TRANSPARENT SALES TRACKING FOR MALL RENT VIA BLOCKCHAIN

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING

Use Case Report

submitted by

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Kanuru, Vijayawada-520 007

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CERTIFICATE

This is to certify that the Use Case report entitled **" TRANSPARENT SALES TRACKING FOR MALL RENT VIA BLOCKCHAIN"** that is being submitted by **INNAMURI SRI NAGA VENKATA RAJA (22501A0567)**, as part of Assignment-1 and Assignment-2 for the **BLOCKCHAIN TECHNOLOGY(20CS4601C)** course in **3-2** during the academic year **2024-25**.

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1. INTRODUCTION

1.1. Overview of Blockchain Technology

Blockchain technology is a decentralized and distributed ledger system that records transactions across multiple nodes, ensuring transparency, security, and immutability. Unlike traditional databases, blockchain operates on a peer-to-peer network, eliminating the need for central authorities. Each block in the chain contains a cryptographic hash of the previous block, making data tampering virtually impossible. Originally designed for cryptocurrency transactions, blockchain has now expanded into various domains, including finance, supply chain, healthcare, and digital warranty management. [4]

1.2. Relevance of Blockchain in Transparent Sales Tracking For Mall

Integrating blockchain technology into mall operations significantly enhances transparency and efficiency in item tracking and rent calculation. By recording each product's journey on an immutable ledger, blockchain ensures real-time visibility into the supply chain, allowing retailers to monitor goods from production to delivery. This heightened transparency helps detect inefficiencies, reduce fraud, and ensure compliance with regulations.[1]

In the context of rent calculation, blockchain facilitates a paradigm shift by automating processes through smart contracts. These contracts can automatically calculate invoices based on real-time shipping data and issue payments, ensuring that amounts paid are based on a single source of truth. This automation reduces disputes and enhances trust between mall owners and retailers.[2]

Furthermore, blockchain's decentralized nature enhances security by providing tamper proof records of all transactions. This ensures that data is secure and transparent, reducing the need for intermediaries and lowering operational costs. By integrating blockchain into supply chain management, businesses can streamline operations, cut costs, and enhance trust among stakeholder. Overall, adopting blockchain technology in mall operations not only improves item tracking and rent calculation but also fosters a more transparent, efficient, and secure retail environment.[3]

2. BACKGROUND

Mall owners rely on retailers to report their sales accurately for rent calculation. However, retailers often underreport their revenue to reduce rent, creating a trust gap. Additionally, traditional inventory tracking methods lack transparency, making it difficult to verify stock movement within the mall. A blockchain-based system can solve these issues by providing real-time, immutable, and verifiable transaction records. [5]

2.1. Importance of Transparent Item Tracking

Retailers receive goods from suppliers, and without proper tracking, inventory discrepancies and fraud can occur. Blockchain ensures every product entry, sale, and movement is recorded on a tamper-proof ledger. This helps mall owners monitor inventory, detect fraudulent practices, and ensure fair business operations. [3]

2.2. Blockchain for Fraud Prevention in Rent Calculation

One of the biggest challenges in mall management is ensuring retailers pay rent fairly based on actual sales. Blockchain-powered smart contracts automate rent calculation, ensuring payments are based on verified sales data. Since transactions are immutable and customer-verified, retailers cannot manipulate revenue reports to reduce their rent. [5]

2.3. Customer Verification for Sales Transparency

A key feature of this system is customer verification. When a customer makes a purchase, they confirm the transaction on the blockchain, ensuring that sales data is accurate and tamper-proof. This eliminates the risk of retailers claiming to sell at a loss while actually making a profit. The customer has no incentive to falsify transaction data, making this method highly reliable. [3]

2.4. Smart Contracts for Automated Rent Collection

Blockchain automates rent payments using smart contracts. When a sale is verified, the smart contract calculates the exact rent percentage owed and processes payments instantly. This removes manual errors, reduces disputes, and ensures fair rent collection. [5]

