International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 06 | June - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Blockchain for Drug Traceability in Healthcare

Mrs. Parimala, G.Lokeshwar[2], G.Shivani[3], A.Keerthika[4], B.Vikas Ram[5]

[1] *Mrs. Parimala (assistant professor)*
[2]*G.Lokeshwar Department of Computer Science and Engineering (Joginpally BR Engineering College)*
[3] *G.Shivani Department of Computer Science and Engineering (Joginpally BR Engineering College)*
[4]*A.Keerthika Department of Computer Science and Engineering (Joginpally BR Engineering College)*
[5]*B.Vikas Ram Department of Computer Science and Engineering (Joginpally BR Engineering College)*

ABSTRACT

Ensuring the authenticity and safety of pharmaceuticals is a growing concern in today's complex and globalized healthcare supply chains. Counterfeit drugs and inefficiencies in tracking systems threaten patient health and burden healthcare providers. This paper investigates how blockchain technology can offer a reliable solution by enabling end-to-end drug traceability. With its decentralized, tamper-proof ledger, blockchain allows all stakeholders—including manufacturers, distributors, regulators, and pharmacies—to securely access and verify real-time data throughout a drug's lifecycle.

We examine key use cases, recent pilot projects, and regulatory frameworks to demonstrate how blockchain enhances transparency, reduces fraud, and improves recall management. By streamlining data sharing and strengthening accountability, blockchain not only ensures drug safety but also supports compliance with evolving healthcare regulations. This paper concludes that blockchain has strong potential to reshape pharmaceutical traceability, contributing to a safer and more efficient healthcare system.

1. INTRODUCTION

The integrity of pharmaceutical supply chains is critical to patient safety, yet counterfeit and substandard drugs continue to infiltrate global markets. Traditional tracking systems often rely on siloed data, manual processes, and limited visibility, making it difficult to trace a drug's origin, verify authenticity, or respond swiftly to recalls. As healthcare systems grow increasingly complex, there is an urgent need for more transparent, secure, and interoperable solutions.

Blockchain technology offers a promising path forward. With its decentralized, tamper-resistant ledger, blockchain can provide real-time, end-to-end visibility into the movement of drugs across the supply chain. This ensures that every transaction—from manufacturing to dispensing—is securely recorded and easily auditable. By empowering all stakeholders with trusted data, blockchain has the potential to reduce fraud, improve patient outcomes, and streamline regulatory compliance in the pharmaceutical sector.

2. LITERATURE REVIEW

Recent studies highlight the increasing adoption of blockchain in healthcare supply chains, particularly for improving transparency and traceability. Researchers have explored how blockchain's immutable ledger can securely record each transaction in a drug's lifecycle, from production to patient delivery. For instance, projects like MediLedger and IBM's blockchain initiatives have demonstrated practical applications in tracking pharmaceutical products, enhancing data integrity, and ensuring compliance with regulations such as the Drug Supply Chain Security Act (DSCSA). These implementations emphasize blockchain's potential to reduce fraud, prevent counterfeit drugs, and improve the efficiency of recalls.

However, the literature also reflects ongoing challenges, including issues around data privacy, interoperability with legacy systems, and the scalability of blockchain solutions. Some scholars argue that while blockchain provides technical trust, successful adoption also requires strong collaboration among stakeholders and supportive policy frameworks. Despite these hurdles, the consensus is growing that blockchain can significantly strengthen drug traceability when integrated thoughtfully with existing healthcare infrastructures.

3. PROBLEM STATEMENT

The pharmaceutical industry faces a persistent challenge in ensuring the authenticity and traceability of drugs as they move through complex, multi-tiered supply chains. Traditional systems often lack transparency, are vulnerable to tampering, and fail to provide real-time data, making it difficult to detect counterfeit drugs or respond effectively to

recalls. This not only compromises patient safety but also leads to financial losses and regulatory non-compliance. There is an urgent need for a secure, reliable, and transparent system that can enhance drug traceability and restore trust in the healthcare supply chain.

4. METHODOLOGY

Fig 4: Features of blockchain

4.1 Immutability

Immutability means that once data is recorded, it cannot be changed or deleted. In the context of blockchain, this ensures that every transaction or piece of information is permanently locked in place, creating a trustworthy and tamper-proof record. This feature is crucial because it prevents fraud, errors, or unauthorized changes, giving users confidence that the information they see is accurate and reliable

4.2 Traceability

Traceability is the ability to track the entire history and journey of a product or item, step by step, from its origin to its final destination. In industries like pharmaceuticals, traceability means knowing exactly where a drug was made, how it was handled, and where it has been along the supply chain. Simply put, traceability gives a clear and detailed story of a product's life.

4.3 Secure Data Exchange

Secure data exchange ensures that information is shared safely between parties without unauthorized access. It uses encryption and authentication to protect data during transfer. This builds trust by keeping sensitive information private and intact.

4.4 Decentralization

Decentralization means distributing control across many independent participants instead of one central authority. This makes systems more secure and resistant to failure or manipulation. It ensures transparency and fairness by sharing power equally.

4.5 Time and Cost Effective

Time and cost effective means saving both time and money by using efficient methods or technologies. It reduces delays and lowers expenses while maintaining quality. This helps businesses and individuals get better results faster and cheaper.

4.6 Transparency

Transparency means openly sharing information so everyone can see and understand what's happening. It builds trust by making processes clear and easy to verify. This helps prevent mistakes and dishonesty.

