replicating its data across interconnected server networks, reducing single points of failure.
- **Scalability:** Blockchain technology increases its scalability by using cloud computing's on-demand resources, which helps to process large amounts of transactions smoothly.
- **Risk management:** The combination of blockchain and cloud computing advances the system availability for uninterrupted business processes through the cloud's backup and disaster recovery services.

Implementation throughout corporate sectors:

- **Financial and Banking Services:**The financial sector takes advantage of the combination of blockchain technology and cloud computing to create scalable, reliable and innovative financial services, including crypto trading, direct loan apps, etc.
- **Supply Chain Management:** Blockchain-enabled cloud computing improves supply chain management systems through secure product tracking, higher work speed and lower fraud risk.
- **Modernising the healthcare system:**Blockchain-powered cloud computing boosts the healthcare system with its secure Electronic Healthcare Record (EHR), smooth medical data sharing, trusted digital patient record checks, and fast patient care digital services, etc(Habib, G., et.al. (2022). [20]), (Hameed et al. (2024). [21]).
- **Securing Smart Homes with Blockchain:**Blockchain-driven cloud computing upgrades smart homes with its secure, automated data control, live monitoring and total data privacy.
- **Ledger-based transportation:**Blockchain-managed cloud computing promotes smart transportation systems via its smart and secure traffic networking system that improves travel and communication.
- **Advanced manufacturing:**Blockchain's integration with cloud computing services advances manufacturing systems through minimising dependency on third parties and decentralising the system architecture, etc.

- **Online retail industry:**Blockchain enhances cloud computing services in online retail industries by upgrading secure transactions, transparent tasks, digital identity management, and efficient e-governance services.

Blockchain integration in cloud computing services for enhanced business development comes with some hurdles. They are including ***Scalability*** requirement for large-scale industries: Despite scalability being the core benefit of these combined technologies, the huge scalability requirement for large-scale industries is quite a challenge for Blockchain-enabled cloud computing technology (Joel et al. (2024). [22]), (Kitsantas (2022). [23]). ***Interoperability*** **is** Another major challenge of blockchain-based cloud computing is interoperability, due to the absence of a common format; the data sharing process and communication become tough. ***Regulation*** **is** another major limitation of blockchain-based cloud technology is regulation. Diverse laws and the lack of skilled manpower slow down the adoption of blockchain-enabled cloud computing technology. The future of blockchain-enabled cloud computing is highly promising and with ample benefits as described in Fig. 4. Some of the prospects are as follows-

- **Blockchain-based:**Cloud Computing infrastructure:Blockchain-based cloud computing will offer businesses secure, transparent and decentralised, more advanced virtual computing architecture.
- **Decentralised Cloud Computing Networks**:Decentralised cloud computing networks can use blockchain technology to disable cyber-attacks and enhance secure, less-costly computing resources.
- **Growth of smart Applications:**Businessindustriessuch as healthcare, finance, supply chain management and others' advancement can be dependenton smart, secure cloud applications.

These days, modern businesses adopt blockchain-based cloud computing for accessing cloud services with blockchain's secure, transparent, and decentralized nature to create robust digital architecture. These combined technologies improve companies' work efficiency, Innovative ideas, trust and security. Business industries also face some limitations, such as huge scalability, interoperability and regulations, etc. The continuous advancement of these technologies can help to resolve these limitations. With these advancements in technologies, blockchain-enabled cloud computing plays a vital role in business industries to make a secure, transparent, resilient, sustainable and competitive business environment.