2.5. Security & Trust in Mall Operations

Blockchain eliminates data tampering, unauthorized stock movement, and rent fraud. Since the ledger is decentralized and secure, neither the mall owner nor the retailers can alter records without consensus. This builds trust between all parties and ensures seamless, fraud-free mall management. [3]

2.6. Eliminating Manual Audits and Discrepancies

Traditionally, mall owners rely on manual audits and financial reports from retailers to calculate rent. This process is time-consuming, prone to manipulation, and inefficient. Blockchain eliminates the need for manual audits by maintaining a decentralized, real-time ledger of all transactions, ensuring accurate, dispute-free rent calculations. [5]

2.7. Enhancing Supplier and Inventory Transparency

Malls often have multiple suppliers delivering stock to retailers. Without a proper system, stock discrepancies, theft, and fake invoicing can occur. Blockchain allows end-to-end tracking of each product, ensuring that only authorized goods are received, stored, and sold. This transparency prevents stock fraud and ensures suppliers, retailers, and mall owners have aligned inventory data. [3]

2.8. Improving Customer Trust and Engagement

Customers today demand transparency in pricing and authenticity of goods. A blockchain-based system enables customers to verify product authenticity, purchase history, and fair pricing by scanning a product's blockchain record. This not only enhances trust but also encourages customer participation in the verification process, further strengthening fraud prevention. [5]

2.9. Real-Time Insights for Mall Management

A blockchain-powered system enables real-time tracking of sales trends, inventory levels, and rent payments, allowing mall owners to make data-driven decisions. These insights help in:

- Optimizing store placements based on sales data
- Identifying underperforming retailers for better space allocation
- Ensuring fair rent distribution among tenants

By leveraging real-time analytics, malls can improve operational efficiency and maximize revenue. [3]

2.10. Reducing Operational Costs and Middlemen

In traditional mall operations, multiple intermediaries (accountants, auditors, payment processors) are involved in managing inventory, sales reporting, and rent calculation. Blockchain removes the need for intermediaries by providing an automated, trustless system where transactions are verified in real-time, reducing operational costs and increasing financial efficiency. [5]

3. BLOCKCHAIN BASICS

Blockchain technology is a distributed ledger system that ensures secure, transparent, and tamper-proof transactions. It eliminates the need for intermediaries, enabling trustless peer-to-peer interactions. Below are the key concepts that define blockchain technology:

3.1. Decentralization

Traditional databases are controlled by centralized authorities like banks or corporations, creating a single point of failure. Blockchain operates on a decentralized network, where multiple nodes validate and store the data. This ensures:

- No single entity has full control over the system.
- **Greater security**, as hacking one node doesn't compromise the entire network.
- **Transparency**, as all participants can verify transactions. [6]

3.2. Immutability

Once a transaction is recorded on the blockchain, it cannot be altered or deleted. This is achieved through:

- **Cryptographic hashing**, where each block links to the previous one, forming a secure chain.
- **Consensus mechanisms**, ensuring all network participants agree before adding data.
- **Fraud prevention**, as tampering with one block would require modifying all subsequent blocks, which is computationally infeasible. [7]

3.3. Transparency

Blockchain transactions are publicly verifiable, meaning anyone can audit them. Transparency is ensured by:

- **Distributed ledger technology (DLT)**, where every participant has access to the same data.
- **Open access** in public blockchains like Bitcoin and Ethereum, ensuring fairness.
- **Reduced corruption**, as records cannot be manipulated without detection. [6]

3.4. Smart Contracts

Smart contracts are self-executing contracts embedded in the blockchain. They automatically execute transactions when conditions are met, providing:

- **Automation**, eliminating the need for intermediaries.
- **Trustless execution**, reducing fraud and disputes.
- **Cost reduction**, as manual processing is minimized. [6]

3.5. Consensus Mechanisms

Blockchain networks use consensus algorithms to validate transactions and maintain integrity. Common methods include:

- **Proof of Work (PoW):** Miners solve cryptographic puzzles to confirm transactions (e.g., Bitcoin).
- **Proof of Stake (PoS):** Validators are chosen based on the number of tokens they hold (e.g., Ethereum 2.0).
- **Delegated Proof of Stake (DPoS):** A small group of elected nodes verify transactions, improving efficiency. [7]

3.6. Cryptographic Security

Blockchain relies on advanced cryptography to secure data and ensure user anonymity. This includes:

- **Public and private keys**, which authenticate users and sign transactions.
- **Hash functions**, converting data into fixed-length unique codes for integrity.
- **Encryption**, protecting sensitive information from unauthorized access. [6]

3.7. Tokenization

Blockchain enables tokenization of assets, allowing digital representation of physical goods, services, and ownership rights. Key aspects include:

- **Fungible tokens (FTs):** Identical and interchangeable (e.g., cryptocurrencies like Bitcoin).
- **Non-Fungible Tokens (NFTs):** Unique digital assets representing ownership (e.g., collectibles, digital warranties).
- **Transferability**, allowing resale and verification of digital warranties.[6]

3.8. Scalability

Blockchain scalability refers to its ability to handle increasing transaction loads efficiently. Challenges include:

- **Transaction speed**, as some blockchains process only a few transactions per second (e.g., Bitcoin).
- **Network congestion**, causing delays and higher fees.
- **Layer-2 solutions**, like the Lightning Network and sharding, improving scalability.[7]

These fundamental blockchain principles make it secure, transparent, and efficient, enabling applications in finance, healthcare, supply chains, and digital warranties.

4. USE CASE OVERVIEW

The Blockchain-Based Mall Item Tracking & Rent Calculation system ensures transparent, fraud-proof retail operations by recording sales and inventory on an immutable ledger. Retailers' rent is automatically calculated through smart contracts based on verified sales, preventing revenue underreporting. Customer-verified transactions enhance trust, ensuring fair rent payments and accurate inventory tracking.

4.1. Objectives

The primary objective of this use case is to enhance transparency and fairness in mall operations by leveraging blockchain technology for item tracking and rent calculation. Traditional mall management relies on retailers to report sales, which can lead to fraudulent underreporting to reduce rent payments. By implementing blockchain, all transactions are immutable and verifiable, ensuring accurate revenue-based rent collection. [5]

A key goal of this system is to prevent fraud in rent payments. Retailers often claim losses or manipulate sales data to pay lower rent, making it difficult for mall owners to enforce fair rent policies. By using customer-verified blockchain transactions, sales data becomes tamper-proof, and smart contracts can automatically calculate and enforce rent payments based on actual sales. This eliminates disputes and ensures equitable revenue-sharing between mall owners and retailers. [3]

The use case also aims to empower customers with transaction verification capabilities. When a customer purchases an item, they verify the transaction on the blockchain, ensuring that retailers cannot alter sales data. Since customers have no incentive to manipulate purchase amounts, their validation acts as an authentic proof of transaction, making fraud impossible. This builds trust and accountability in mall operations. [3]

Another major objective is to automate rent payments using smart contracts. Instead of relying on manual calculations and financial reports, blockchain-powered smart contracts calculate and deduct rent based on pre-agreed terms and verified sales. This reduces administrative workload, prevents delays, and ensures accurate rent distribution, benefiting both mall owners and retailers. [5]

Additionally, this system aims to eliminate intermediaries and reduce operational costs. Traditional mall operations require auditors, accountants, and legal teams to track sales and resolve disputes. Blockchain automates record-keeping and contract enforcement, reducing the need for intermediaries, saving time, and lowering operational expenses. This makes mall management more efficient and cost-effective. [3]

4.2. Scope of the System

The blockchain-based warranty system focuses on securing, managing, and transferring digital warranties. The system includes:

4.2.1. Sales Transaction Verification

- Every sale made by a retailer is **recorded on the blockchain**, ensuring that all transactions are immutable and cannot be manipulated.

4.2.2. Automated Rent Calculation and Payment

- Smart contracts automatically calculate rent based on sales data, ensuring fair payment without the need for manual intervention

4.2.3. Customer Participation and Transparency.

- Customers validate transactions, ensuring **retailers cannot alter the actual purchase amounts**.

