BLOCKCHAIN MINI PROJECT

Title of Mini Project: A blockchain-based supply-chain system to detect and prevent fake products using QR-linked provenance and Sepolia ETH payments.

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Theory:

Problem statement:

Counterfeit goods cause financial loss, brand damage, and safety risks. Current centralized supply-chain records are easily altered or forged, making it hard for consumers and downstream partners to verify a product's authenticity and full provenance.

Concept / Overview:

Use a public blockchain as an immutable ledger to record product lifecycle events (manufacture → supplier → retailer). Each manufactured item is assigned a unique serial number and a public QR code that links to its on-chain record. Role-based actors (manufacturer, supplier, retailer) update product state and pay small transaction fees (Sepolia test ETH in development) via a connected wallet (MetaMask). An admin manages user accounts in the web app. The QR code lets any participant or consumer fetch the canonical history and verify authenticity.

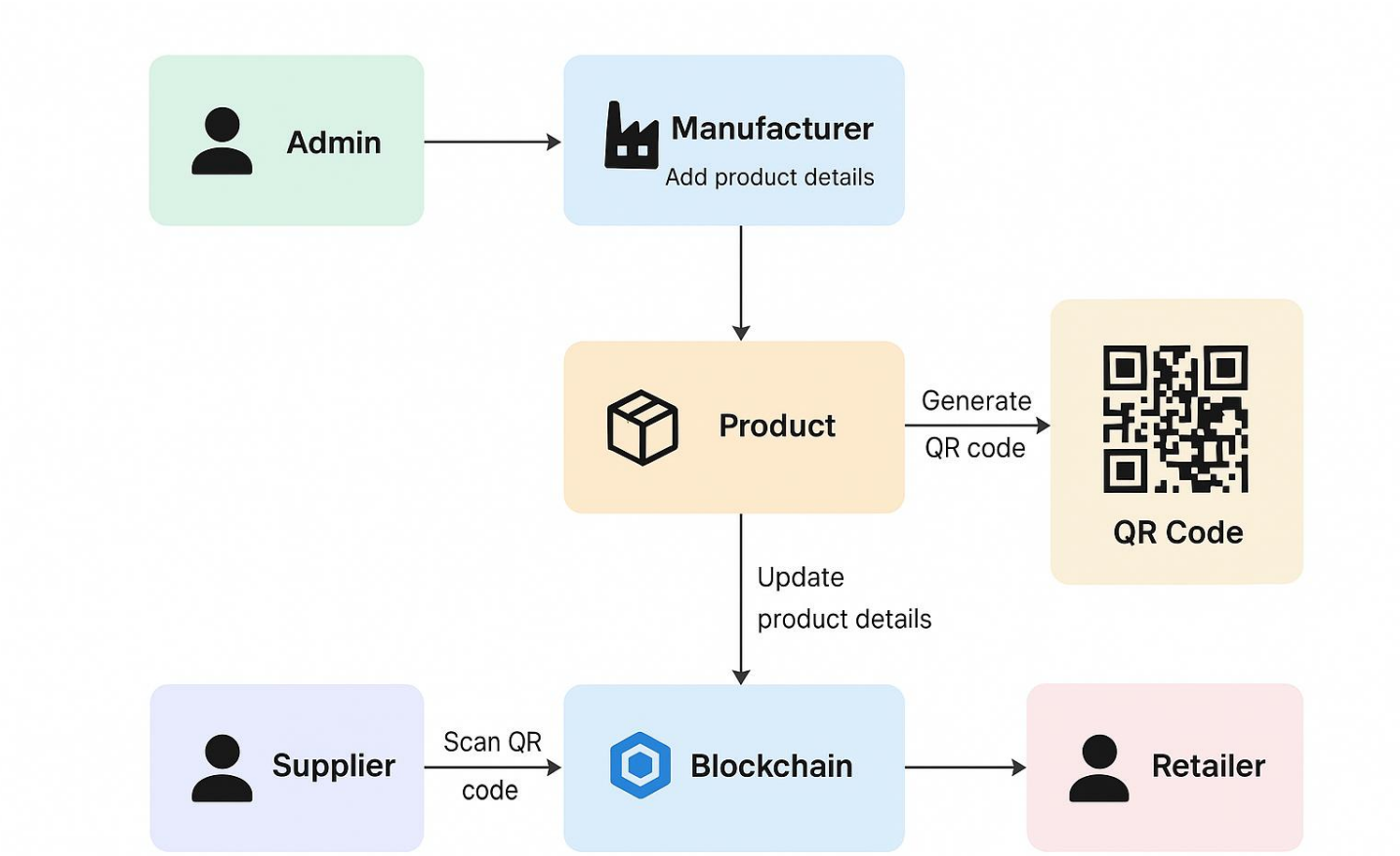
Key features:

- Immutable provenance: Every state change (creation, transfer, update) is recorded on-chain so history cannot be silently altered.
- Role-based workflows: Admin, Manufacturer, Supplier, Retailer each have defined permissions (create, update, verify).
- QR code issuance: After on-chain registration, a QR (containing contract address + serial) is generated and published for scanning.
- Wallet-based payment & signing: Actors pay transaction gas and sign actions with their wallets (MetaMask).
- Off-chain metadata + on-chain anchor: Detailed product data (images, descriptions,

location) stored off-chain (or IPFS) and anchored on-chain via hashes to save cost.

- Public verifiability: Anyone scanning the QR can query the contract to validate the canonical record.
- Audit trail & timestamps: On-chain timestamps provide tamper-proof time ordering for all events.

Flowchart:



Applications:

- Luxury goods anti-counterfeiting: Handbags, watches, jewellery.
- Pharmaceutical supply-chain: Track batches and expiry to prevent fake/expired medicines.
- Electronics and spare parts: Validate origin of components.
- Food provenance: Verify farm-to-shelf history for high-value or regulated foods.

