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SECURE MED: SAFEGUARDING HEALTH WITH BLOCKCHAIN AGAINST COUNTERFEIT MEDICINES

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Abstract: Counterfeit products and medicines are increasing in the market, as it is difficult to detect fake products by visual inspection alone. Pharmaceutical supply chains often suffer from poor coordination and a lack of transparency, giving fraudsters a hard time for legitimate companies. Previous systems such as the Internet of Things generated a lot of sensitive data. The project aims to improve the detection of counterfeit medicines by using blockchain technology to trace the historical origin of the product. Blockchain-based systems ensure the authenticity and traceability of medicines in a decentralized supply chain accessible to many parties. All medicines have a unique QR code. This project proposed a blockchain-based system designed to detect counterfeit drugs.

Keywords **- Blockchain, Counterfeit, Pharmaceutical supply chain, Health care, QR Code.**

I. INTRODUCTION

The chance of counterfeit medicine increases due to the duplication of the original medicine, which has the exact picture of the original with very minute changes. In general, the common citizens cannot identify such changes. Though there will be a sequence checking process in the supply chain of the medicine, the counterfeiterers somehow manage to enter through the backdoor to sell their medicine to the retailer lesser than the money the retailer pays for the actual reputed companies. It has negative effects on the economy, but also on citizens too. Such counterfeit medicines contain variable usage of the components, which leads to some allergic reactions or sometimes may risk the consumer's life. Many consumers are not aware of the side effects associated with counterfeit medicines or how to identify them. Lack of education and awareness leaves consumers vulnerable to purchasing and using counterfeit drugs unknowingly. All people need medicine on a regular basis, regardless of their financial situation. Therefore, it is essential to ensure that the medications are authentic. Low-income consumers are notably more inclined to buy drugs and prescription medications from small local businesses. Falsified medication is becoming a major issue in developing nations like Bangladesh, India, Pakistan, and Latin America, as well as in far too many Middle Eastern, European, and African nations.

Many countries have inadequate regulations or enforcement mechanisms to control the sale of counterfeit medicines. This creates a conductive environment for counterfeiters to operate with impunity. The global pharmaceutical supply chain is complex and often lacks transparency. Counterfeiters exploit these vulnerabilities to introduce fake drugs into the supply chain, making it difficult to trace and intercept them.

In this past few years, blockchain has come to prominence as one of the rising technologies in today's digital world. Every pharmaceutical product that has a QR code attached ensures utmost security. Users will have access to the medication in the future at every stage from manufacture to the pharmacy bringing flexibility to all parties involved. By the usage of blockchain

technology, it will be eliminating communication problems the Pharma chain blockchain-based system can speed up order processing and guarantee the seamless functioning of dispersed businesses. By eliminating blind parties and establishing a transparent supply chain, the proposed Pharma chain can facilitate cooperative efforts and timely decision-making by providing access to data for all parties involved.The two main types of blockchain are permission-based (or private) blockchain and public blockchain. In a permission-based blockchain, only those with authorization to write or access data may contribute to it. A permission-based blockchain is a superior option in the medical field.

The traditional blockchain platforms such as Bitcoin and Ethereum offer generic functionalities suitable for a wide range of applications, customized blockchains are designed to address particular needs, preferences, or constraints of a specific organization, industry. Customized blockchains are often developed to address the unique requirements and challenges of specific industries or sectors. For example, supply chain management, healthcare, finance, logistics, real estate, and government may require customized blockchain solutions tailored to their specific needs and regulatory requirements. Permissioned blockchains provide greater control over network participants, data access, and transaction validation, making them suitable for enterprise applications where privacy and security are paramount.

II. LITERATURE SURVEY

The survey on blockchain-based studies for the pharmaceutical supply chain encompasses a variety of methodologies. Where it proposes a Private Blockchain using PBFT consensus for traceability and immutability [1] and also utilizes the Hyperledger Blockchain and Beru system for supply chain visibility [2]. In few blockchain methodologies, it integrates IoT and DAPPs with Local Blockchain for counterfeit prevention and presents a Private Blockchain-based SCM system for tracking and authentication [3] [4]. It can also be done by proposing a Private Blockchain with QR codes for tracing and authenticating medicines [5].