4.2.4. Operational Cost Reduction

- **Reduces reliance on** auditors, accountants, and legal teams **by automating** sales verification and rent calculations

4.2.5. Operational Cost Reduction

- Reduces reliance on auditors, accountants, and legal teams by automating sales verification and rent calculation

4.2.6. Scalability and Multi-Mall Integration

- The system is scalable and can be implemented across multiple malls and retail centers.
- Can be adapted to different rental models and sales tracking methods based on business needs.

4.3. System Architecture

The architecture of the Blockchain-Based Digital Warranty System consists of the following components:

4.3.1. User Layer (Front-End Web/Mobile Interface)

The User Layer provides an interface for stakeholders to interact with the system via a web-based application or mobile app.
Key Components:

- Retailer Dashboard → Displays sales transactions and automated rent calculations.
- Mall Owner Dashboard → Provides real-time visibility into retailer revenues and rent payments.
- Customer Interface → Allows customers to verify transactions and confirm purchases.
- Authentication & Access Control → Secure login using OAuth, biometrics, or Web3 wallets (e.g., MetaMask, WalletConnect).

4.3.2. Application Layer (Smart Contracts & Business Logic)

- The Application Layer contains the core business logic, executed through smart contracts to handle rent calculations and transaction validation. User Interface:

Key Functionalities:

- **Smart Contracts for Rent Payment** → Automates rent collection based on retailer sales.
- **Transaction Validation** → Ensures customer-verified transactions before updating revenue records.
- **Dispute Resolution System** → Handles discrepancies between reported and actual sales.

4.3.3 Blockchain Layer (Decentralized Ledger & Security Mechanisms)

The Blockchain Layer is the core of the system, ensuring that transactions and rent payments are securely recorded and immutable.
Key Components:

- **Blockchain Network** → Ethereum, Binance Smart Chain (BSC), Polygon, or Hyperledger Fabric.
- **Consensus Mechanism** → Proof of Stake (PoS) or Practical Byzantine Fault Tolerance (PBFT) for private chains**.**
- **Decentralized Ledger** → Stores all transactions, ensuring tamper-proof data**.**
- **Smart Contract Execution** → Automates rent payments and sales validation.