Use Case:

1. Admin — manages web app accounts (create manufacturer/supplier/retailer).
2. Manufacturer — creates a product record in the web UI (name, image, description, location, manufacture date). The dApp:
   - uploads image/metadata off-chain (or to IPFS),
   - calls contract to register product (serial number, metadata hash),
   - pays Sepolia ETH via MetaMask, and
   - receives a public QR code (contract address + serial) to attach to the item.
3. Supplier — scans QR, fetches canonical data, updates shipment/receiving events on-chain (signed & paid via wallet).
4. Retailer — scans QR on receipt or at point-of-sale to confirm authenticity and update sale or shelf status.
5. Consumer/Verifier — scans QR and reads the complete on-chain provenance to confirm authenticity and ownership history.

Advantages:

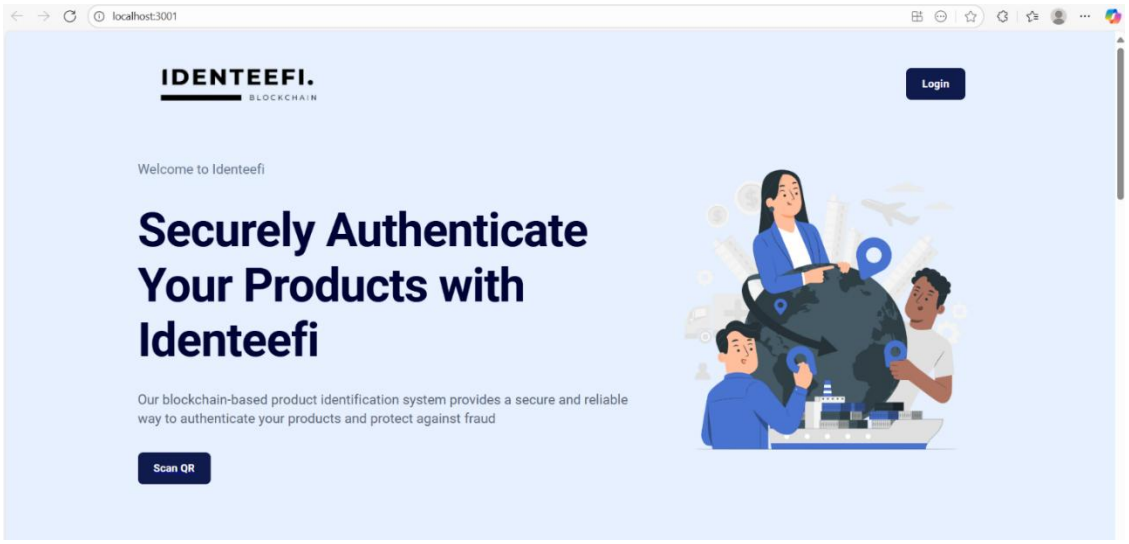
- Tamper resistance — record immutability discourages and detects fraud.
- Transparency — easy public verification without trusting a single central authority.
- Accountability — every actor's actions are signed by their wallet address.
- Interoperability — standard contract interfaces let other services integrate verification.

Limitations & considerations:

- Gas costs & UX: On-chain transactions cost gas — use test net (Sepolia) for development and consider batching or Layer-2/main net optimizations for production.
- Off-chain data integrity: Store large data off-chain (IPFS/S3) and anchor cryptographic hashes on-chain to prevent tampering while keeping costs low.
- Privacy: Public on-chain data is transparent—avoid storing sensitive PII on-chain; store only hashes or encrypted payloads off-chain.
- Key management: Actors must securely manage wallet keys (MetaMask). Lost keys = loss of ability to sign updates.
- Trust bootstrapping: The system's effectiveness improves with ecosystem adoption—brands and partners must participate.

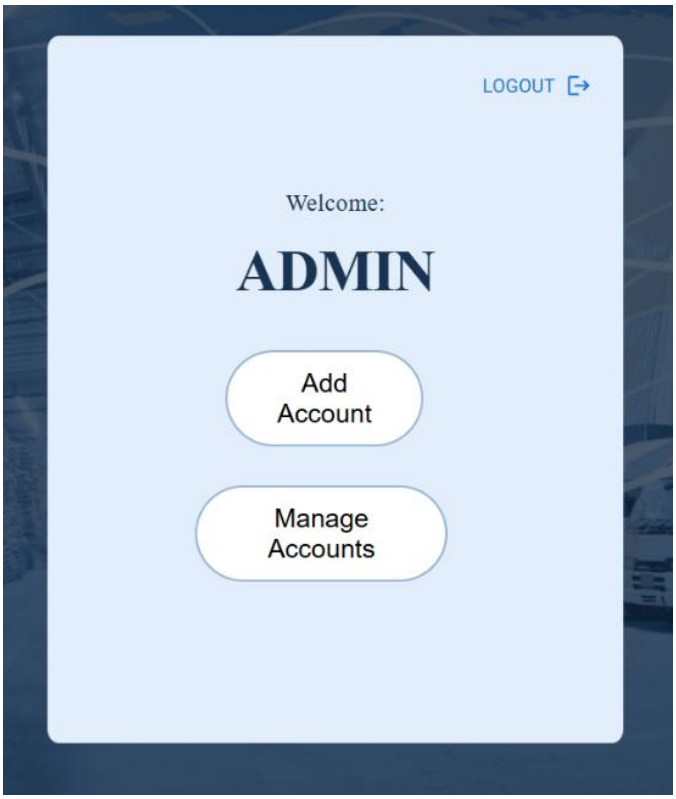
Output:

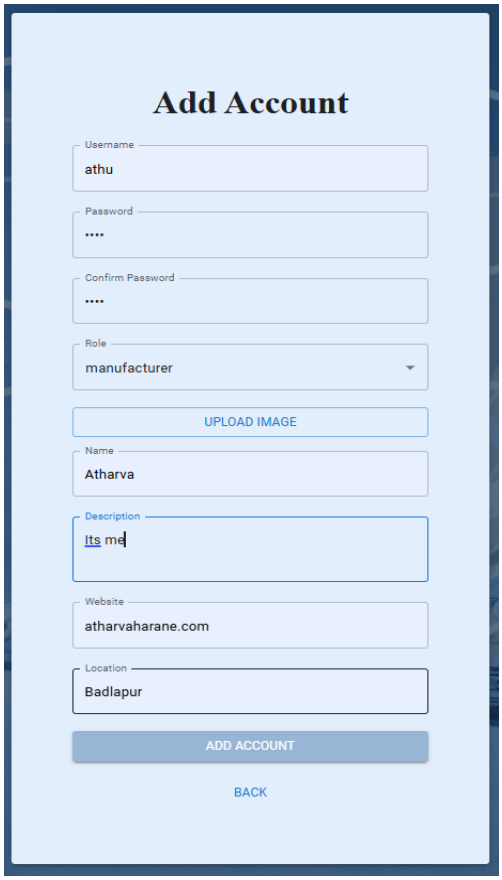
1.1 Landing Page



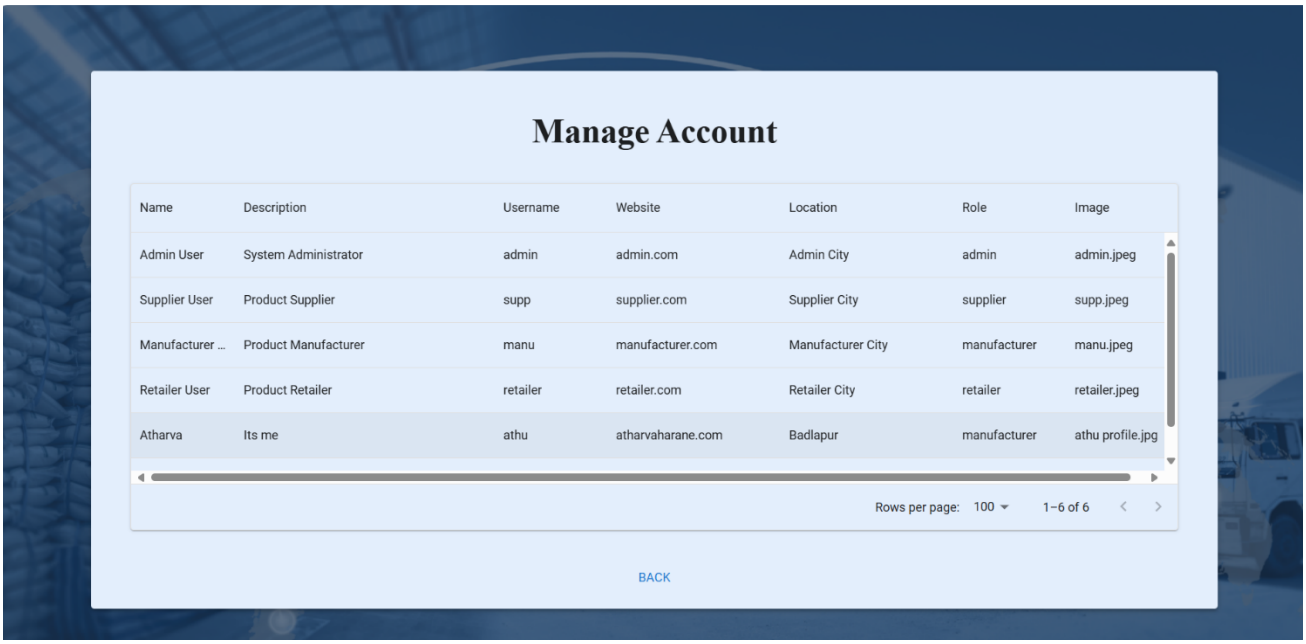
1.2 Login Page

1.2.1 Add Account by Admin

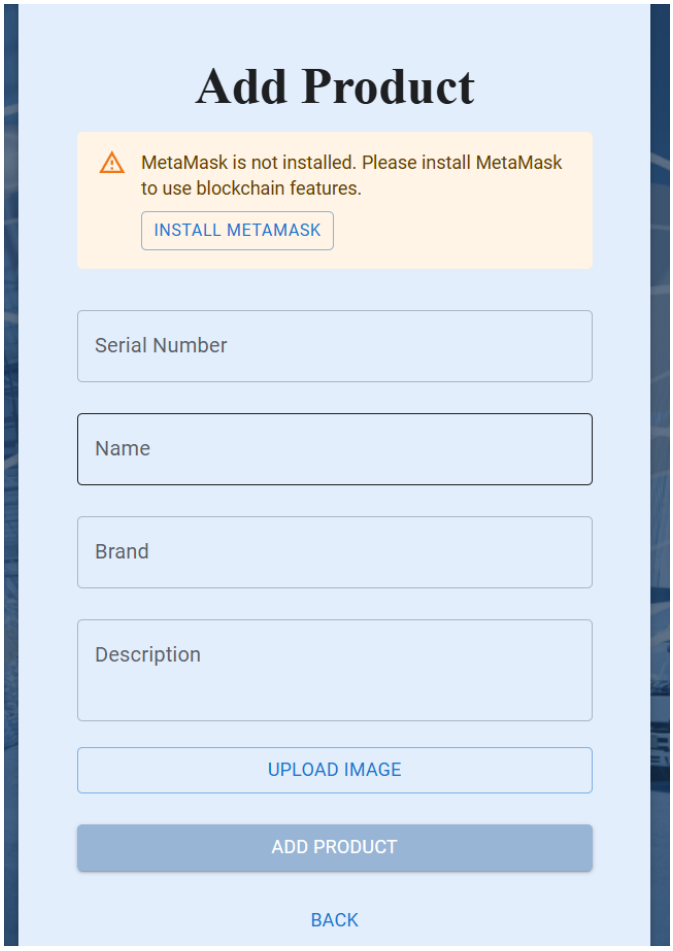




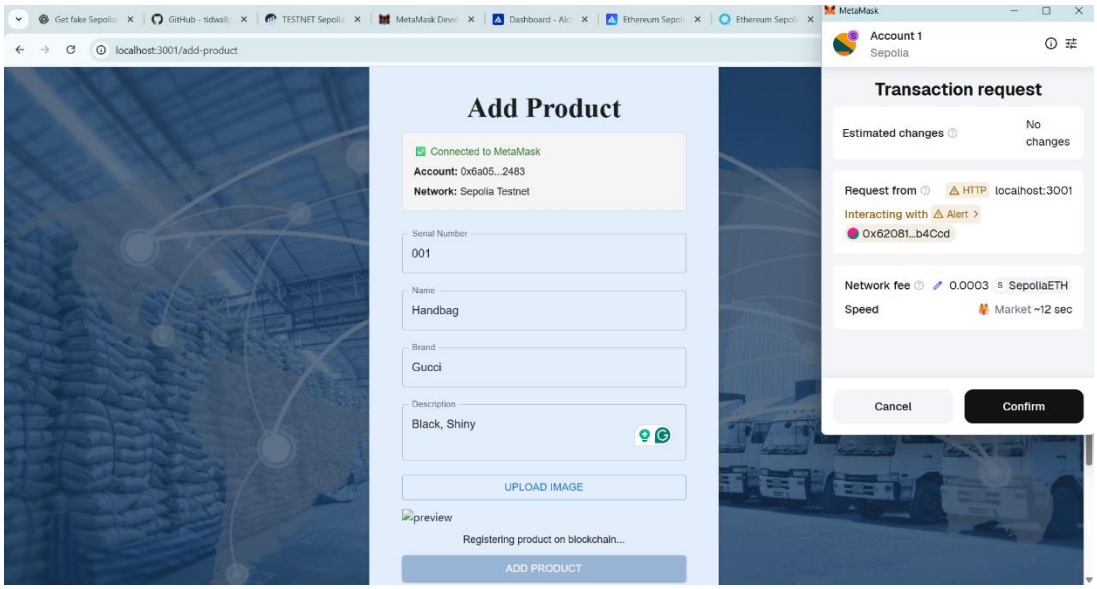
