SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMKURU- 572103

MINI PROJECT PRESENTATION

ON

HealthLedger - Decentralized Health Insurance Claims in EHR Management System using BLOCKCHAIN

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PROBLEM STATEMENT

❑ **Manual Workflows and Intermediaries**: The current health insurance claims process is bogged down by time-consuming manual workflows and the involvement of multiple intermediaries.

❑ **Lack of Transparency and Fraud Risk**: There is a lack of transparency and vulnerability to fraud, including duplicate claims and inflated bills.

❑ **Delayed Settlements and High Costs**: Policyholders and healthcare providers face challenges such as delayed claim settlements and inflated operational costs.

❑ **Compromised Data Privacy**: The process compromises data privacy, undermining trust among stakeholders and reducing the overall customer experience.

OBJECTIVES

❑ **Automate Claim Processing:** Use smart contracts to streamline the verification, approval, and payout of claims, reducing human intervention.

❑ **Improve Fraud Detection**: Implement real-time fraud detection mechanisms to identify duplicate submissions, overbilling, and suspicious patterns.

❑ **Reduce Administrative Costs and Processing Time**: Eliminate intermediaries and minimize paperwork, reducing operational costs and accelerating claim settlements.

❑ **Facilitate Real-Time Data Access and Verification:** Integrate external healthcare systems and EHRs for seamless, real-time validation of claims and medical records.

INTRODUCTION

❑ Blockchain technology helps to create a secure, tamper-proof, immutable distributed system. Initially, blockchain was developed to overcome double-spending problems. It has evolved with time, and nowadays, blockchain is widely used in many business solutions that require distributed methods of trust management among different entities.

❑ A classical insurance system is usually dependent on a single trusted entity to verify and authenticate major transactions and information exchange. The centralized model of operation makes the system vulnerable to security attacks and performance bottlenecks. The generic insurance system requires continuous monitoring and administration. Manual maintenance makes the system prone to inadvertent and deliberate errors.

❑ Blockchain-based Smart Contract enabled distributed architecture to automate the transactions among different entities. The relevant business rules and regulations for every transaction are part of the smart contract.

LITERATURE SURVEY

Author(s)	Title	Publication Year	Remarks
Roehrs, A., da Costa, C. A., & Righi, R. R.	OmniPHR: A Distributed Architecture Model to Integrate Personal Health Records	2019	Evaluates OmniPHR's performance and highlights blockchain's role in streamlining insurance claims.
Niranjanamurthy, M., Nithya, B. N., & Jagannatha, S.	Analysis of Blockchain Technology: Pros, Cons and Future Applications	2018	Demonstrates blockchain's potential in automating insurance processes with smart contracts.

Author(s)	Title	Publication Year	Remarks
Kuo, T. T., Kim, H. E., & Ohno-Machado, L.	Blockchain Distributed Ledger Technologies for Biomedical and Health Care Applications	2017	Focuses on using blockchain to prevent healthcare fraud and enhance data integrity.
Ganne, E., & Seshadri, N.	The WTO and Blockchain: Opportunities and Challenges	2019	Shows blockchain's impact on operational efficiency and cost reduction in insurance claims.

Author(s)	Title	Publication Year	Remarks
Chen, X., Zhang, J., & Xu, Q.	Blockchain and Smart Contracts: Enhancing Healthcare and Insurance Claims processes	2021	Explores smart contracts to automate health insurance claims and reduce manual intervention.
Sharma, P., & Zhang, L.	Blockchain-Based Processing of Health Insurance Claims for Prescription Drugs	2023	Focuses on blockchain to secure and streamline prescription drug claims processing.

Author(s)	Title	Publication Year	Remarks
Kamran, M., Khan, S., & Khan, I.	Blockchain and IoT-Based Framework for Healthcare Interoperability	2021	Combines blockchain and IoT for improved interoperability in health insurance claims.
Krawiec, R. J.	Blockchain: Opportunities for Health Care	2018	Examines blockchain's potential in enhancing privacy and security in healthcare systems.