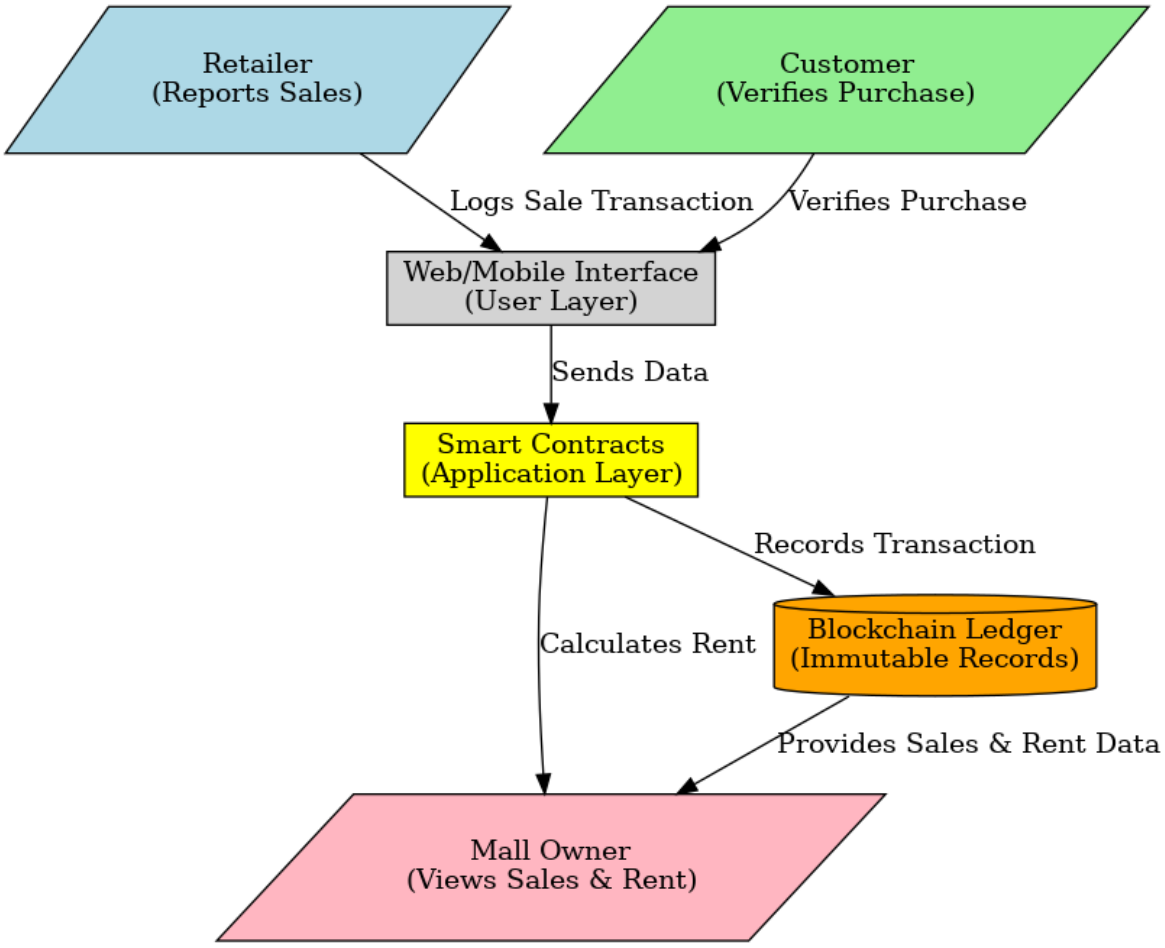

Figure 4.3.4: Architecture based on blockchain-enabled sales tracking, customer verification, and automated rent calculation using smart contracts.

As per the figure 4.3.4 the Blockchain-Based Retail Rent Calculation System ensures transparency, accuracy, and automation in tracking sales and calculating rent for retailers in a mall. Retailers log their sales through a web/mobile interface, while customers validate their purchases, preventing fraudulent reporting. Smart contracts process these transactions, automatically calculating rent based on verified sales data and storing records on an immutable blockchain ledger. The mall owner can access real-time sales and rent data, ensuring fairness and efficiency. This system eliminates manual errors, reduces disputes, and enhances trust among stakeholders, making mall operations more secure and transparent.

By leveraging blockchain technology, this system enhances data integrity and security, ensuring that all transactions are tamper-proof and auditable. The smart contract layer automates rent calculation, eliminating the need for intermediaries and reducing operational costs. Additionally, the customer verification mechanism prevents retailers from underreporting sales, fostering a fair and accountable ecosystem. With seamless access to real-time data, mall owners can make informed decisions, while retailers benefit from a transparent and dispute-free rent system. This approach streamlines financial operations, builds trust, and promotes efficiency in mall management.

