Optimizing Resource Management in Algerian Traditional Brick Manufacturing (SNG) Using Blockchain-Based Smart Contracts with Solidity

Aimene Boughrira, Samia Aitouche, El Hocine Grabsi,

Hichem Aouag, Kamel Taouririt, Khireddine Bourmel

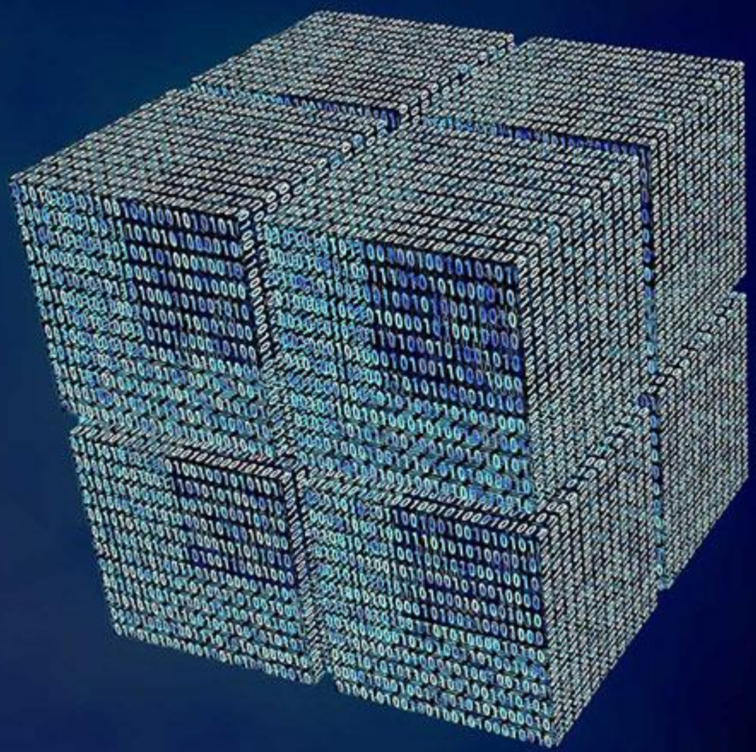
Batna2 University (Algeria), Faculty of Technology,
Industrial Engineering Department,
Automation and Manufacturing Laboratory (LAP)
Contact email: **aimene.boughrira@univ-batna2.dz**

AIMENE BOUGHRIRA

Aimene Boughrira received the master's degree in industrial management from University of Batna 2, Algeria, in 2019. He is currently pursuing a Ph.D. in industrial engineering at University of Batna 2, Faculty of Science and Technology.

- His research focuses on **proposing a Green Blockchain for industrial applications.**

Research Focus



01 **Green Blockchain for Industry**

02 **Energy-efficient consensus mechanisms**

03 **Alternative, low-power mining methods**

04 **Sustainable integration of blockchain in industrial systems**

Conducted within the Automation and Manufacturing Laboratory (LAP)

Agenda

01 1. Aim and Contribution

02 2. Introduction

03 3. Benefits of Blockchain and Smart Contracts

04 4. Research Gap

05 5. Case Study

06 6. Conclusion & Future Work

1. Aim and Contribution

Aims:

- Improve resource management in brick factories
- Resources:
  - **Now:** Material, Human, Time, Information and Data.
  - **Later:** Energy, Equipment and Machinery, etc.

Contributions:

- Proposed a smart contract-based solution for a local traditional factory (SNG)
- Case study of the SNG factory
- Implemented on Green Blockchain using Smart Contracts

2. Introduction

Context

Traditional brick manufacturing in Algeria struggles with:

- Inefficient resource tracking
- Lack of transparency
- Minimal digital integration

Objective

Propose a **blockchain-based** solution using **Solidity** smart contracts to address these challenges.

Case Study

SNG Brick Factory

Goals

- Optimize resource flows
- Ensure tamper-proof data recording
- Enable real-time process visibility

2.1 Blockchain

Blockchain

"**Blockchain** is a **digital ledger** that keeps a record of all transactions across a network of computers."

Decentralized Digital Ledger

➤ *Records transactions across a network of computers.*

Chain of Blocks

➤ *Ledger is composed of a chain of blocks, where each block contains a number of transactions.*

Record Immutable

➤ *The transactions are grouped together and added to the chain in a linear, chronological order. Once added, the information in the block cannot be altered or deleted.*

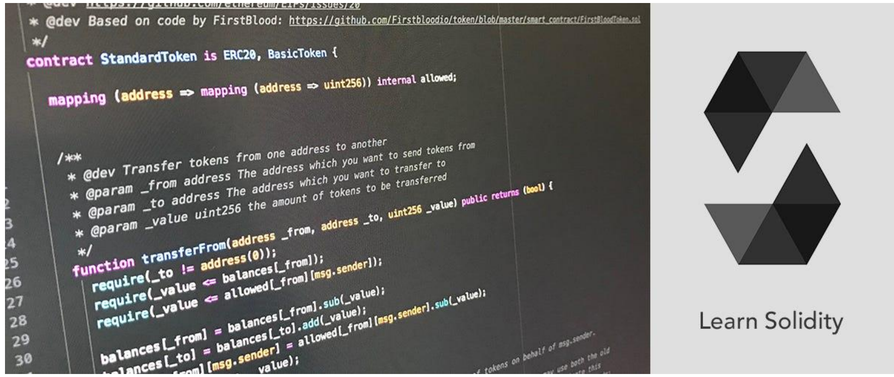
Cryptographic Security

➤ *Cryptography is used to secure the information stored in the blocks, and enables secure transfer of digital assets and information.*