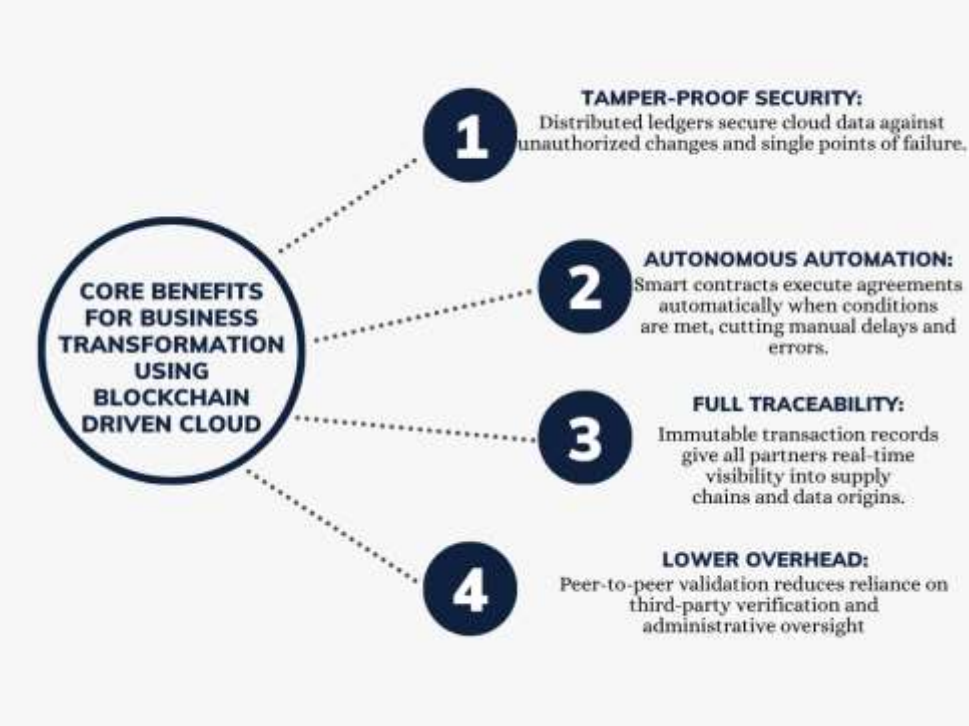

Fig. 4: Core Benefits for Business Transformation

7. BARRIERS, CHALLENGES, AND ISSUES OF BLOCKCHAIN IN DIGITAL TRANSFORMATION :

Let us discuss the various barriers to blockchain in Digital Transformation in Business, which are crucial for business leaders, Researchers, Policymakers, and technology enthusiasts and professionals (also refer Fig. 5)

- Scalability and Performance Limitations
- High Implementation and Operational costs
- Lack of Skilled human resource
- Regulatory and legal Uncertainty
- Security and Privacy Concerns
- Integration with Legal systems
- Interoperability Challenges
- Energy Consumptions and Environmental concerns
- Governance and Organizational Resistance
- Smart Contract Risks
- Data Storage and Management Issues
- User Adoption and Digital Literacy
- Ethical and Social Challenges
- Industry-Specific Challenges

***Scalability and Performance Limitations*—**The major barrier to blockchain technology is its Limited Salacity. Most blockchain systems are decentralized; therefore, the transaction speed is comparatively slower than that of centralized database systems. Every transaction must be verified and recorded by multiple participating nodes, which increases the processing time and reduces the transmission rate (Korolyuk et. al. (2024, September).[24]), (Kumar et al. (2023). [25]). Network Cognition is quite normal because the number of users increases, which may lead to transaction delays and increased transaction fees. Businesses such as banks, E- Commerce platforms, and payment gateways face operational efficiency problems. This may lead to the use of traditional high-performance database systems from blockchain technology. Although newer consensus algorithms such as Proof-of-Stake (PoS), Delegated Proof-of-Stake (DPoS), and Layer-2 scaling solutions have improved block chain performance, achieving enterprise-level scalability remains a significant technical challenge.

High Implementation and Operational Costs-Implementing of Block Chain technologies in need High Investments. The Organizations should Invest on Hardware, Software Up gradation, Cloud infra structure, Cybersecurity Specialists, Employee training, Experienced developers, ongoing maintenance and legal Consultants. In developing economies, small and medium enterprises (SMEs) do not have many financial resources to adopt blockchain successfully. The Return on investment discourages organizations from making large-scale blockchain investments. Only Larger Corporations are implementing the Block Chain Technology with Grater Financial and technological Capabilities.

Lack of Skilled Human Resources-The Another major Problem is Skilled Human resources, It Requires Multidisciplinary expertise involving distributed Computing, Cryptography, cybersecurity, programming Languages, Cloud Computing and Smart Contract development there is a big gap and Skilled Professional Need is there globally Many educational institutions including Premier Tech educational organizational have recently introduced Block Chain Related Courses, It's also difficult to organizations for recruiting experiences Developers and also Increases the Training costs It also Risks the Projects (Kumar & Kumar (2025). [26]), (Li et al. (2023). [27]).