5.IMPLEMENTATION

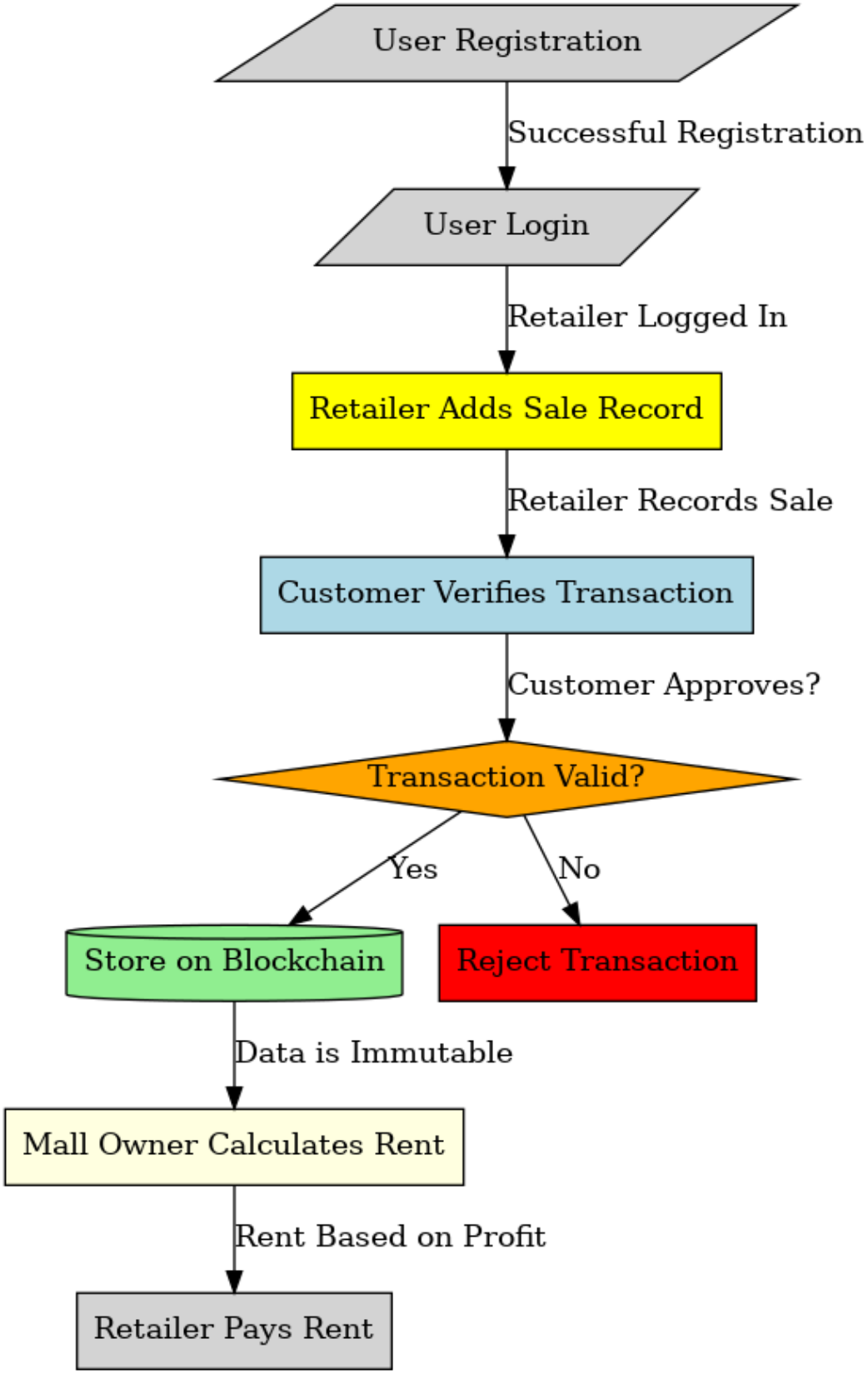

Figure 5.1: Workflow of Blockchain based Digital Warranty System

As per the figure shown in 5.1 the implementation description is as follows

5.2 Implementation of Blockchain-Based Mall Sales Tracking & Rent Calculation System

Frontend Implementation:
User Registration & Login

- Web/Mobile UI: Developed using React.js (Web) or Flutter (Mobile).
- User Roles: Retailers, customers, and the mall owner.
- Authentication:
    - Users register with email, phone number, and blockchain wallet address.
    - Login is managed using Metamask or WalletConnect (for blockchain integration).

5.2.1 Retailer Adds Sale Record

Frontend Implementation:

- Retailers enter product details, quantity, and price into a dashboard.
- Transactions are signed using Metamask/Ethers.js to prevent tampering.

Smart Contract Implementation:

- Solidity-based Smart Contract tracks sales on Ethereum/Polygon.
- The contract includes:
    - addSaleRecord(saleID, amount, timestamp, retailerAddress): Stores each sale.
    - getSalesByRetailer(retailerAddress): Retrieves all sales of a retailer.
    - storeTransaction(saleID, hash): Links off-chain and on-chain data.