1.2.2 Manage Accounts by Admin

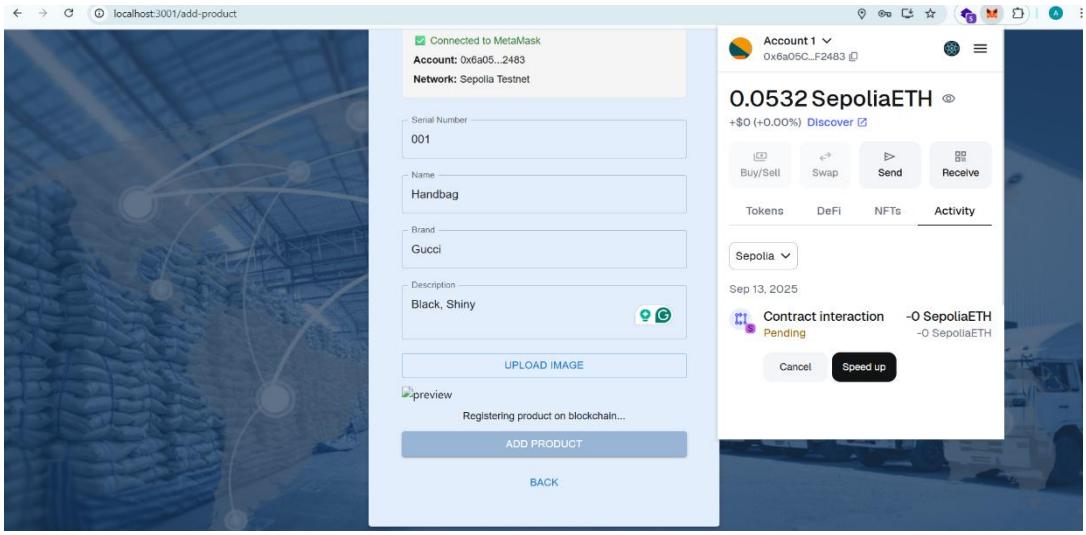


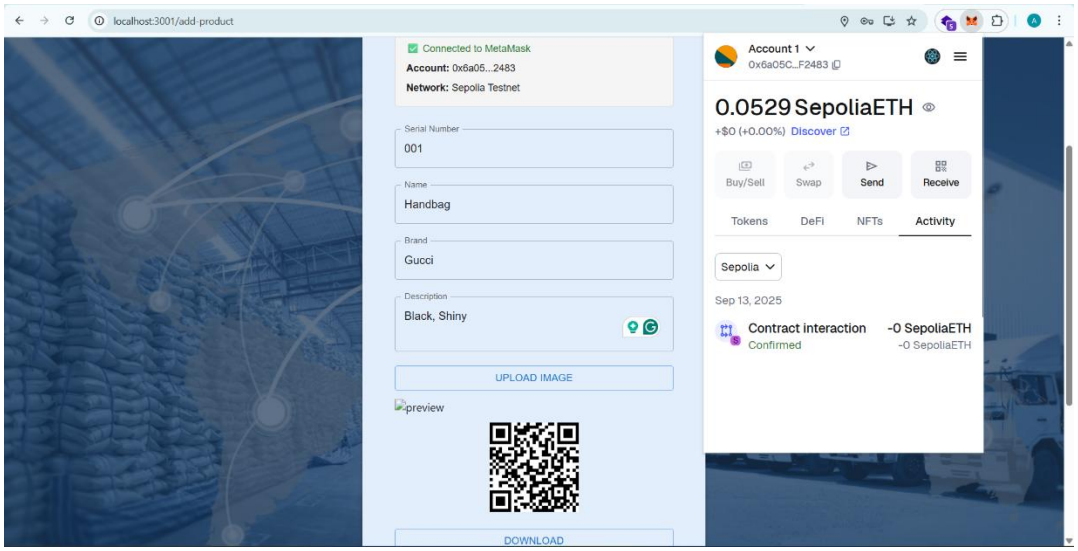
1.3.1 Add New Product by Manufacturer



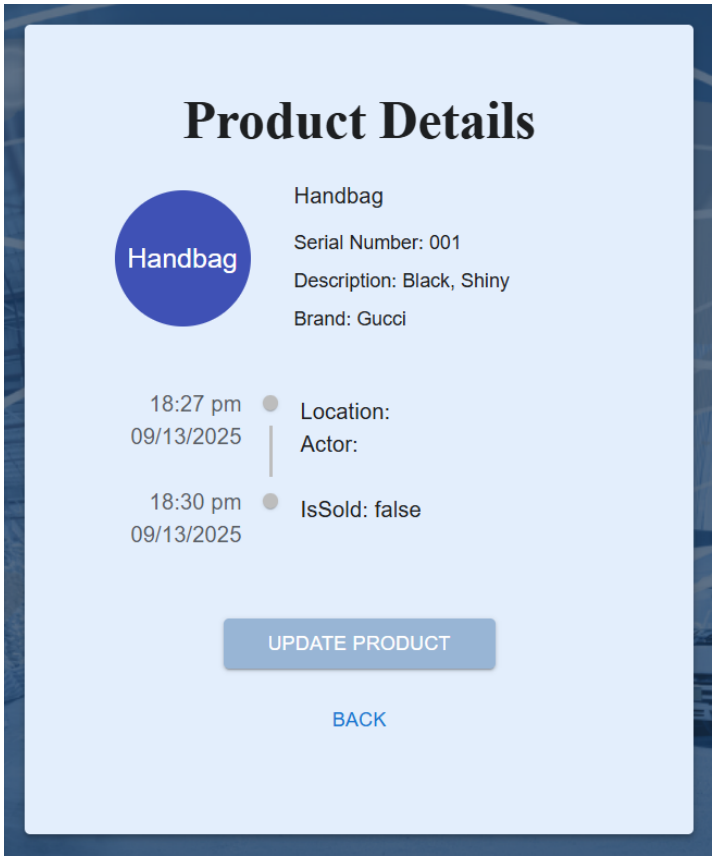
1.3.2 Registering Product on Blockchain by Manufacturer