Regulatory and Legal Uncertainty—Clear and Consistent Regulatory authorities are another Problem, Each Country have Differences in legal approaches towards cryptocurrencies, digital assets, decentralized finance (DeFi), smart contracts, and blockchain governance. Business Operations are conducted internationally and must comply with multiple regulatory systems, which creates legal complexity and increases compliance costs. Questions regarding taxation, digital identity verification, anti-money laundering (AML), Know Your Customer (KYC) requirements, intellectual property rights,

and cross-border transactions remain unresolved in several jurisdictions (Li, Y., & Chen, T. (2023). [28]), (Liyanaarachchi G. (2024). [29]). This legal uncertainty discourages organizations from making long-term investments in blockchain-based solutions.

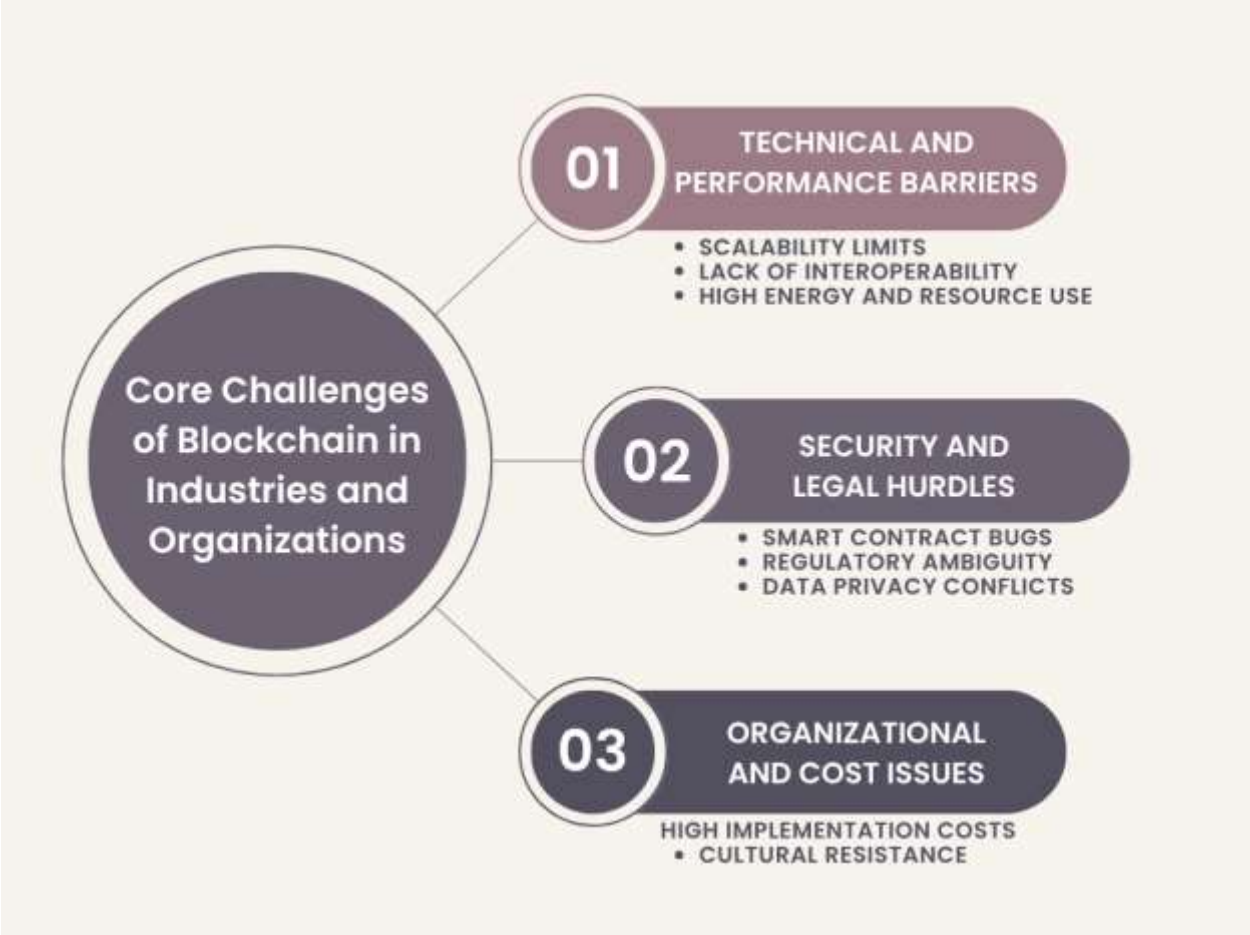

Fig. 5: Core Challenges of Blockchain in Industries and Organizations

Security and Privacy Concerns—Blockchain is widely used for its strong security features, which include decentralization, cryptographic inception, and immutable records; however, it remains vulnerable to several security threats. Smart contracts may contain programming errors and vulnerabilities that attackers can exploit. Cyber cryptocurrency exchanges, digital wallets, and blockchain applications are frequent Targets of Hacking, Phishing attacks, Malware, Ransomware, and permanent loss of Private Cryptographic keys, which Can Result in Irreversible Loss of digital assets. Privacy is also a big problem. Inpublic blockchains, the transition history is permanently Visible, It will exploit organizations sensitive business information like financial records, customer data, health Records and Confidential data.

Integration with Legacy Systems—At present, most corporates and other organizations are using systems such as enterprise resource planning (ERP), Customer Relationship Management (CRM), Human Resource Management Systems (HRMS), and conventional relational databases. Integrating blockchain into these existing infrastructures is technically challenging. Data migration, software compatibility, API development, workflow redesign, and interoperability between traditional and decentralized systems require considerable planning and investment. During integration, organizations may experience operational disruptions and temporary reductions in productivity (Mirzaye Shirkoohi & Mohiuddin (2025). [30]), (Munira (2025). [31]), (Nguyen, D.et al. (2020). [32]).