SYSTEM ARCHITECTURE
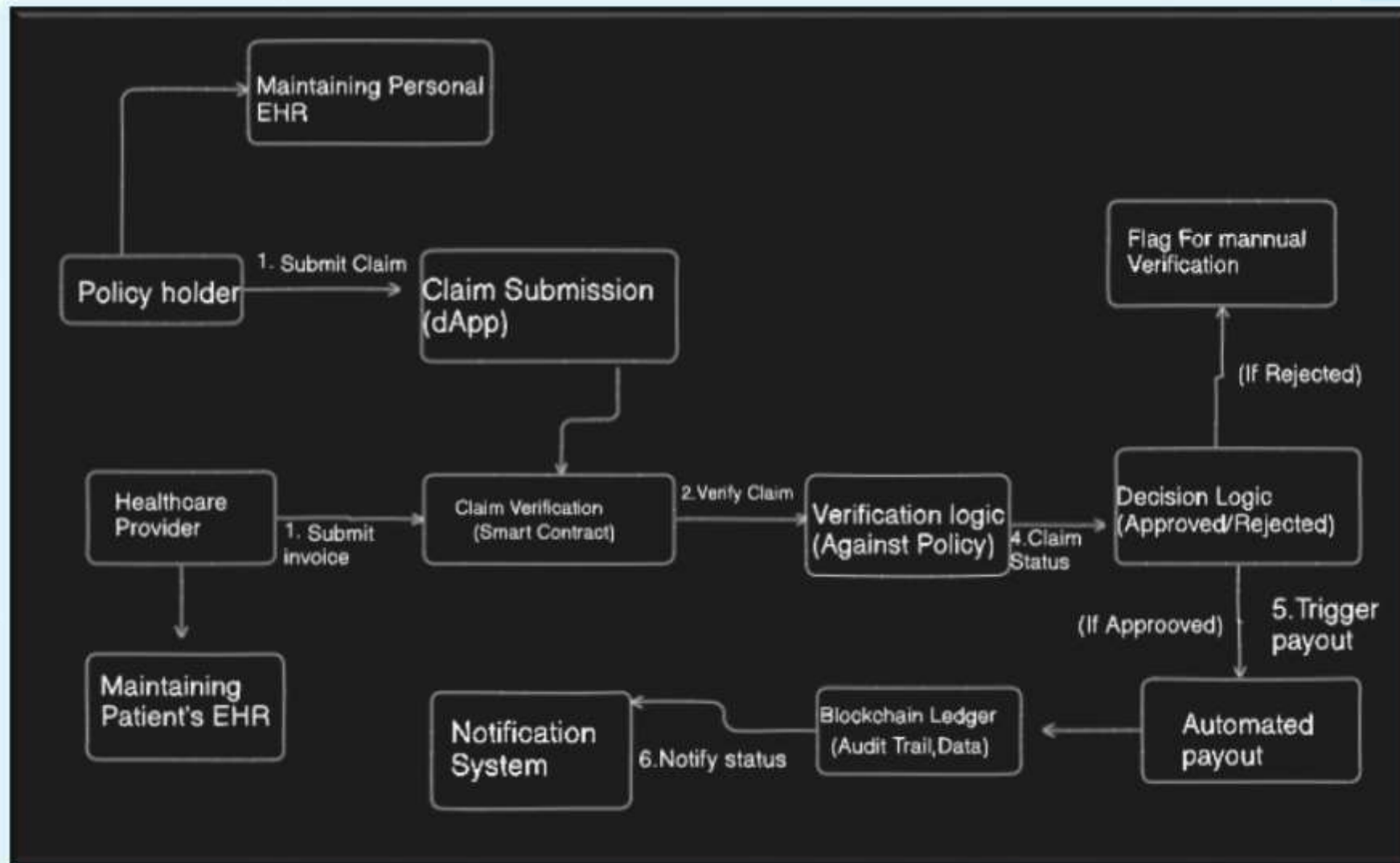
User Interfaces:

o **Web Portal**: Used by policyholders to submit claims, track claim status, and access insurance details.

o **Provider Dashboard**: Doctor submit treatment details and bills directly.

o **Insurance Admin Panel**: Insurers monitor claims, approvals, and policy details.

Blockchain Layer (Decentralized Ledger):

o **Public Blockchain**: Maintains an immutable ledger of all claims, payments, and policy transactions.

o **Consensus Mechanism:** (e.g., Proof of Authority) ensures trusted validation of transactions.