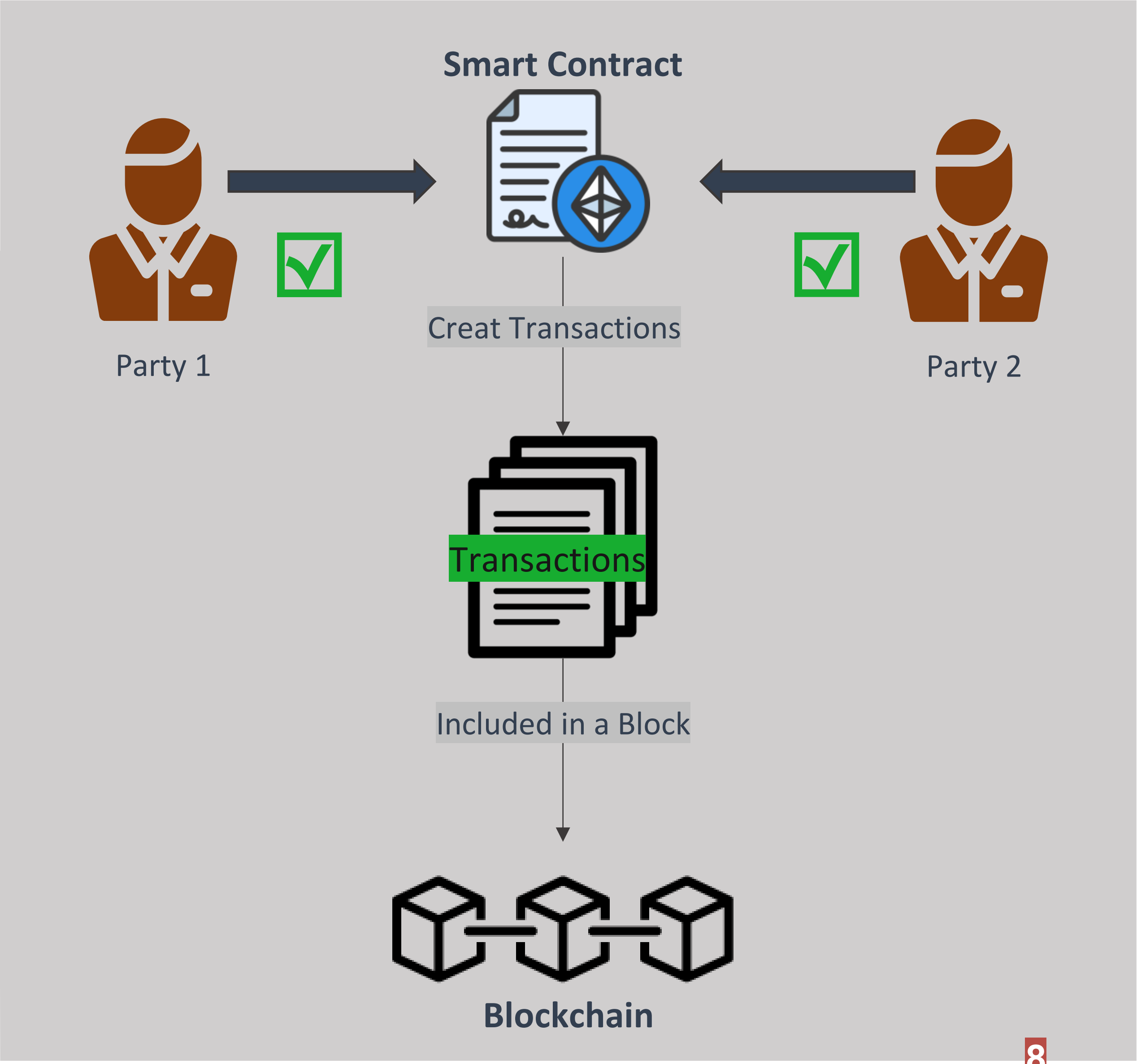
2.2 Smart Contract

A smart contract is a self-executing program that automates agreements on the blockchain when predefined conditions are met.