***Interoperability Challenges*—**At present, many Blockchain platforms are being used globally, such as Ethereum, Hyperledger Fabric, Corda, Solana, Polygon, and Ripple. However, these platforms often operate independently using different protocols, consensus algorithms, and programming

environments. The inability of different blockchain networks to communicate efficiently restricts data sharing, cross-platform transactions, and collaborative business ecosystems. Organizations may become locked into a single block chain platform, limiting flexibility and future expansion (Nguyen et al. (2025). [33]), (Nguyen et al. (2025). [34]). Although cross-chain communication technologies are actively being developed, interoperability remains one of the most significant technical obstacles to widespread block chain adoption.

Energy Consumption and Environmental Concerns—Blockchain technology requires a huge amount of electricity, Raising Concerns regarding environmental sustainability and carbon emissions. As governments and organizations are very sensitive to the Environmental, Social, and Governance (ESG) objectives for running the economy, high energy consumption, such as blockchain technology, faces high criticism. This May leads to Environmental concerns to Influence public perception and regulatory decision (Omol (2024). [35]).

Governance and Organizational Resistance—Blockchain technology works on decentralized decision process, and it is very difficult for software upgrades, Protocol Changes, Network governance, and dispute resolution processes, which require consensus among multiple stakeholders. Within organizations, employees and managers may resist blockchain adoption due to fear of job displacement, technological uncertainty, and disruption of established workflows (Parry (2024). [36]), (Pineda et al. (2024). [37]).

Smart Contract Risks—Smart contracts automate business agreements by executing predefined conditions without human intervention. While they significantly improve operational efficiency, they also introduce new risks. Errors in smart contract code cannot always be easily corrected after deployment because block chain records are immutable. Programming mistakes, logical flaws, or inadequate security testing may lead to financial losses, operational disruptions, and legal disputes (Ratna et al. (2024). [38]).

Data Storage and Management Issues—Block chain stores transaction records across multiple distributed nodes, meaning every participant maintains a copy of the ledger. As transaction volumes increase, block chain size grows continuously, increasing storage requirements and network synchronization time. Large multimedia files, medical images, engineering drawings, and enterprise databases are generally unsuitable for direct block chain storage (Saari et al. (2025). [39]). Consequently, organizations often rely on hybrid architectures where large datasets remain off-chain.