Smart Contract Layer:

o **Claims Fraud Prevention:** Validates claim data with EHR records to prevent duplicates and ensures each unique event triggers only one claim.

o **Identity and Eligibility Fraud:** Uses decentralized identity systems (Adhaar) and biometrics to authenticate patients, allowing only eligible individuals to access benefits.

o **Phantom Billing Fraud :** Requires patient and provider confirmation, using timestamps and location data to ensure services were provided.

o **Automatic Payment Trigger for Claims**: Releases funds via an escrow contract upon successful claim validation, reducing processing time and manual intervention when claims are approved.

Integration Layer:

o **Electronic Health Record (EHR) System Integration:** Validates treatment details with external healthcare systems via APIs.

o **Fraud Detection Algorithms:** Monitors transactions for anomalies and suspicious patterns (rule-based fraud detection algorithm with linear search).

Database Layer:

o **Off-Chain Storage:** Stores large data (e.g. are scanned medical documents) outside the blockchain to enhance scalability.

o **IPFS or Cloud Storage:** Links to blockchain with secure references (e.g., cryptographic hashes).

Workflow of the Proposed System:

Claim Submission:

o Policyholders or healthcare providers submit a claim through the web or mobile portal. The claim includes details such as policy ID, treatment type, bill amount etc...

Smart Contract Execution:

o The smart contract automatically verifies the claim based on:
- ♣ Policy coverage and eligibility.
- ♣ Patient's history from linked EHR systems.

Consensus and Ledger Update:

o Once the claim passes smart contract checks, the blockchain's consensus mechanism verifies the transaction and adds it to the immutable ledger.

SOFTWARE REQUIREMENTS / TECHNOLOGY STACK

Blockchain Platform:

o **Ethereum**: A popular choice due to its mature ecosystem, smart contract capabilities, and large developer community.

Smart Contract Language:

o **Solidity:** The primary language for developing smart contracts on the Ethereum platform.

Frontend Development:

o **ReactJs:** A popular JavaScript library for building user interfaces, ideal for creating intuitive and responsive web applications.

Backend Development:

o **Node.js:** A JavaScript runtime environment for building server-side applications, providing a non-blocking, event-driven architecture.

Database:

o **MongoDB:** A flexible NoSQL database for storing unstructured and semi structured data, like medical records and insurance policies.

o **IPFS pinata:** IPFS with Pinata ensures decentralized, secure, and persistent file storage for applications, making it ideal for managing sensitive data in blockchain ecosystems.

Additional Tools and Libraries:

o **Ganache:** A personal blockchain for testing smart contracts locally.

o **HardHat:** HardHat is a development environment and framework for building, testing, and deploying Ethereum-based smart contracts, offering tools like debugging, scripting, and local blockchain simulation.

o **MetaMask:** MetaMask is a browser-based cryptocurrency wallet and gateway to Ethereum-based dApps, enabling users to securely store private keys, interact with smart contracts, and manage blockchain transactions.

o **Ether.js:** Ether.js is a lightweight, JavaScript library designed for interacting with the Ethereum blockchain, providing tools to send transactions, read smart contract data, and manage wallets, all with a user-friendly API.

PROJECT SCHEDULING

Week	Tasks Completed	Details/Features Implemented
Week 1 (Oct 16 - 22, 2024)	Project Initiation & Planning	Conceptualized the health insurance claims platform. Decided on tech stack: Solidity, Web3.js/Ethers.js, Ganache, Alchemy.
	UI Design	Designed initial layout for admin and insurer dashboards.
Week 2 (Oct 23 - 29, 2024)	Admin Dashboard Development	Developed the admin dashboard for managing policies, users, claims, reports, compliance, and settings.
	Insurer Dashboard Development	Created the insurer dashboard for handling insurance claims.
Week 3 (Oct 30 - Nov 5, 2024)	Patient Dashboard UI Design	Started working on the patient dashboard, including profile overview, health summary, claim status, document management, and claim filing features.
	Authentication Implementation	Integrated JWT authentication with bcrypt for secure login and signup.

