BlockSupply: Blockchain-Based Logistics Traceability Solution

Meryem YOUSFI, Ghita LAAYOUNE, Hanae HANIM

ENSAJ, meryemelyoussfi175@gmail.com

ENSAJ, layouneghita@gmail.com

ENSAJ, hanae.hanim01@gmail.com

Abstract

Embarking on a paradigm shift in supply chain management, the 'Blockchain-Based Logistics Traceability' project is poised to redefine industry practices.

This pioneering initiative seeks to seamlessly monitor the real-time movement of products, materials, and goods across the entire supply chain. By embracing blockchain technology, the project aspires to establish a new standard of transparency, elevate data security measures, and deliver authentic traceability for all stakeholders involved in the supply chain. Encapsulating a visionary commitment to harnessing the full potential of blockchain, the project ensures a future characterized by streamlined, secure, and transparent supply chain operations.

Keywords: Blockchain, Supply chain, Real-time, traceability, logistics.

Metadata

Nr.	Code metadata description	Please fill in this column
C1	Current code version	v1.1
C2	Permanent link to code/repository used for this code version	`https://github.com/ghm-group/Tracabilit-logistique-\basee-sur-la-technologie-\Blockchain`
C3	Permanent link to Reproducible Capsule	`https://github.com/ghm-group/Tracabilit-logistique-basee\-sur-la-technologie-Blockchain\/blob/main/README.md`
C4	Legal Code License	MIT license
C5	Code versioning system used	git
C6	Software code languages, tools, and services used	web3.js, reactjs, solidaty, Truffle
C7	Compilation requirements, operating environments & dependencies	Metamask, Ganache, npm, node v20.9.0, Chrome, Visual Studio
C8	Support email for questions	layouneghita@gmail.com

Table 1: Code metadata (mandatory)

1. Motivation and significance

The architecture "Blockchain-based Logistics Traceability" aims to revolutionize supply chain management through the robust capabilities of blockchain technology. This initiative is driven by the need to create an innovative solution that monitors the real-time movement of products, materials, and goods throughout the entire supply chain. By embracing blockchain, the project strives to provide unparalleled transparency, enhanced data security, and true traceability for all stakeholders in the supply chain.

- *This software addresses critical challenges in supply chain management by leveraging blockchain technology to enhance transparency, security, and traceability. It mitigates risks of fraud, counterfeiting, and errors, optimizes inventory management, and ensures compliance with regulatory standards, thereby revolutionizing the logistics industry. Through real-time monitoring and improved data integrity, the software contributes to scientific advancements in secure and efficient supply chain operations.*

- *The software's implementation in real-world scenarios could lead to publications showcasing its impact on improving data reliability, security, and operational efficiency in supply chain research.*

- *Users engage with the software by participating in a blockchain-based supply chain management system. They interact with the platform through a user-friendly interface, accessing real-time data on product movements, locations, and quantities. Through features like secure authentication, role management, and interactive dashboards, users can navigate and contribute to the traceability of goods. The software facilitates the recording of immutable data, enhancing transparency and security across the supply chain. Users receive real-time alerts for abnormal events, contributing to proactive decision-making. The experimental setting involves users actively utilizing the system for transparent, secure, and efficient supply chain management.*

- *The project, utilizing technologies such as Web3.js, React.js, Solidity, Ganache, and GitHub, aligns with a dynamic landscape in blockchain-based supply chain solutions. Despite a lack of explicit citations or algorithms, the integration of Web3.js underscores a focus on decentralized web interactions. React.js enhances user interfaces in blockchain applications, while Solidity signifies a reliance on Ethereum-based solutions for smart contract development. Ganache acts as a local blockchain for testing smart contracts, ensuring robust implementation. GitHub facilitates version control and collaborative development. Though specific literature references may vary, these technologies collectively represent a comprehensive strategy for developing efficient and secure blockchain-based supply chain solutions.*

- *In comparison to existing projects, the proposed "Blockchain-based Logistics Traceability" architecture represents a significant advancement in supply chain management leveraging blockchain technology, several common themes*

emerge, such as the integration of blockchain and IoT for traceability, transparency, and security enhancement. The motivation and significance of our project lie in addressing key challenges faced by the logistics industry, offering a comprehensive solution that outshines current approaches.