User Adoption and Digital Literacy—Block chain applications frequently involve complex concepts such as digital wallets, cryptographic keys, decentralized identities, consensus mechanisms, and tokenized assets. Many users find these concepts difficult to understand. Poor user interfaces, technical terminology, and complicated authentication procedures reduce user acceptance (Santoso et al. (2025). [40]). Without sufficient digital literacy and public awareness, block chain applications struggle to achieve widespread adoption, particularly among elderly populations, rural communities, and non-technical users (Sarmah (2019). [41]), (Sharma et al. (2020). [42]).

Ethical and Social Challenges—Block chain technology raises important ethical considerations regarding fairness, accessibility, accountability, and inclusion (Somanathan (2023). [43]), (Su, X. et al. (2024). [44]). Although decentralization aims to democratize access to information and financial services, unequal access to digital infrastructure may widen the digital divide between developed and developing regions (Paul et al. (2023). [45]), (Paul et al. (2023). [46]). Automation enabled by block chain and smart contracts may also reduce employment opportunities in administrative, financial, and intermediary roles. Ethical concerns further arise regarding algorithmic transparency, decentralized governance, and accountability when automated systems make business decisions (Paul (2024). [47]), (Sujee et al. (2024, April). [48]).

Some Blockchain Challenges and Solutions for effective Business Informatics Practice

Core Challenge	Description	Proposed Solution	How It Works
Scalability & Speed	Low transaction throughput and high latency.	Layer-2 Networks & Sharding	Moves transactions off the main chain or splits the database into smaller parts.
Data Privacy	Public ledgers expose sensitive business transactions.	Zero-Knowledge Proofs (ZKPs)	Verifies transactions without revealing the underlying data.
High Energy Usage	Proof-of-Work consensus consumes massive power.	Proof-of-Stake (PoS) & Eco-Consensus	Replaces miners with validators based on coin ownership, cutting energy use.
Regulatory Uncertainty	Lack of clear legal frameworks globally.	Hybrid Models & Compliance Frameworks	Uses permissioned ledgers and designs systems to meet local data laws like GDPR.
Interoperability	Siloed blockchains cannot talk to each other.	Cross-Chain Bridges & Protocols	Connects different networks so data and assets move freely.

Fig. 6: Core Challenges of Blockchain in Industries and Organizations

Industry-Specific Challenges—Different industries encounter unique block chain implementation challenges.

- In banking and finance, regulatory compliance, cybersecurity, fraud prevention, and financial stability remain primary concerns (Uddin et al. (2021). [49]), (Umar & Rana (2024). [50]).
- In healthcare, maintaining patient privacy while ensuring secure data sharing presents significant technical and ethical challenges. In supply chain management, ensuring data authenticity, supplier participation, and Iota integration requires extensive collaboration among multiple stakeholders (Vasileiou et al. (2025). [51]), (Vayadande et al. (2024). [52]).
- In education, institutions face challenges in standardizing digital credentials, certificate verification, and institutional interoperability.
- Government agencies encounter additional issues involving digital identity management, public trust, legislative reforms, and national cybersecurity requirements (Wong et al. (2020). [53]), (Xue et al. (2025). [54])
- These sector-specific challenges indicate that block chain adoption strategies must be customized according to organizational objectives and regulatory environments (Yulianti et al (2026). [55]).

It is worthy to note that though the Blockchain has certain issues and challenges in but at the same time as far as technical challenges are concerned can be solved using as depicted in Fig. 6.

8. CONCLUDING REMARKS :

Block chain technology has enormous potential to reshape digital transformation by improving transparency, trust, security, efficiency, and accountability across businesses and public institutions. Its applications extend well beyond cryptocurrencies into healthcare, education, finance, manufacturing, logistics, governance, and many other sectors. Nevertheless, successful implementation requires overcoming numerous barriers including scalability limitations, high implementation costs, regulatory uncertainty, cybersecurity risks, interoperability issues, governance complexities, organizational resistance, skill shortages, environmental concerns, and ethical challenges. Future block chain adoption will depend not only on technological innovation but also on supportive government policies, international regulatory harmonization, workforce development, standardized protocols, sustainable consensus mechanisms, and effective organizational change management. As these challenges are gradually addressed through continuous research, policy reforms, and technological advancements, block chain is expected to become a foundational technology driving secure, transparent, and resilient digital transformation across industries worldwide.

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