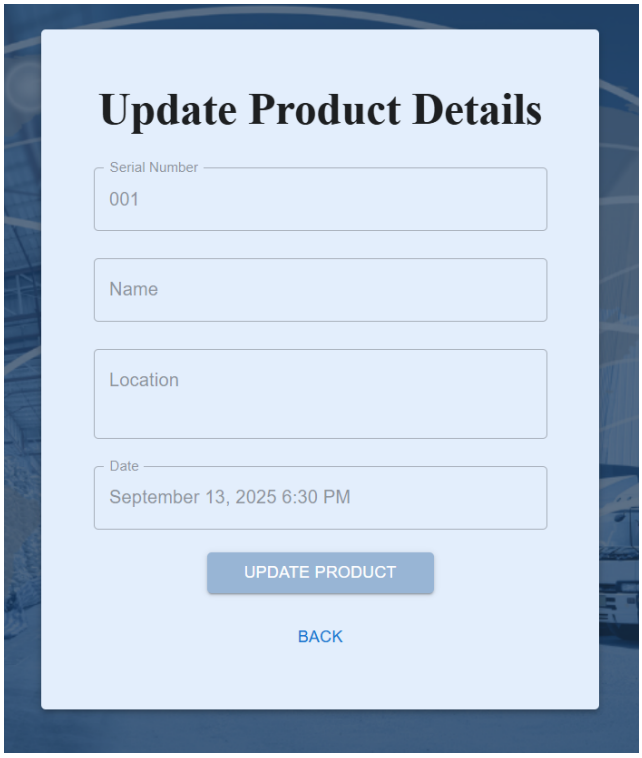


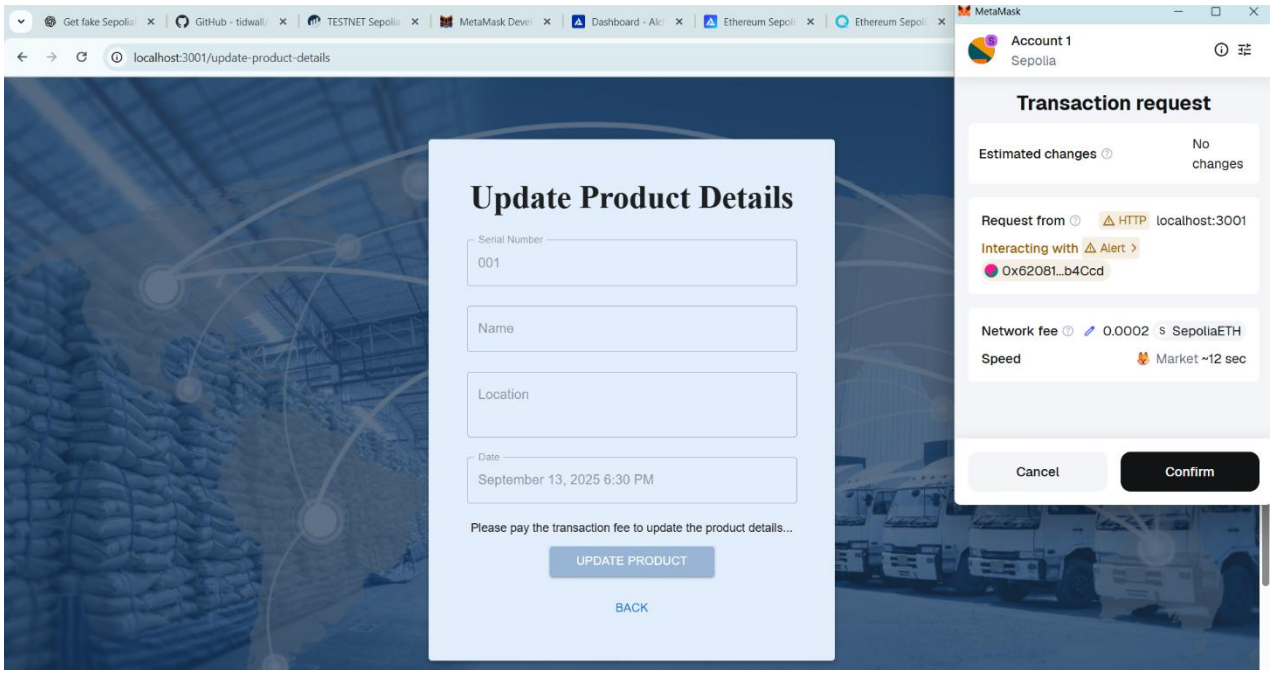


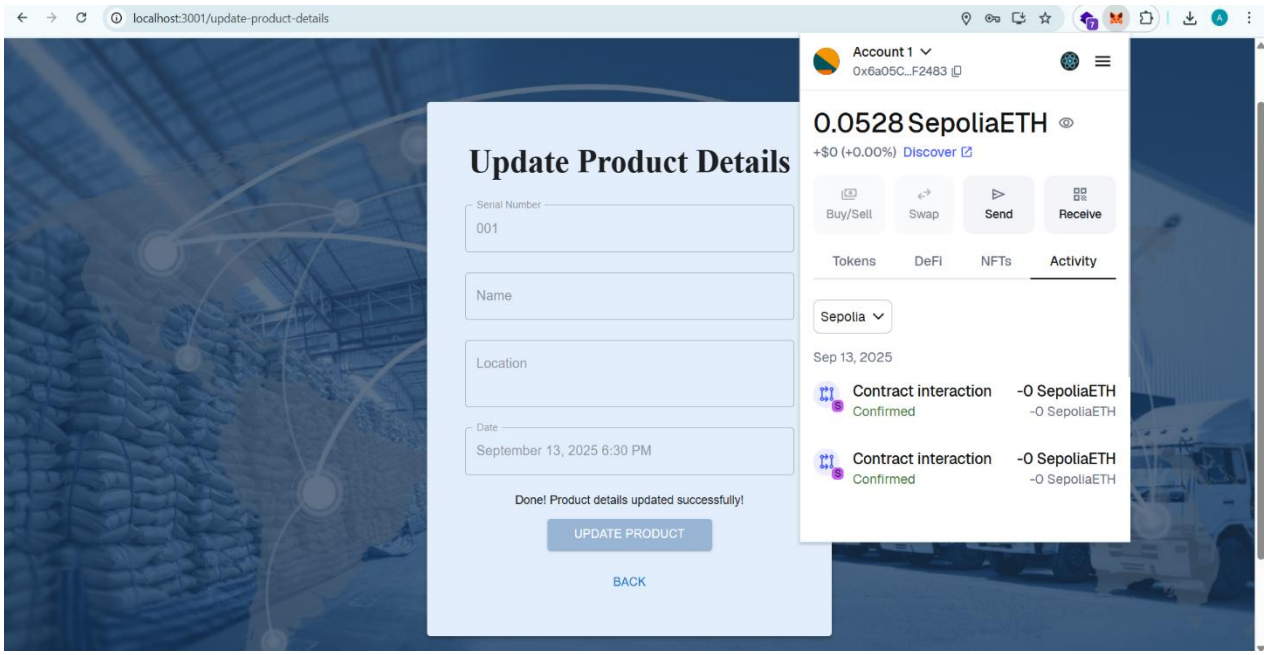