- *The first notable contribution lies in our emphasis on real-time monitoring of product movements, materials, and goods across the entire supply chain. While existing solutions acknowledge the importance of traceability, the "Blockchain-based Logistics Traceability" architecture takes it a step further by ensuring continuous and instantaneous visibility into the supply chain processes. This contributes to improved decision-making and operational efficiency, reducing the risk of fraud, counterfeiting, and errors.*

- *Furthermore, our software goes beyond the conventional focus on transparency and security by integrating features such as role management, and interactive dashboards. These aspects not only enhance user engagement but also empower stakeholders to actively contribute to the traceability of goods. The provision of real-time alerts for abnormal events demonstrates our commitment to proactive risk mitigation, setting our solution apart in terms of responsiveness and adaptability.*

- *In contrast to existing works that may lack explicit citations or algorithms, our project's transparency extends to its technological foundation. The use of Web3.js underscores a commitment to decentralized web interactions, while React.js enhances user interfaces for a seamless user experience. Solidity indicates reliance on Ethereum-based solutions for smart contract development, ensuring a robust and standardized approach. The employment of Ganache for local blockchain testing and GitHub for version control aligns with industry best practices for collaborative development.*

2. Software description

2.1. Software architecture

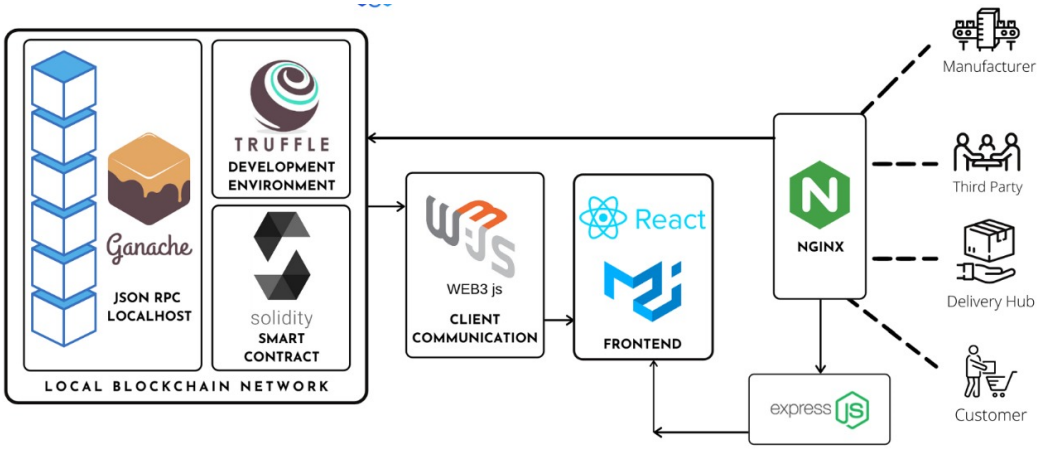

Figure 1 : Software's Architecture

This architecture present the different components of our project's architecture, The smart contract is authored in Solidity, subsequently compiled, migrated, and

deployed using Truffle.js on the local blockchain network created with Ganache-cli. The frontend leverages Web3.js to interact with the smart contract and the local blockchain network, and is developed using the React.js framework for enhanced component lifecycle management and state handling. User requests are relayed to the frontend through Nginx (load balancer) and Express.js for dynamic routing.[3]

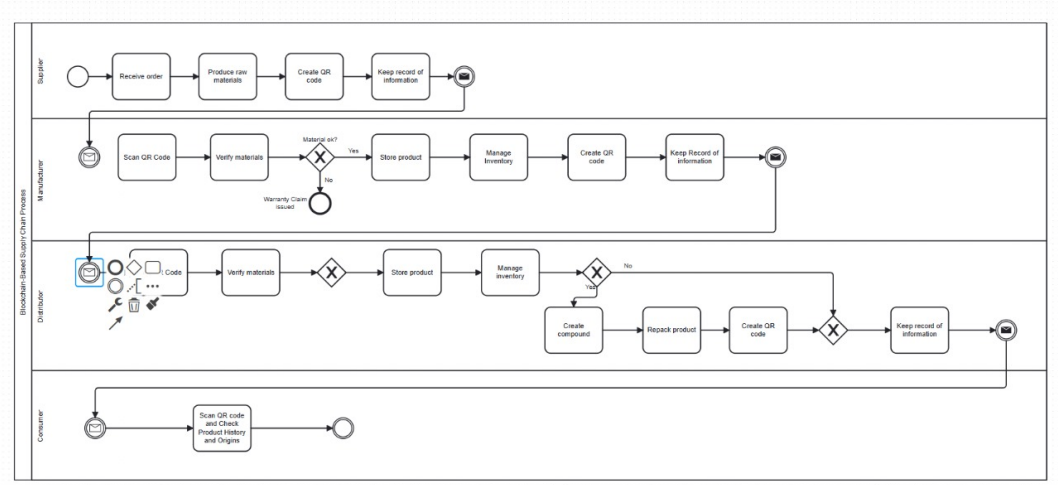

Figure 2 :Supply chain BPMN

The Business Process Model and Notation (BPMN) diagram for the project illustrates the end-to-end logistics traceability system. It begins with the user launching the application, followed by the entry of product information and its movement across the supply chain. The BPMN diagram depicts the sequential flow of tasks, including blockchain network creation, real-time data collection, secure user authentication, and anomaly alerts. Through various stages, the system ensures the integrity and security of data stored on the blockchain. The diagram represents a comprehensive visualization of the logistics process, incorporating key components and interactions in a standardized notation for clear understanding and effective communication among project stakeholders.

