

# SupplyGuard: A Decentralised Supply Chain Management Solution

Albert Mendes

SupplyGuard 1.0,

May 3, 2024

## Abstract:

This paper describes supplyGuard, a secure scalable decentralised supply chain management tool. We describe the technology, and How it works and security mechanism that provide blockchain level guarantees at scale.

## 1. Introduction

Decentralized applications (dApps) empower users by granting them full control over their data, fostering a direct benefit from its usage while ensuring stringent privacy measures. This paradigm shift holds particular appeal for companies and consumers disillusioned by the data monopolies of the Web2 era, which often exploit user information for profit, thus constraining economic opportunities and autonomy.

Within supply chain management, these centralized systems often result in disparities in terms of product quality, transactional transparency, and delivery

schedules. Along with looking for measures to protect their operational data and their clients' data from unlawful exploitation, firms are also responding to growing regulatory scrutiny aimed at safeguarding consumer rights. However, traditional supply chain models still have serious problems with integrity and openness in spite of numerous national restrictions.

Enter the decentralised supply chain management application—designed to harness the benefits of Web3 technology to establish unprecedented levels of trust and transparency. Such applications eliminate the need for central oversight, allowing companies and customers to interact in a verifiably transparent environment without the logistical burdens of self-hosting.

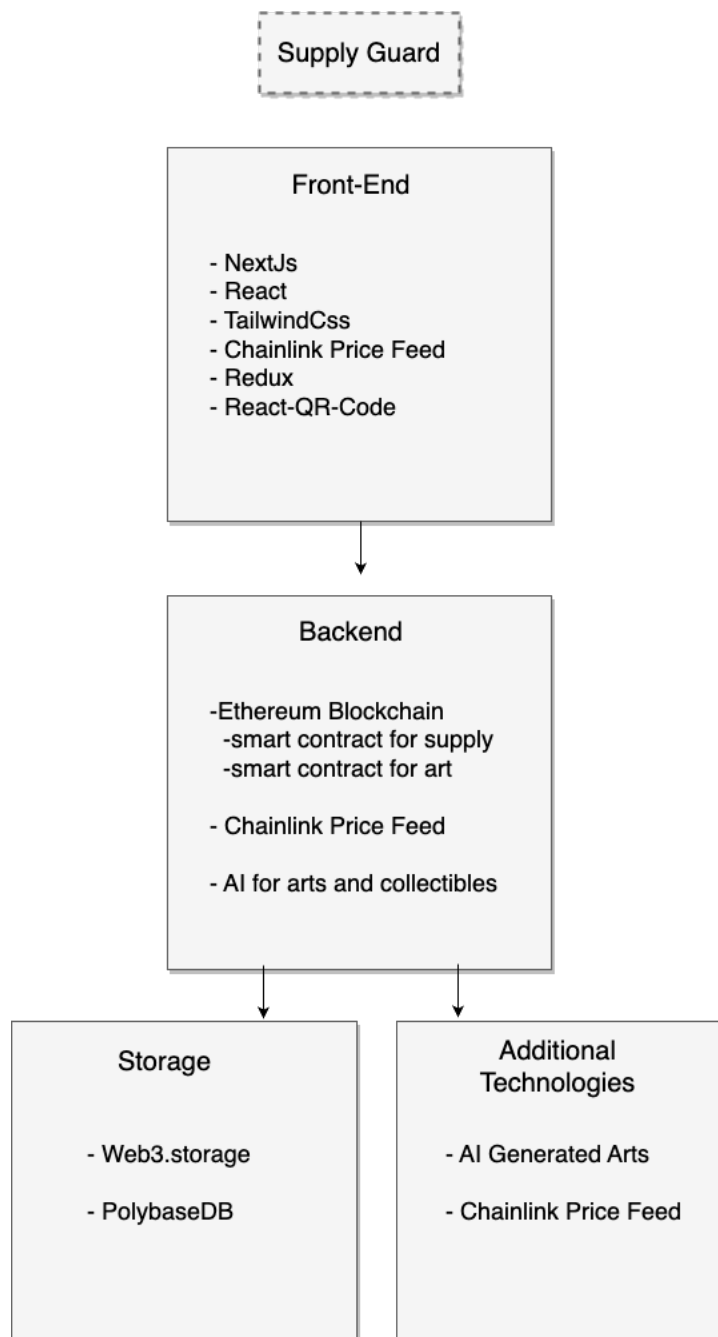
However, the development of these transformative dApps faces several challenges, including complex integration with existing technologies, the steep learning curve associated with blockchain technologies, and concerns over network scalability and performance. These obstacles have prompted some users to revert to outdated systems, which unfortunately perpetuate issues of opacity and mistrust.