1.4.1 Supplier can get Product Details



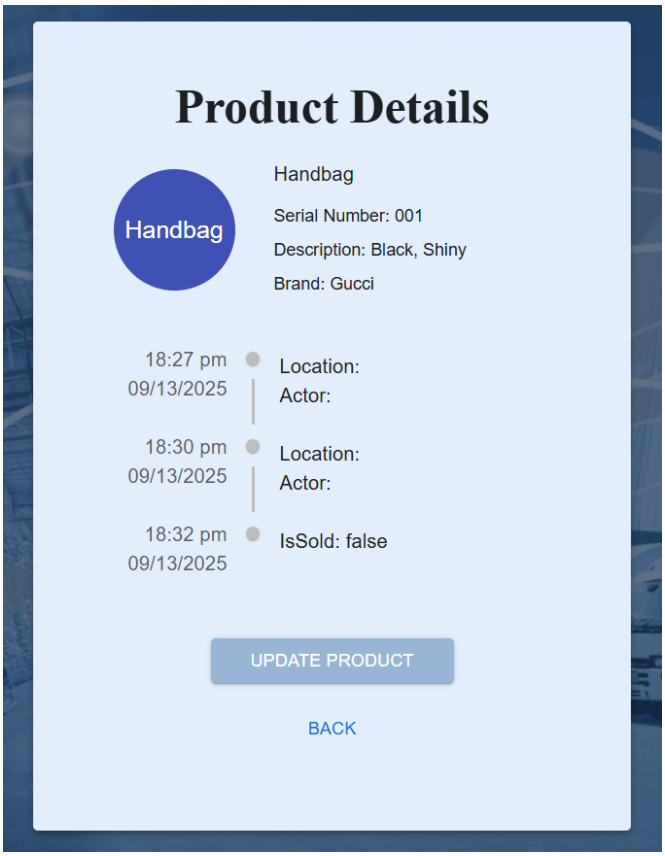
1.4.2 Supplier can Update the Product Details