In [6], they utilize Ethereum Blockchain, NFTs, IoT, and IPFS for secure traceability and counterfeit prevention. An Ethereum Blockchain system with EHR, QR codes, and IPFS for medicine management and also can present a Hyperledger Fabric Blockchain model with QR codes for data verification and counterfeit drug prevention [7] [8]. In [9] they have proposed a mobile application with cryptocurrency, QR codes, and NEM Blockchain for authentication and transactions which has limitations for iOS. By using Node.js, Yeoman Generator, and QA&QC on a Private Blockchain for verification and authentication is implemented [10].

A Hyperledger private Blockchain for quality control is also used in many projects for identifying counterfeit medicine which is secure [11] and utilizes an Ethereum Blockchain DAPP with QR codes and hashing for counterfeit identification and verification [12]. [13] proposes smart contracts and EVM on Ethereum Blockchain for fake drug detection and automation which has few limitations. In [14] it presents a Hyperledger Fabric Blockchain supply chain solution with Ganache for simulation and privacy. Many of the papers and projects have used private/ Permissioned blockchain which has more advantages [15]. By implementing an Ethereum Blockchain DAPP with Web3.js and Ganache [16] for evaluating transactions and throughput and also proposes an Ethereum Blockchain MSC solution with IPFS Network for practical and reliable tracing [17].

A Blockchain supply chain solution with KNN and SVM for fake medicine prevention and accuracy which is done with both Blockchain and Deep Learning algorithm to identify the medicines [18]. In [19] they propose smart contracts and hash encryption on a permissioned Blockchain for security analysis. [20] For preventing Fake medicines it presents a cloud-based Hyperledger Fabric Blockchain solution with IPFS for efficiency and scalability.

2.1 Comparison Table

Table1: Comparison table of survey papers

Paper	Proposed Method	Type of Blockchain	Results	Advantages	Limitations
1	PBFT consensus	Private Blockchain	Probability and efficiency	Traceability, immutability	Simulation-based
2	Blockchain and Beru	Hyperledger Blockchain	Improved traceability, Secure data exchange	Enhanced supply chain visibility	Lack of government participation
3	Blockchain, IoT, DAPPs	Local Blockchain	Counterfeit prevention	Quality, Security, and data protection	Need for significant investment, privacy.
4	SCM System	Private Blockchain	Tracking, verifying, and authentication	Improved security, healthcare, and efficiency	Network congestion, Computing power
5	Blockchain, QR	Private Blockchain	Tracing and authentication of medicine	Data privacy, Location tracking	Scalability, Lack of quantitative evaluation
6	NFT, IOT, IPFS storage	Ethereum Blockchain	Secure traceability, Counterfeit prevention	Real-time tracking, Data Integrity	Cost, Complex implementation
7	EHR, QR code, IPFS	Ethereum Blockchain	Medicine reminders, Locating Pharmacies, fake medicine detection	Immutability, Patient accessibility, Medicine authenticity	Limited medicine covered,
8	Blockchain model, QR codes,	Hyperledger Fabric	Verify data, Prevent counterfeit drugs, Store records	Secure, transparent, Automated tracking, simple	Limited to official supply chain, Expensive, Security Risk
9	Mobile application, cryptocurrency, QR Code, XEM	NEM Blockchain,	Authenticate medicine, Execute transactions, Medicine purchase	Real-time tracking, User friendly, distributed	Replicable, Tamperable
10	Node JS, Yeoman Generator, QA & QC	Private Blockchain	Verification, Detection of medicines, Authentication	Accurate, Secure, immutable	Requires smartphone, Cost, Noise-sensitive
11	Blockchain, QC	Hyperledger private Blockchain	Throughput, Access control, Transaction processing	Immutable transactions, secure access, Quality control	No parallelism, centralized control