Week	Tasks Completed	Details/Features Implemented
Week 4 (Nov 6 - 12, 2024)	Blockchain Integration (Smart Contract Development)	Developed Solidity smart contracts for health insurance claim processes.
	Testing & Debugging Contracts	Conducted tests on smart contracts using Ganache and integrated them with the existing system.
Week 5 (Nov 13 - 19, 2024)	Blockchain Integration for Claims	Integrated blockchain-based health insurance claims processing into the UI.
Week 6 (Nov 20 - 26, 2024)	Patient Dashboard Development	Continued development of the patient dashboard, focusing on claim filing and document management.
Week 7 (Nov 27 - Dec 3, 2024)	Final Testing & Debugging	Final round of testing for all features (patient dashboard, claim filing, report management).

Week	Tasks Completed	Details/Features Implemented
Week 8 (Dec 4 - 10, 2024)	Deployment	Deployed the full system to the production environment for live testing and user feedback.
Week 9 (Dec 11 - 13, 2024)	Final Adjustments & Review	Final tweaks, adjustments, and documentation updates based on user feedback.

DEMONSTRATION
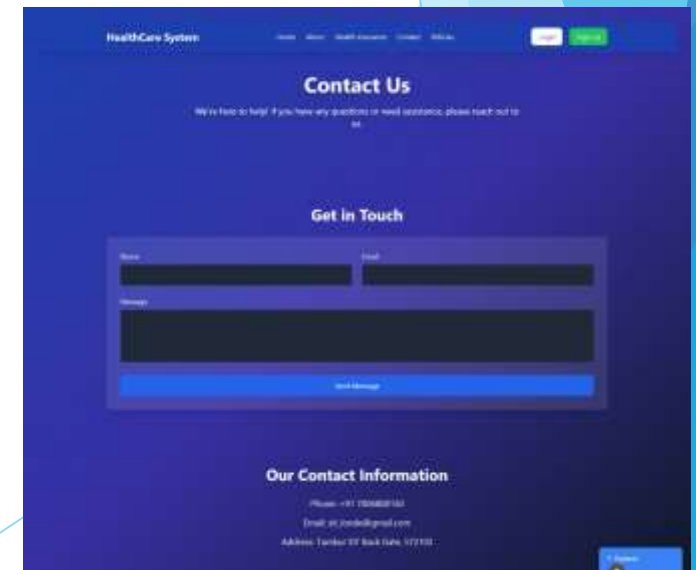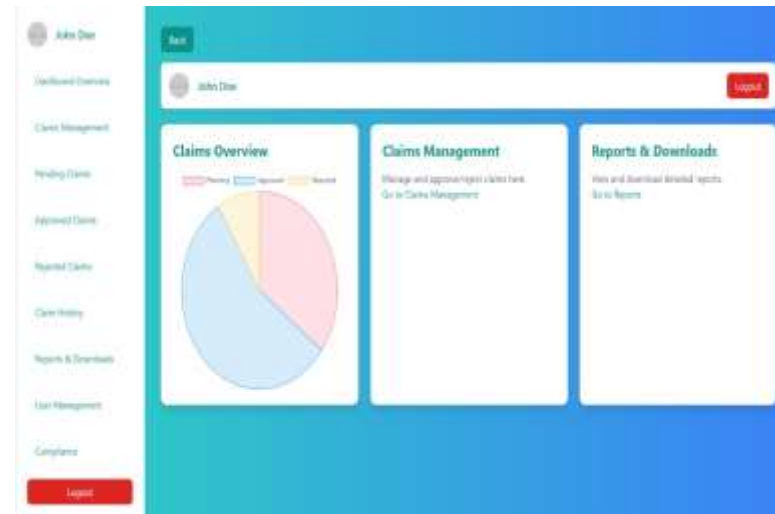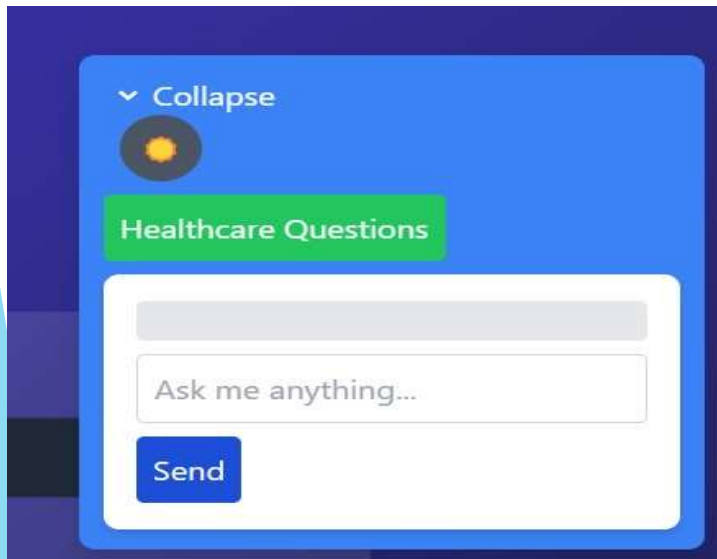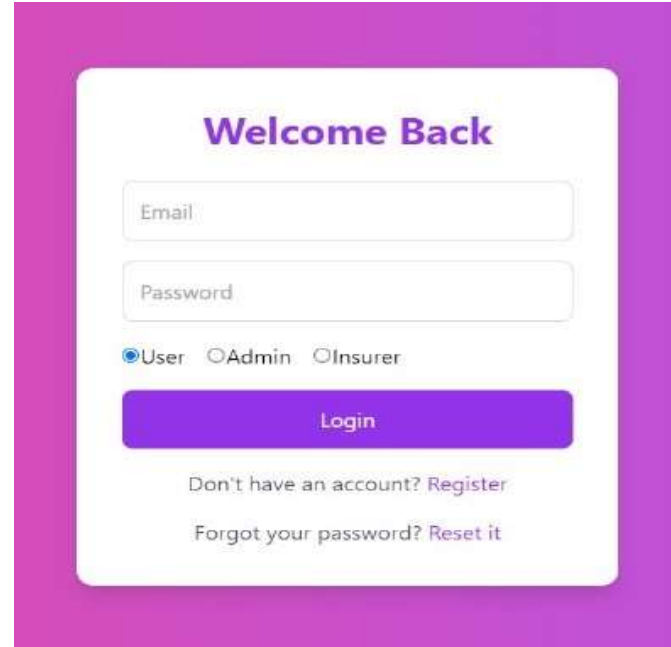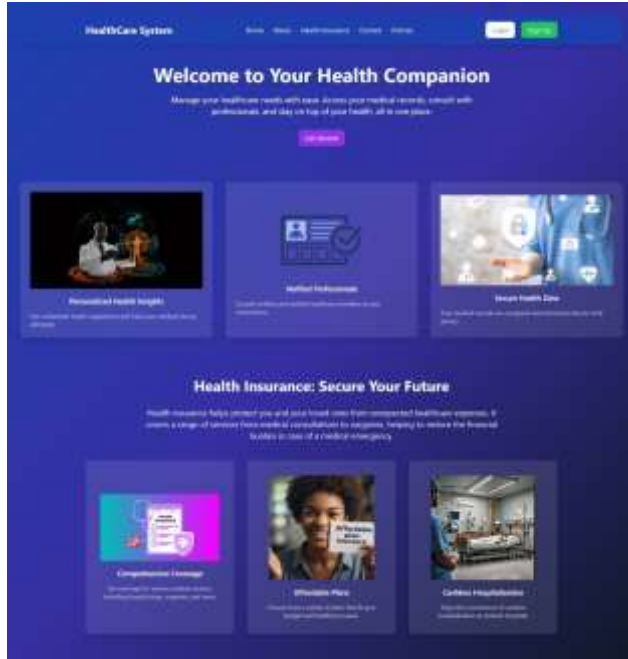
Submit a Claim

Connect MetaMask Wallet

Doctor Name

Patient Name

Doctor ID

Patient ID

Diagnosis

Treatment

Claim Amount

Report (PDF only)

Choose File | No file chosen

Submit Claim

Check Claim Status

Claim Submission Process:

o **Connect MetaMask Wallet:** The user connects their MetaMask wallet to integrate their blockchain identity for secure claim submissions.

o **Enter Claim Details:** The user fills in the claim form with details such as doctor and patient names, IDs, diagnosis, treatment, and claim amount.

o **Attach Supporting Documents:** The user uploads relevant documents (e.g., PDF reports) to support the claim.

o **Submit the Claim:** After completing the form, the user clicks "Submit Claim" to record the claim on the blockchain and send it to the insurance provider.

o **Check Claim Status:** The user can track the progress of their claim by clicking "Check Claim Status."