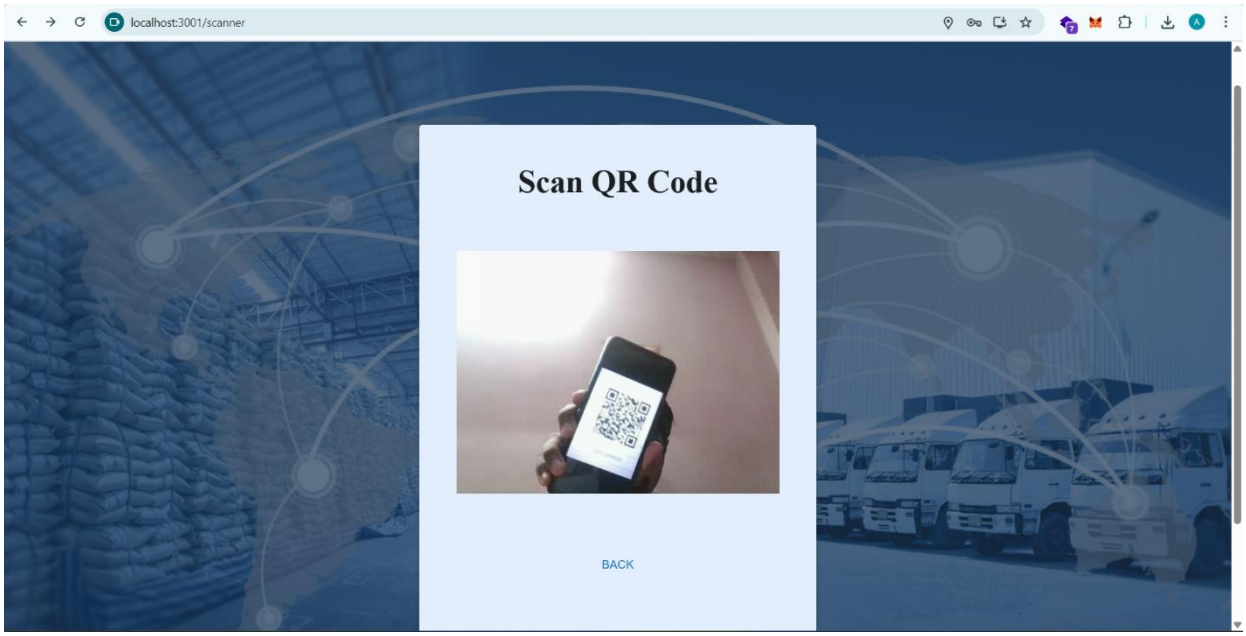

localhost:3001/update-product-details
Update Product Details
Serial Number
001
Name
Location
Date
September 13, 2025 6:30 PM
Please pay the transaction fee to update the product details...
UPDATE PRODUCT
BACK
MetaMask
Account 1
Sepolia
Transaction request
Estimated changes
No changes
Request from
HTTP localhost:3001
Interacting with
Alert
0x62081...b4Ccd
Network fee
0.0002 SepoliaETH
Speed
Market ~12 sec
Cancel
Confirm


localhost:3001/update-product-details
Update Product Details
Serial Number
001
Name
Location
Date
September 13, 2025 6:30 PM
Done! Product details updated successfully!
UPDATE PRODUCT
BACK
Account 1
0x6a05C...F2483
0.0528 SepoliaETH
+$0 (+0.00%) Discover
Buy/Sell
Swap
Send
Receive
Tokens
DeFi
NFTs
Activity
Sepolia
Sep 13, 2025
Contract interaction
Confirmed
-0 SepoliaETH
-0 SepoliaETH
Contract interaction
Confirmed
-0 SepoliaETH
-0 SepoliaETH

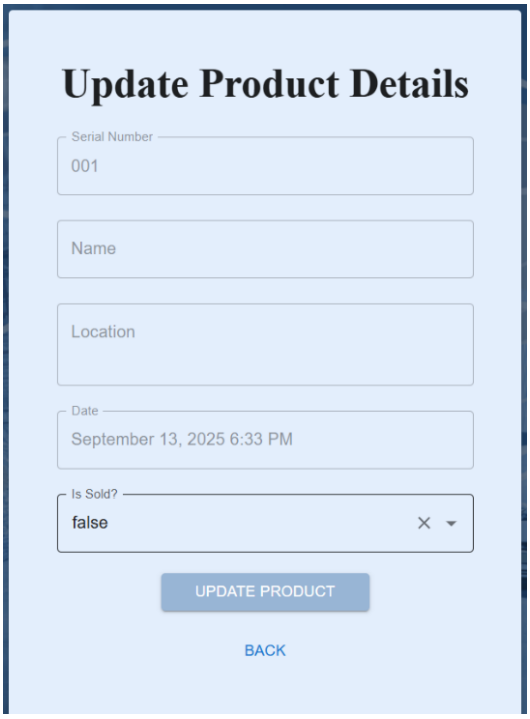
1.5 Supplier can see the Updated Product Details