12	DAPP, QR code, Keccak256 Hashing	Ethereum Blockchain	Identify Counterfeits, Product verification, Data Integrity	Transparent, Immutable, Secure	Less Scope
13	Smart contracts, EVM,	Ethereum Blockchain	Detect fake drugs, Tamper-proof records, Automate verification	Efficient, Standardized, Flexible	Slow, Limited Scalability, Complex resource intensive
14	Supply chain, Ganache	Hyperledger Fabric Blockchain	Simulation, Privacy, 90% Accuracy	Decentralized record, Service-oriented	Limited network size, No advance technology
15	Multichain	Private / Permisioned Blockchain	Recorded drug information, Validate data	Immutable data, easy tracking	Single node simulation, limited drug types
16	DAPP, Web3.js, Ganache	Ethereum Blockchain	Transactions per second, Throughput, Capacity	Transparency, Data privacy, Conflict minimization	Network size, Performance
17	MSC, IPFS Network	Ethereum Blockchain	Practical, Anti-clone, Reliable tracing	Low cost, Cloning resistance, Customer oriented	Cost, Limited Users
18	Blockchain, KNN, SVM	Web application Supply chain	Prevention of fake medicine, Accuracy	Transparency, traceability	Storage Cost, Scalability, Accurate Data
19	Smart Contracts, Hash Encryption	Permissioned Blockchain	Successful Security Analysis	Integrity, Confidentiality, Interoperability	Cost, Scalability
20	Cloud Based Blockchain, Distributed ledger, IPFS	Hyperledger Fabric Blockchain	Efficiency, Scalable	Privacy, security, Consensus, Access control	Development of new supply chain, Extra Handling

III.METHODOLOGY

3.1 Waterfall Methodology

The Waterfall Methodology was initially proposed by W.W. Royce in 1970, but he later redesigned it, introducing an iterative approach with feedback loops between each phase. However, his criticism of the initial non-iterative model was largely overlooked, leading to the widespread adoption of the current linear Waterfall methods.

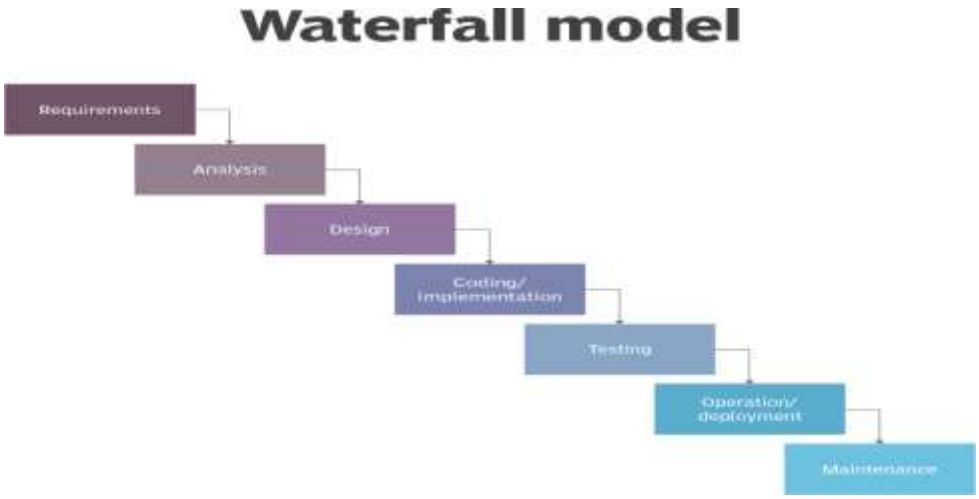

Fig 1. Waterfall model

Most modern Systems Analysts prefer not to use the Waterfall method due to its inflexible, non-iterative design process. The Waterfall method follows a sequential approach, where each phase must be completed perfectly before proceeding to the next, without any overlap or ability to go back to previous phases.

The phases of the Waterfall Methodology are as follows:

1. Requirements: The system requirements are defined and set in stone, leaving no room for changes later.
2. Design: Based on the requirements, a detailed design blueprint is created for the implementers (coders) to follow.
3. Implementation: Once the design is complete, coders implement the system according to the design specifications. Towards the end of this phase, components developed by different teams are integrated.
4. Verification or Testing: After implementation and integration, the system undergoes testing and debugging to identify and remove any faults introduced in earlier phases.
5. Installation & Maintenance: When all components are integrated, the system is installed within the company, and user training for the system begins.

The Waterfall Methodology follows a rigid, linear approach, making it challenging to accommodate changes or adapt to evolving requirements, which is a significant drawback in modern software development practices that emphasize flexibility and iterative processes

3.2 SOFTWARE IMPLEMENTATIONS

The Java Swing UI: It is used to create an Admin Page for authentication, medicine product management, QR code generation and also a User Page for authentication, product listing, QR code verification. A QR Code Verification Page for scanning/verifying QR codes using a customized blockchain implementation integrated with the UI.