Addressing these performance and scalability challenges is pivotal. By leveraging on-chain data storage and processing, our system is designed to scale efficiently through the innovative use of a recursive Ethereum blockchain network. This approach allows for rapid verification of cryptographic proofs, ensuring that all transactions and state changes are processed correctly without requiring each network node to perform redundant validations.

Our solution not only promises to enhance the efficiency and transparency of supply chain operations but also sets a new standard for the integration of

blockchain technology in critical business processes, paving the way for a more secure, transparent, and equitable economic landscape.

## 2. SupplyGuard Protocol Architecture



SupplyGuard is initially developed as a web solution, with plans to extend its functionalities to mobile and desktop platforms in the near future. The

architecture of SupplyGuard is meticulously designed to harness the full potential of decentralized technology across six fundamental components:

### **Web3 Image Storage Solution**

Our application utilizes the [Web3.storage](#) platform to ensure secure and decentralized storage of NFT images and associated metadata. This storage solution leverages IPFS (InterPlanetary File System) technology, which facilitates peer-to-peer storage and sharing of data in a distributed file system, enhancing the reliability and speed of access while ensuring data permanence without reliance on centralized data centers.

### **Database - PolybaseDB**

PolybaseDB serves as our primary database for storing detailed records of products and user data. It is chosen for its ability to handle large volumes of data efficiently and its compatibility with decentralized applications, ensuring that all transaction data remains secure and easily accessible across the network.

### **Frontend - Next.js, React, TailwindCSS, Redux**

The frontend of SupplyGuard is built using a combination of Next.js, React, TailwindCSS, Redux and React-QR-Code:

- ❑ **Next.js** is utilized for its excellent SEO capabilities, which address React's limitations in search engine optimization, making it ideal for achieving better visibility and faster page loading times.
- ❑ **React** is employed for its robust ecosystem and flexibility in building interactive user interfaces, enhancing the overall user experience.
- ❑ **TailwindCSS** is chosen for its utility-first approach to CSS, which accelerates the development of custom designs without leaving behind a hefty CSS footprint.

- ❑ **Redux** is integrated for efficient state management across the application, ensuring that UI components have consistent access to the application state.
- ❑ **Heroicons** are used for incorporating scalable vector icons, enhancing the visual elements of the user interface.
- ❑ **React-QR-Code** is added to generate QR codes for order tracking and verification, providing a simple and efficient way for users to access real-time information about their transactions and product shipments.

## **Backend - Ethereum Smart Contracts**

The backend leverages Solidity to craft two main types of smart contracts:

- ❑ One for managing the approval processes and storing supply chain data on the blockchain, ensuring transparency and immutability of transaction records.
- ❑ Another dedicated to managing AI-generated arts and collectibles, which supports the creation and trade of digital assets within the platform. These contracts are deployed to an Ethereum testnet, with Hardhat as the development environment for compiling, deploying, and testing our contracts.
- ❑

## **AI-Generated Arts and Collectibles**

This component leverages artificial intelligence to create unique digital arts and collectibles. The integration of AI allows for the generation of diverse and innovative artworks, which can be tokenized as NFTs (Non-Fungible Tokens) and traded on the platform, adding a unique aspect to the application and fostering a creative economy.

## **Chainlink Price Feed**

To facilitate real-time pricing of products in ETH, we integrate the Chainlink price feed, a decentralized oracle network that provides high-integrity and tamper-proof data for complex smart contracts on any blockchain. This feature ensures that the conversion rates between fiat currencies and ETH are accurate and updated in real time, enabling transparent and fair transactions.

## **3. How supplyGuard works**

Supply Guard revolutionizes the interaction between suppliers and customers by leveraging blockchain technology to enhance transparency, accountability, and ease of use in the supply chain process.