2.2. Software functionalities

The Blockchain-based logistics traceability solution is designed to address various project requirements through a range of key functionalities and operations. Starting with the establishment of a Blockchain network, the system involves configuring and deploying a private network, alongside transaction validation through dedicated nodes.

The integration of tracking sensors is implemented for real-time data collection, with a secure transmission of this data to the Blockchain. Recording product data involves capturing location information, timestamps, and details of product holders, all securely stored within the Blockchain.

User authentication is ensured through a robust registration and authentication process, complemented by role and access rights management. The user interface is designed to be intuitive, offering interactive dashboards for visualizing traceability data and facilitating easy navigation to specific information.

Authorization management extends to defining access levels for different stakeholders and adjusting permissions as needed. Anomalies or irregularities are promptly

addressed through configured alerts, providing real-time notifications to relevant users. The overarching security measure involves the use of cryptography to guarantee data confidentiality.

This comprehensive approach ensures that the solution effectively addresses the intricacies of logistics traceability in a Blockchain environment, contributing to enhanced transparency and security throughout the supply chain.[2]

2.3. Illustrative example

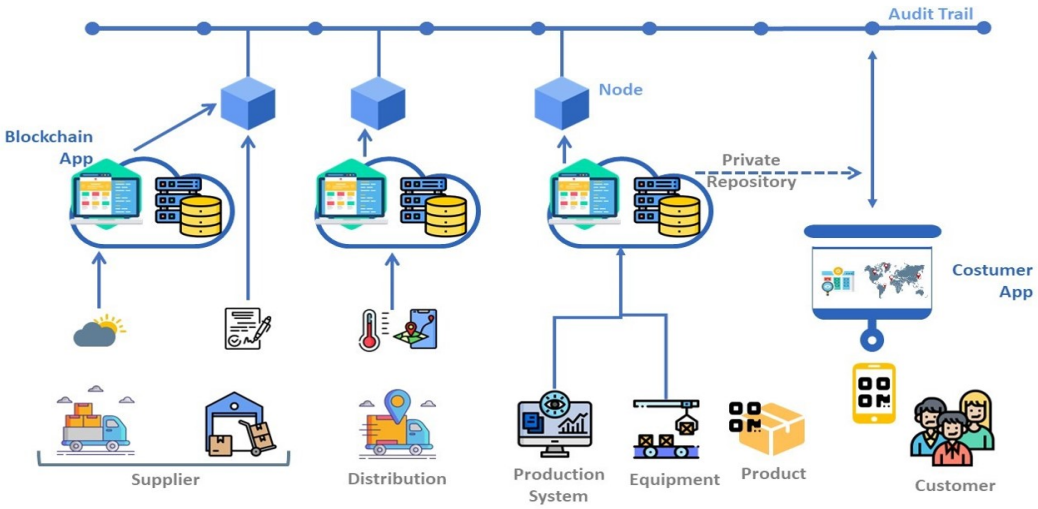

Figure 3 :Supply chain process

This figure represents Supply chain traceability through blockchain technology is revolutionizing every component of the process, providing unparalleled transparency and efficient management. From suppliers to customers, each transaction is immutably recorded on the blockchain. Suppliers play a pivotal role by logging not only material details but also leveraging the power of IoT (Internet of Things) sensors to ensure the highest quality at every stage of production. These IoT sensors meticulously track the production process step by step, monitoring factors such as temperature, humidity, and other relevant parameters to guarantee the integrity and quality of the materials.[4]

The integration of IoT technology extends beyond production, encompassing system components through to integration phases. The data collected by these sensors makes every stage traceable. This comprehensive traceability is a key contributor to the optimization of distribution, as transparent records of product movements enable real-time monitoring and decision-making. Customers, at the receiving end of this technologically advanced supply chain, gain immediate access to detailed information about the origin and quality of products. This not only enhances their overall experience but also fosters trust in the supply chain process. Furthermore, the automation of processes through smart contracts, a fundamental aspect of blockchain technology, brings increased efficiency, reduced errors, and ensures total security throughout the end-to-end supply chain management. As IoT sensors continue to evolve, their integration with blockchain will play an even more critical role in shaping the future of supply chain processes, setting new standards for transparency, efficiency, and trustworthiness.[5]. In our case study, we implemented a "Blockchain-based Logistics Traceability" architecture to showcase its

transformative impact on supply chain management. The study focused on real-world scenarios, emphasizing continuous monitoring from suppliers to customers. Each transaction was immutably recorded on the blockchain, ensuring unparalleled transparency and efficient management.