The Java core application handles the blockchain implementation for generating and verifying QR codes, managing blocks, transactions, and consensus mechanisms, while also integrating with the MySQL database using JDBC for data storage and retrieval related to user information, product details, QR codes, and supply chain history.

The MySQL database stores and manages various types of data: user information for authentication and access control, product details for inventory management, QR code data generated from the blockchain implementation, and the complete supply chain history for each product, enabling traceability and verification.

The web page, developed using Java Server Pages (JSP) technology, serves as a platform for displaying comprehensive product information and supply chain history, seamlessly retrieving and presenting data from the blockchain implementation and MySQL database, providing users with a centralized view of authenticated product details and traceability records.

IV. CONCLUSION

The custom blockchain, is an open ledger accessible to multiple parties simultaneously. The fact that recorded information is difficult to alter without permission from the parties participated. The paper discusses the use of QR codes within the medical field to prevent counterfeit drugs, which can lead to significant financial losses and harm to consumers health and the reputation of pharmaceutical companies. By using this blockchain technology, a transparent and reliable system is established, allowing only authorized administrators to add medicines to the network and generate QR codes. This system enables retailers to directly request the medicines, ensuring that users are able to easily confirm the authenticity of the Medicine. The elimination of intermediaries also saves time and provides consumers with the assurance that their medication is genuine. The paper highlights the benefits of using blockchain in the healthcare sector, such as increased security, privacy, and interoperability of health data, and its capacity to transform healthcare supply chain management by providing full transparency in the shipping process.

V.RESULT

Admin has access to add the medicine. Once the medicine is added, a QR code for that particular medicine will be generated. Users can confidently verify the the authenticity of the medicine with the available QR code, that has been generated while the admin adds the medicine to the block. If the medicine has already been added to the block, then it shows that the medicine is genuine.

Fig 2. Original medicine identification

If the Medicine is not registered to the blockchain, it may be fake. In this way, Users can avoid purchasing counterfeit medicine.

Fig 3. Fake medicine identification

VI. FUTURE SCOPE

Several integration methods and improvements can enhance the security and efficiency of a custom blockchain, it could be consensus mechanism, smart contract support. In consensus mechanisms like Proof of stake, or practical Byzantine Fault Tolerence for faster transaction validation and reduced energy consumption compared to proof of work. Integrating the smart contract can help to improve the management of large transactions across multiple networks. And the security of the data will be improved when adopted for the realtime application. It should be made user friendly, by improving the availability of the QR code not only the one using smart phone but also one mostly found in rural areas who cannot afford smart phone and few uneducated people can be made by making the QR code available on the medicine box which involves the usage of the Ethereum blockchain

REFERENCES

[1] Zhu P, Hu J, Zhang Y, Li X. A blockchain based solution for medication anti-counterfeiting and traceability. IEEE Access. 2020;8:184256–72.

[2] Malshan P, Weerasinghe TDB. A proposal for a Blockchain based applicationto trace Healthcare Supply Chain across Sri Lanka. In: 2023 IEEE 8th International Conference for Convergence in Technology, I2CT 2023. Institute of Electrical and Electronics Engineers Inc.; 2023.

[3] Shalini S, Sheela S, Abhishek S, Bhavyashree P, Gunashree C, Rohan KS. An Effective Counterfeit Medicine Authentication System Using Blockchain and IoT. In: 2023 4th International Conference for Emerging Technology, INCET 2023. Institute of Electrical and Electronics Engineers Inc.; 2023.

[4] Noman MA Al, Hossain MJ, Kalimulla MM, Azad S, Wadud MAH. An Intelligent Application for Preventing the Counterfeit Medicines Through a Distributed Blockchain. In: 2021 3rd International Conference on Sustainable Technologies for Industry 40, STI 2021. Institute of Electrical and Electronics Engineers Inc.; 2021.

[5] Alam N, Hasan Tanvir MR, Shanto SA, Israt F, Rahman A, Momotaj S. Blockchain based counterfeit medicine authentication system. In: ISCAIE 2021 - IEEE 11th Symposium on Computer Applications and Industrial Electronics. Institute of Electrical and Electronics Engineers Inc.; 2021. p. 214–7.

[6] Sarkar A, Roy M. Blockchain Based Drug Supply-Chain Management System. In: OCIT 2023 - 21st International Conference on Information Technology, Proceedings. Institute of Electrical and Electronics Engineers Inc.; 2023. p. 950–6.