5. MODELING AND ANALYSIS

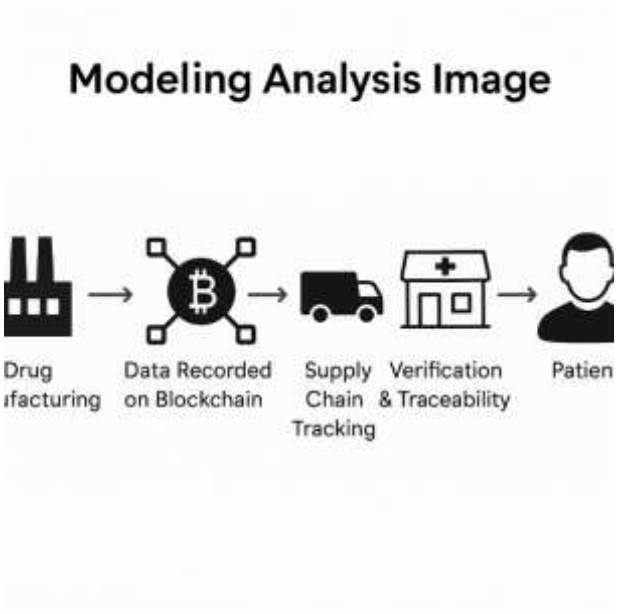

Fig 5. modeling and analysis

5.1 Drug Manufacturing

Blockchain helps make drug manufacturing safer by tracking every step of a medicine's journey. This way, it's easier to spot fake drugs and make sure patients get the real, trusted treatment they need.

5.2Data Recorded

This creates a transparent and tamper-proof history of each medicine, helping to ensure its authenticity and safety. By capturing important data—from raw materials to final delivery—blockchain allows manufacturers, regulators, and consumers to trace a drug's journey with confidence.

Key data recorded includes:

- **Batch Information:** Manufacturing date, batch number, and expiration date to track specific drug lots.
- **Raw Material Details:** Source and quality checks of ingredients used in production.
- **Manufacturing Steps:** Documentation of every process like mixing, testing, and packaging.
- **Storage Conditions:** Temperature and environmental data to ensure proper handling.
- **Shipping Records:** Time-stamped tracking of drug movement through the supply chain.
- **Verification and Audit Logs:** Records of quality inspections and authentication checks.

5.3 Supply Chain Tracking

Supply chain tracking with blockchain ensures every step of a drug's journey is securely recorded and easily traceable**.**

Key points:

- Real-time tracking of drug location and status
- Transparent record of all handlers and checkpoints
- Immediate detection of delays or tampering
- Improved coordination between manufacturers, distributors, and retailers
- Enhanced trust through immutable transaction history
- Faster response to recalls or safety issues

5.4 Verification & Traceability

Blockchain enables reliable verification and traceability by recording every transaction in a secure, unchangeable ledger. This helps ensure that each drug is genuine and its journey from manufacturer to patient is fully trackable.

5.5 Patient

After all the steps of manufacturing, tracking, verification, and traceability are securely recorded on the blockchain, the final stage is drug delivery to the patient. By the time the medicine reaches the pharmacy or healthcare provider, its entire journey—from raw materials to production, storage, and transportation—has been transparently documented. This means that the patient receives a drug that is not only genuine but has also passed through strict quality checks and secure handling processes. With blockchain ensuring authenticity and safety at every step, patients can trust that the medication they are taking is safe, effective, and exactly what was prescribed.

6.RESULTS

Blockchain-based drug traceability is making it easier and safer to track medicines from the factory all the way to the patient. It creates a secure digital trail that can't be tampered with, helping to stop fake drugs from entering the supply chain. This means people can feel more confident that the medicine they're taking is real and safe. It also helps companies and healthcare providers quickly find and remove any bad batches if something goes wrong.

6.1 Home Page

6.2 Result

7. CONCLUSION

Using blockchain for drug traceability is changing healthcare for the better by making it safer and more trustworthy. For years, issues like fake medicines, missing records, and delays in the supply chain have put patients at risk. With blockchain, every step a drug takes—from the factory to the pharmacy—is recorded in a secure, transparent way that can't be changed or tampered with. This means everyone involved, from manufacturers to doctors to patients, can see exactly where the medicine has been and know it's real and safe. It also helps speed up recalls if there's a problem, and ensures that drugs are handled and stored properly. In the end, patients get peace of mind knowing their medications are exactly what they should be—authentic, approved, and safe to use. Blockchain is helping healthcare move toward a future where trust, safety, and accountability come first.

8. REFERENCES

1. **Kumar, P., Tripathi, R., & Kaur, P. (2020).** *"Blockchain-based drug traceability system for counterfeit drugs in pharmaceutical industry."*

2. **Mackey, T. K., Nayyar, G. (2017).** *"A review of existing and emerging digital technologies to combat the global trade in fake medicines."*

3. **FDA (2023).** *"Drug Supply Chain Security Act (DSCSA)."* U.S. Food & Drug Administration.

4. **Tijan, E., et al. (2021).** *"Blockchain technology implementation in logistics." Sustainability, 13(4), 2273.*

5. **World Health Organization (WHO). (2017).** *"A study on the public health and socioeconomic impact of substandard and falsified medical products."*

6. **Nakamoto, S. (2008).** *"Bitcoin: A Peer-to-Peer Electronic Cash System."*

7. **Mettler, M. (2016).** *"Blockchain technology in healthcare: The revolution starts here.".*

8. **IBM Blockchain for Healthcare. (2022).** *"How blockchain can improve healthcare supply chains."*

9. **Tandon, A., et al. (2021).** *"Blockchain technology for healthcare applications: A review."*

10. **Accenture. (2019).** *"Accenture Technology Vision for Healthcare: Blockchain and intelligent supply chain."*