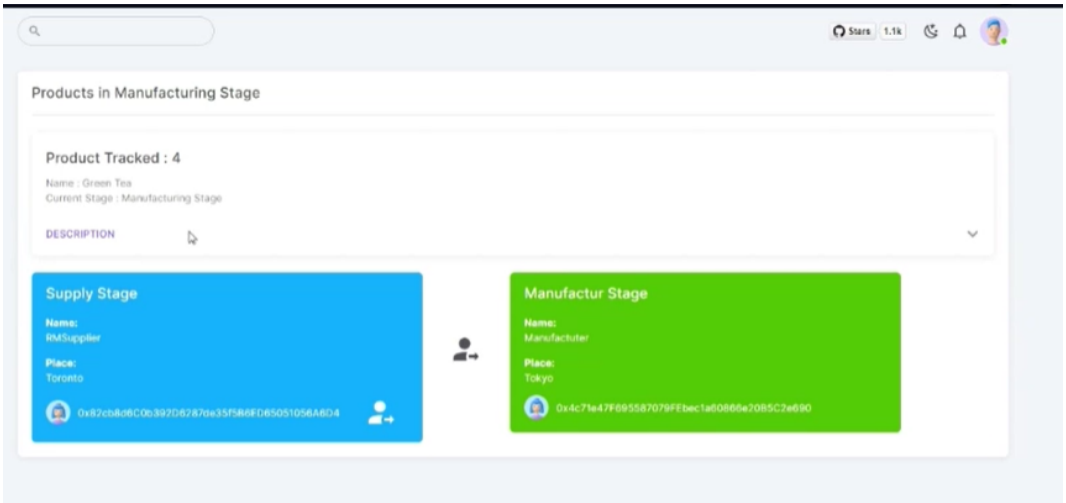

Figure 4 : Track Product interface

Customers gained immediate access to detailed product information, enhancing their overall experience and fostering trust in the supply chain process. Blockchain integration ensured transparency, allowing customers to make informed decisions based on trustworthy data.

3. Impact

The "Blockchain-Based Logistics Traceability Solution" represents a groundbreaking leap forward in supply chain management. By harnessing the power of blockchain technology, the project endeavors to redefine industry norms, introducing a comprehensive solution that ensures real-time monitoring of products, materials, and goods across the entire supply chain. With an unwavering commitment to transparency, heightened data security, and genuine traceability, the initiative not only addresses critical challenges in supply chain management but also pioneers a paradigm shift towards a future characterized by streamlined, secure, and transparent operations. The software's integration of cutting-edge technologies, including Web3.js, React.js, Solidity, Ganache, and GitHub, reflects a dynamic approach to blockchain-based supply chain solutions. Beyond its technical prowess, the project holds the potential to contribute significantly to scientific advancements in secure and efficient supply chain operations, ultimately reshaping the landscape of logistics traceability. As the software gains traction in real-world scenarios, its impact is poised to extend into publications, showcasing its transformative influence on data reliability, security, and operational efficiency in the realm of supply chain research.

4. Conclusions

The Blockchain-based logistics traceability solution relies on a robust architecture, encompassing the creation of a private Blockchain network, the integration

of tracking sensors for real-time data collection, secure recording of product data, user authentication, a user-friendly interface, authorization management, alerts for abnormal events, and the use of cryptography to ensure data confidentiality.

In summary, the project aims to create a Blockchain-based logistics traceability solution that addresses the needs of suppliers, producers, transporters, distributors, customers, and system administrators, while adhering to security, performance, and usability constraints.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors gratefully acknowledge the support of their professor, Mr. Lachgar, and the Department of Telecommunications, Networks, and IT.

References

[1] Microsoft Word, EQAIQYFDYD.docx (iop.org) `hhttps://iopscience.iop.org/article/10.1088/1742-6596/1972/1/012069`, Last accessed: 20/10/2023

[2] Oracle SCM Cloud Reviews 2023: Details, Pricing, Features — G2, `https://www.g2.com/products/oracle-scm-cloud/reviews`, Last accessed: 20/10/2023

[3] 5 Exemples De Blockchain Dans La Gestion De La Chaine D'approvisionnemt(OYELABS.COM), `https://oyelabs.com/fr/blog/blockchain-dans-la-gestion-de-la-chaine-dapprovisionnement/`, Last accessed: 30/10/2023

[4] Building a Transparent Supply Chain (hbr.org) `https://hbr.org/2018/03/building-a-transparent-supply-chain`, Last accessed: 20/10/2023

[5] QuickBooks Commerce Reviews 2023: Details, Pricing, Features — G2, `https://www.g2.com/products/quickbooks-commerce/reviews`, Last accessed: 10/10/2023