Blockchain Storage:

- IPFS/Filecoin stores large off-chain data (e.g., digital receipts).
- Each sale has a unique cryptographic hash recorded on-chain.

5.2.2 Customer Verifies Transaction

Frontend Implementation:

- Customers can scan a QR code (linked to the sale).
- Verification is done through a Web3-enabled interface.
  Smart Contract Implementation:
- verifyTransaction(saleID, customerAddress):
    - The customer confirms the purchase.
    - If valid, the sale gets finalized.
    - If not, it’s flagged for review.
    -

Blockchain Storage:

- Once a customer verifies a sale, the transaction is marked immutable in the ledger.

5.2.3 Transaction Validation & Storage

Smart Contract Implementation:

- If the customer approves, the smart contract:
  - Writes transaction details to Ethereum/Polygon blockchain.
  - Updates the retailer's total revenue records.
- If not verified, the transaction is rejected and flagged as fraud.

Blockchain Storage:

- Valid transactions are recorded on-chain.
- Fraudulent transactions are excluded from rent calculation.

5.2.4 Rent Calculation by Mall Owner

Smart Contract Implementation:

- A dedicated smart contract calculates rent:
  - calculateRent(retailerAddress): Fetches total verified sales.
  - Applies a fixed percentage formula on profits.
- getDueRent(retailerAddress): Returns the retailer's rent due.

Backend Processing:

- Smart contract data is fetched via Web3 API.
- Rent summaries are displayed on the mall owner's dashboard.

5.2.5 Payment Processing

Frontend Implementation:

Retailers receive rent invoices via the mall's portal.

Payments are made using cryptocurrency (USDC, ETH, or stablecoins) or traditional banking.

Smart Contract Implementation:

- payRent(retailerAddress, amount):
  - Retailers pay rent using crypto transactions.
  - The smart contract updates the mall's financial records.
- Non-payment results in restricted access for the retailer.

This implementation process ensures secure, tamper-proof, and automated rent calculations for mall retailers, preventing fraud. Blockchain & smart contracts eliminate rent manipulation, making mall management transparent & fair.

6. BENEFITS

6.1 Prevents Retailer Fraud

- Ensures that retailers cannot manipulate sales data to reduce their rent.
- Transactions are verified by customers and stored on an immutable blockchain.

6.2 Transparent Rent Calculation

- The mall owner gets real-time access to accurate retailer sales data.
- Rent is calculated fairly based on actual profits.

6.3 Customer Trust & Engagement

- Customers actively verify transactions, ensuring genuine sales reporting.
- Incentives can be given for verification, increasing customer participation.

6.4 Eliminates Manual Record-Keeping

- Automates rent collection, reducing paperwork & human errors.
- Smart contracts handle all calculations and enforce rent payments.

6.5 Immutable & Secure Data Storage

- Sales records are tamper-proof as they are stored on blockchain.
- Cybersecurity risks & data breaches are minimized compared to traditional databases.

6.6 Reduces Disputes Between Mall & Retailers

- Clear, transparent records prevent arguments over sales reports.
- Automated smart contract execution ensures no favoritism or manipulation.

6.7 Faster & Efficient Rent Collection

- Retailers can pay rent via cryptocurrency instantly, avoiding banking delays.
- The system ensures timely payments and can enforce penalties for non-payment.

6.8 Prevents Retailer Fraud & Ensures Transparency

- Retailers cannot manipulate sales data to reduce their rent.
- Transactions are verified by customers and immutably stored on the blockchain.

6.9 Automated & Fair Rent Calculation

- Rent is calculated based on actual verified sales, eliminating disputes.
- Smart contracts automate the process, ensuring accuracy and timely payments.

7. CHALLENGES

7.1 Customer Participation in Transaction Verification

- Customers may forget or refuse to verify purchases, affecting the accuracy of retailer sales data.
- Incentives may be required to encourage participation.