Claim Status Tracking:

o **Access Claim Status:** Users can visit the "Track Claim Status" section to view their submitted claims.

o **View Claim Details:** The system displays a table with key details: Claim ID, Policy Number, Current Status, Submission Date, Transaction Hash, and Available Actions.

o **Understand Claim Status:** The "Status" column shows the claim's current state (e.g., "under review", "Transaction Pending", "Processed").

o **Monitor Blockchain Transaction:** The "Transaction Hash" provides a unique ID to track the claim's progress on the blockchain explorer.

o **Take Necessary Actions:** Based on the claim status, users can take actions like "Approve", "Reject", or "Request More Info".

o **Delete Claim Records:** Users can remove outdated claims using the "Delete" action.

Claim Status Progress

Claim Status Progress

Week 1 Week 2 Week 3 Week 4

Claim Submissions Per Month

Claims Submitted

January February March April May June

Recent Activities

Track Claim Status

View and track the status of your insurance claims here.

Claim ID	Policy Number	Status	Submission Date	Transaction Hash (Chain ID)	Actions
f790212f-da31-45cb-a25b-284bfae8e27c	N/A	under review	2024-12-07T12:57:48.784Z	N/A	Delete
20fb721c-c32e-41cd-ae40-1f77c5aa9133	N/A	under review	2024-12-08T07:11:46.791Z	N/A	Delete
00f18e24-09d0-4d4b-904f-5fe50ffaa328	N/A	under review	2024-12-08T07:14:18.126Z	N/A	Delete
bb063d9b-84cf-408f-87b6-ede7c7412596	N/A	under review	2024-12-12T09:12:07.806Z	N/A	Delete
bd386738-3d37-4ab7-be27-773194f371d5	N/A	under review	2024-12-12T09:24:53.022Z	N/A	Delete
	N/A	under	2024-12-	N/A	Delete

Approved Claims Overview:

1.View Approved Claims: The "Approved Claims" section displays claims that have been approved, showing key details like Claim Amount, Insurer Contribution, Patient Responsibility, and Payment Status.

2.Audit Trail: Each approved claim includes an "Audit Trail" tracking events like Claim Approval Date and Payment Initiation Date, offering a comprehensive record of the claim's lifecycle.

3.Mark as Processed: After payment completion, users can mark the claim as "Processed," indicating the claim is fully addressed.

4.Transparency and Accountability: The section provides transparency by detailing the claims process and payment actions, ensuring accountability.

Block Information:

o **Block 34:** Transaction included and validated in Block 34 on the blockchain.

o **Mining Timestamp:** Mined on December 13, 2024, at 18:05:49.

o **Gas Usage:** 1,788,854 gas units used for the transaction.

o **Single Transaction:** Only one transaction recorded in this block.

APPLICATIONS

Government Applications:

❑ **National Health Insurance Platforms:** Utilize blockchain for secure, automated claims processing.

❑ **Public Healthcare Systems:** Integrate EHR systems with insurance platforms

Healthcare Industry:

❑ **Electronic Health Record (EHR) Systems:** Integrate with insurance platforms for seamless data exchange.

❑ **Hospital Management Systems:** Utilize blockchain for secure billing and payment processing.

❑ **Clinical Trial Management:** Implement smart contracts for automated trial participant eligibility checks.

❑ **Telemedicine Platforms:** Integrate with insurance platforms for streamlined billing.

CONCLUSION

The integration of blockchain technology into the health insurance claims process offers several advantages, including:

❑ Faster claim settlements.

❑ Reduced fraud and administrative costs.

❑ Enhanced transparency and security for all stakeholders.

Blockchain ensures trust, accuracy, and efficiency, providing an effective solution to current inefficiencies in the health insurance claims process.

REFERENCES

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3. http://www.computer.org/csdl/proceedings-article/blockchain/2021/17600a055/1AqxBfKSwec

4. https://link.springer.com/article/10.1007/s10916-019-1468-1?fromPaywallRec=false

5. https://link.springer.com/article/10.1007/s10916-018-0996-4