### **User Onboarding and Interaction**

Upon visiting the Supply Guard platform, users are prompted to connect their digital wallets through Web3 providers such as MetaMask. This connection not only facilitates secure transactions but also serves as a means of user authentication and account management.

**For Customers:** Customers onboard by selecting the 'Client' option, which directs them to a page where they can complete their profile including shipping details to streamline future transactions. The platform offers a seamless browsing experience where customers can explore product offerings across various categories. Features such as adding items to favorites or cart enrich the shopping experience. Upon checkout, a dynamically generated QR code is displayed, enabling customers to track their orders in real-time, ensuring transparency and trust in the delivery process.

**For Suppliers:** Suppliers register by entering detailed company information. Post-registration, suppliers have the capability to manage their product listings

by adding, editing, or removing items as necessary, thereby maintaining an up-to-date catalog. This feature is crucial for keeping the inventory reflective of current offerings and availability.

## **Role-Based Access and Workflow**

The Supply Guard application is structured around six pivotal roles within the supply chain, each linked to specific responsibilities and actions required to progress an order from placement to delivery:

1. **Supplier Manager:** Oversees supplier relations and manages contractual agreements, ensuring suppliers meet the platform's standards.
2. **Product Overseer:** Responsible for the product catalog, ensuring all listings are accurate and meet quality standards.
3. **Quality Inspector:** Verifies the quality of products and compliance with safety standards before products are shipped.
4. **Inventory Controller:** Manages inventory levels, ensuring sufficient stock is maintained and categorizing items based on demand and supply metrics.
5. **Logistics Coordinator:** Manages shipping and logistics operations to optimize delivery times and costs.
6. **Fulfillment Operator:** Directly handles the packaging and dispatching of orders, ensuring products are correctly fulfilled as per order details.

Each role is integral to the supply chain's operational flow. The process begins with an order placed by a customer, which triggers notifications to the first role in the workflow, the Supplier Manager. Upon validation and approval using their Ethereum address for authentication, the task progresses to the next role. This sequential approval continues until the final product is dispatched and delivered, culminating in the customer receiving their order.

Email notifications are sent to each role as their input or action is required, ensuring that no step is overlooked and that each is authenticated and recorded on the blockchain, thus enhancing the integrity and traceability of the entire process.

## **4. Conclusion**

SupplyGuard represents a pivotal advancement in supply chain management, embodying the full potential of decentralized technology to transform traditional business operations. This platform is not merely a technological innovation; it is a strategic redefinition of how supply chain interactions can be managed with trust, transparency, and efficiency.

The development of SupplyGuard has been guided by the pressing need to overcome the limitations of traditional, centralized systems that often compromise transparency and data security. By leveraging blockchain technology, particularly Ethereum smart contracts, SupplyGuard ensures that every transaction and interaction within the supply chain is immutable, transparent, and verifiable by all parties involved.

The roles defined within the SupplyGuard ecosystem—ranging from the Supplier Manager to the Fulfillment Operator—highlight a comprehensive approach to managing supply chain operations. Each role is crucial, ensuring that from the moment an order is placed to the time it is delivered, every step is authenticated and executed with precision, reflecting the commitment to quality and reliability.

Moreover, the integration of cutting-edge technologies such as AI-generated arts and Chainlink price feeds demonstrates SupplyGuard's commitment to not



only meeting current market demands but also anticipating future trends and needs. These features not only enhance the functionality of the platform but also enrich the user experience, making it more engaging and versatile.

As we look to the future, the potential expansions of SupplyGuard into mobile and desktop applications promise to broaden its accessibility and usability, ensuring that more users can benefit from its robust capabilities. The journey of refining and enhancing this platform continues, with the goal of setting a new standard in the supply chain domain—one that champions decentralization, user empowerment, and seamless operation.

In conclusion, SupplyGuard is more than just a solution; it is a catalyst for change in the supply chain industry, driving forward a future where technology and transparency create a more equitable and efficient marketplace for all stakeholders involved. This white paper not only outlines the functionalities and benefits of SupplyGuard but also sets the stage for its pivotal role in shaping the future of decentralized supply chain management.