[7] Saibhavana A, Archana PE, Poduval VR, Pillai VA, Kumar SS. Blockchain Based Medical Records System and QR Based Medicine Validation. In: 2023 International Conference on Power, Instrumentation, Control and Computing, PICC 2023. Institute of Electrical and Electronics Engineers Inc.; 2023.

[8] Jha RK, Alam P, Priyadarshi N, Ghazi MA, Bhargavi MS. Counterfeit Drug Prevention in Pharma Supply Chain using Blockchain Technology. In: 2023 3rd International Conference on Intelligent Communication and Computational Techniques, ICCT 2023. Institute of Electrical and Electronics Engineers Inc.; 2023.

[9] Subramanian G, SreekantanThampy A, Valbosco Ugwuoke N, Ramnani B. Crypto Pharmacy – Digital Medicine: A Mobile Application Integrated With Hybrid Blockchain to Tackle the Issues in Pharma Supply Chain. IEEE Open Journal of the Computer Society. 2021 Jan 5;2:26–37.

[10] Ahmed M, Reno S, Ferdous M, Shama RM. Detection of Counterfeit Medicine Using a Private and Permissioned Blockchain. In: 2022 2nd Asian Conference on Innovation in Technology, ASIANCON 2022. Institute of Electrical and Electronics Engineers Inc.; 2022.

[11] Reno S, Chowdhury SSRA. Hyperledger Based Private Blockchain Technology in Pharmaceutical Manufacturing Industry for Preventing Substandard Drug Production. In: 2021 International Conference on Smart Generation Computing, Communication and Networking, SMART GENCON 2021. Institute of Electrical and Electronics Engineers Inc.; 2021.

[12] Medhat M, Wagih P, Mamdouh M, Ashraf K, Farid M, Abo-Alian A. Identifying Fake Products using Blockchain Technology in Supply Chain System. In: Proceedings - 11th IEEE International Conference on Intelligent Computing and Information Systems, ICICIS 2023. Institute of Electrical and Electronics Engineers Inc.; 2023. p. 470–5.

[13] Upadhyay A, Bhargava A, Kumar JS. Investigating to detect the fake medicines using blockchain technology. 2023; Available from: https://doi.org/10.21203/rs.3.rs-3003120/v1

[14] Thejaswini S, Karthik S, Roopashree BH, Trupti NK, Sushma PM. Med Secure: A Blockchain based Authenticated System for Counterfeit Medicine in DecentralizedPeer to Peer Network. In: 2021 Asian Conference on Innovation in Technology, ASIANCON 2021. Institute of Electrical and Electronics Engineers Inc.; 2021.

[15] Meyliana, Surjandy, Fernando E, Cassandra C, Marjuki. Medicine Information Record Based on Blockchain Technology. In: 2021 2nd International Conference on Innovative and Creative Information Technology, ICITech 2021. Institute of Electrical and Electronics Engineers Inc.; 2021. p. 169–73.

[16] Sivaganesan D, Kareshmmaa AS, Sharan Shankar AK, Anitha Petricia B. PharmaSafe-Blockchain-Based Counterfeit Detection in the Pharmaceutical Sector. In: Proceedings of the 2023 International Conference on

Intelligent Systems for Communication, IoT and Security, ICISCoIS 2023. Institute of Electrical and Electronics Engineers Inc.; 2023. p. 151–6.

[17] IEEE Thailand Section., Mahāwitthayālai Mahidon, Institute of Electrical and Electronics Engineers. TIMES-iCON2019 : the 4th Technology Innovation Management and Engineering Science International Conference : 11th-13th December 2019, Thailand.

[18] Shah Y, Verma Y, Sharma U, Sampat A, Kulkarni V. Supply Chain for Safe & Timely Distribution of Medicines using Blockchain & Machine Learning. In: Proceedings - 5th International Conference on Smart Systems and Inventive Technology, ICSSIT 2023. Institute of Electrical and Electronics Engineers Inc.; 2023. p. 1123–9.

[19] Gomasta SS, Dhali A, Tahlil T, Anwar MM, Ali ABMS. PharmaChain: Blockchain-based drug supply chain provenance verification system. Heliyon. 2023 Jul 1;9(7).

[20] Mani V, Prakash M, Lai WC. Cloud-based blockchain technology to identify counterfeits. Journal of Cloud Computing. 2022 Dec 1;11(1).