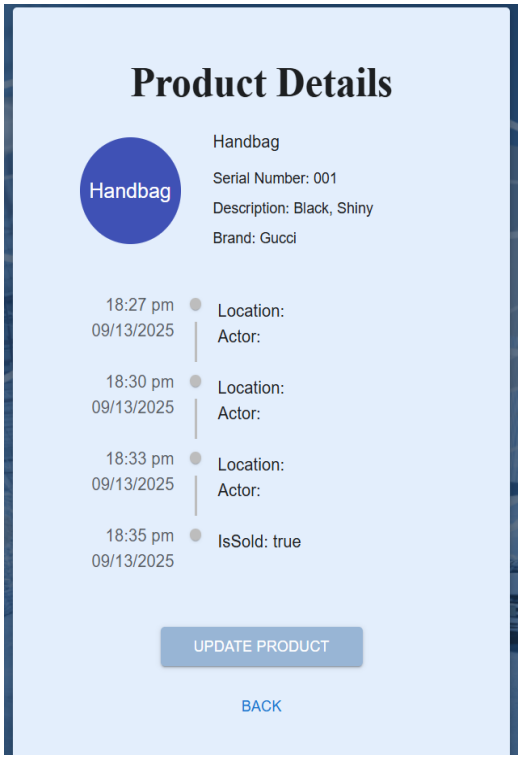


1.6 Retailer needs to Scan QR Code To get the updated Product Details

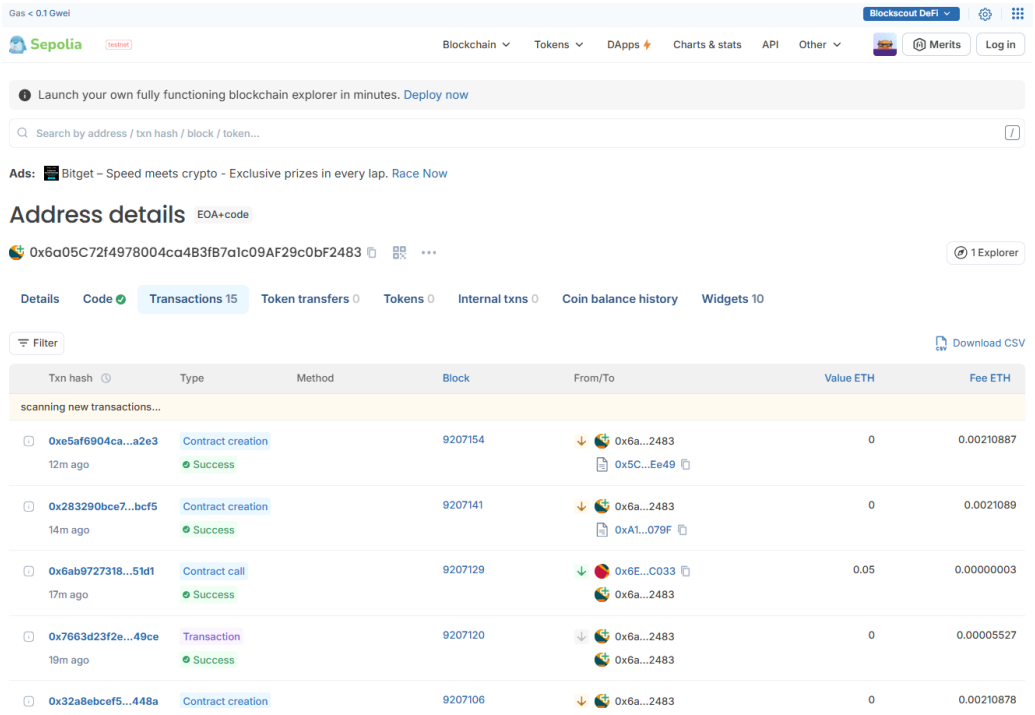


1.6.1 Retailer can update the sells details of product





1.6.2 Transactions Details



Txn hash	Type	Method	Block	From/To	Value ETH	Fee ETH
0x7663d23f2e...49ce 19m ago	Transaction Success		9207120	0x6a...2483 0x6a...2483	0	0.00005527
0x32a8ebcef5...448a 23m ago	Contract creation Success		9207106	0x6a...2483 0x50...eCa9	0	0.00210878
0x4b1dac9bdd...2da7 44m ago	Contract call Success	addProductHistory	9207007	0x6a...2483 0x62...4Ccd	0	0.00020238
0xe353a54c29...8041 48m ago	Contract call Success	addProductHistory	9206985	0x6a...2483 0x62...4Ccd	0	0.00017251
0x064bdf2847...8202 50m ago	Contract call Success	registerProduct	9206974	0x6a...2483 0x62...4Ccd	0	0.00037357
0x1546679837...e88c 1d ago	Contract call Success	addProductHistory	9197313	0x6a...2483 0x62...4Ccd	0	0.00014384
0xb55dbbb6cc...5f9f 1d ago	Contract call Success	addProductHistory	9197305	0x6a...2483 0x62...4Ccd	0	0.00011397
0x95f3dcd479...7c45 1d ago	Contract call Success	registerProduct	9197295	0x6a...2483 0x62...4Ccd	0	0.00013277
0x06911a2106...e385 2d ago	Contract call Success	addProductHistory	9195303	0x6a...2483 0x62...4Ccd	0	0.00011595
0x183cc7adbd...49b9	Contract call	addProductHistory	9195289	0x6a...2483	0	0.00012674

Conclusion:

A QR → blockchain provenance system provides a practical, auditable, and decentralized approach to detect and prevent fake products. By combining off-chain media storage, on-chain anchoring, role-based updates, and wallet-signed transactions, the system creates a verifiable chain of custody from manufacture to sale. For production readiness, address gas-cost strategies, privacy safeguards, and user-friendly wallet flows so that verification becomes frictionless and widely adoptable.

Additionally, this blockchain-powered product verification system fosters trust and transparency across the entire supply chain. Consumers gain confidence by verifying product authenticity themselves, while businesses can protect their brand value and reduce losses due to counterfeiting. Regulatory authorities can also leverage the immutable audit trail for compliance and investigation purposes. By integrating QR-based verification with blockchain, the solution not only combats counterfeit goods but also enhances accountability, efficiency, and collaboration among all stakeholders.