7.2 Retailer Resistance to Transparency

- Some retailers may hesitate to adopt the system due to fear of exposing their actual sales.
- Requires proper education and enforcement from mall management.

7.3 High Initial Setup Costs

- Implementing blockchain infrastructure involves smart contract development, security audits, and blockchain hosting.
- Malls may face high costs before achieving long-term benefits.

7.4 Scalability Issues

- Public blockchains (like Ethereum) can have slow transaction processing times and high gas fees.
- Layer-2 solutions (like Polygon) or private blockchains may be needed for scalability.

7.5 Legal & Regulatory Uncertainty

- Blockchain-based rent calculation may conflict with local business laws or tax regulations.
- Compliance with government policies is required.

7.6 Security Risks & Smart Contract Bugs

- If smart contracts have coding flaws, they may be exploited by hackers.
- Regular security audits are necessary to prevent vulnerabilities.

7.7 Integration with Existing Payment Systems

- Traditional mall payment methods rely on cash, card, or bank transfers, while blockchain uses crypto payments.
- A hybrid payment solution is needed to support both.

7.8 Data Privacy Concerns

- While blockchain ensures transparency, sensitive sales data must remain private.
- Implementing zero-knowledge proofs (ZKP) or permissioned blockchains can help.

7.9 User Adoption & Training

- Retailers, mall owners, and customers may not understand blockchain technology.
- Proper training and easy-to-use interfaces are essential for adoption.

8. CONCLUSION

The Blockchain-Based Mall Sales Tracking & Rent Calculation System introduces a secure, transparent, and automated approach to mall management. By leveraging blockchain and smart contracts, the system ensures that retailers accurately report their sales, preventing fraud and rent manipulation. Customer-verified transactions add an extra layer of trust, making rent calculation fair and dispute-free. This innovation eliminates manual record-keeping, enhances operational efficiency, and fosters a more accountable retail ecosystem within malls.

Despite its numerous advantages, the system faces challenges such as retailer resistance, customer participation, and scalability issues. However, with proper user education, regulatory compliance, and adoption of Layer-2 blockchain solutions, these barriers can be overcome. As blockchain technology continues to evolve, integrating it into mall management will revolutionize transparency, trust, and financial efficiency, benefiting mall owners, retailers, and customers alike.

8.1 Future Outlook for Enhancements

The Blockchain-Based Retail Rent Calculation System has immense potential for future enhancements that can improve efficiency, scalability, and user experience. One key area of advancement is the integration of AI and data analytics to provide predictive insights into sales trends, helping mall owners and retailers make informed business decisions. Machine learning algorithms can be employed to detect anomalies in transactions, preventing fraud and ensuring accurate rent calculations. Additionally, multi-blockchain interoperability can be introduced to allow seamless data exchange across different blockchain networks, enabling interactions with supply chain management, financial services, and customer loyalty programs.

9. SDG's ADDRESSED

Transparent Sales Tracking for Mall Rent via Blockchain aligns with multiple United Nations Sustainable Development Goals (SDGs) by promoting fair business practices, transparency, innovation, and responsible economic growth. Here's a detailed explanation of why these SDGs are addressed:

SDG 8: Decent Work and Economic Growth

- Ensures fair business practices by preventing fraudulent rent calculations.
- Encourages economic transparency, fostering a healthier retail ecosystem.

SDG 9: Industry, Innovation, and Infrastructure

- Introduces blockchain technology to modernize mall management.
- Enhances digital infrastructure for secure and automated transactions.

SDG 12: Responsible Consumption and Production

- Promotes transparent business transactions, ensuring fair pricing for consumers.
- Encourages retailers to adopt ethical business practices.

SDG 16: Peace, Justice, and Strong Institutions

- Reduces disputes between mall owners and retailers through blockchain-based rent calculation.
- Strengthens accountability and transparency in financial transactions.

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11.APPENDIX

https://drive.google.com/drive/folders/1w2BHJpbNrjScHK3ZFlw5zL6NVdUoxJ_O?usp=sharing