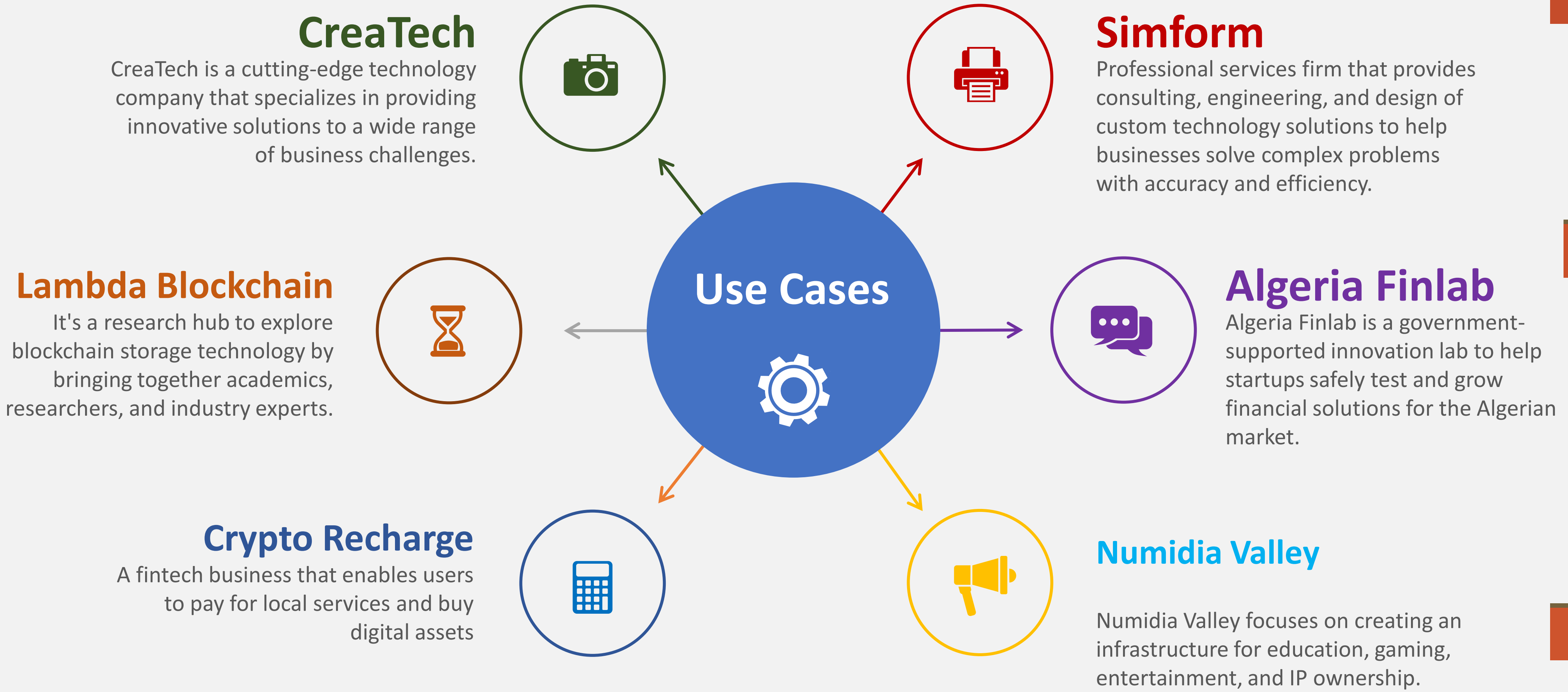
Solidity is a high-level, contract-oriented programming language that is used for writing smart contracts on the Ethereum-compatible blockchain



How smart contract works

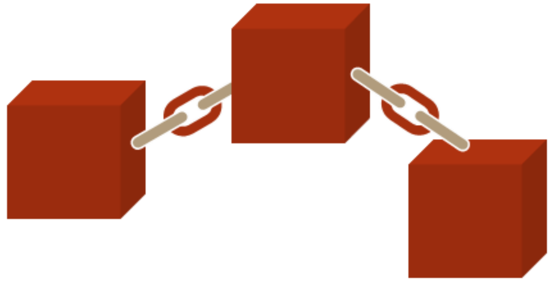


3. Projects using Decentralized applications (Dapps) in Algeria



3. Benefits of Blockchain and Smart Contracts

Blockchain:
- Decentralized, immutable, transparent



Smart Contracts:
- Self-executing code on the blockchain
- Reduces intermediaries and errors

Benefits for Industry:
- Automation, trust, cost savings

4. Research Gap

1 — 2 — 3

Focus Region

- Algeria, Batna
- Traditional brick industries

Traditional brick industries

- Manual systems, lack transparency
- No traceability or energy efficiency

Gap

- Limited digital integration
- Lack of blockchain in the local factories

5. Case Study - SNG

- Founded in 2013 by Spanish firm Equipceramic; nationalized in 2019 to boost Batna’s building materials industry.
- Specializes in manufacturing and delivering **construction materials**.
- Employs 135 staff under general management.
- Directed by **Mr. Taouririt Kamel**, also a co-author of the paper.
- Factory covers 75,000 m²: raw material park, manufacturing workshop, warehouse, and storage area.
- Daily production capacity: ~10,000 bricks.
- Strong candidate for **Smart Contract** integration.

Manufacturing Process



Main steps:

Raw material

Clay

Mixing and homogenising

Additives

Water

Prepare brick mixture

Extrude into standard moulds

Green product

Drying tunnel 96-102°C

Dried product

Firing Kiln 1020-1030°C

End-Product

Bricks

Efflorescence

5.1 Decentralized applications in resource management

1

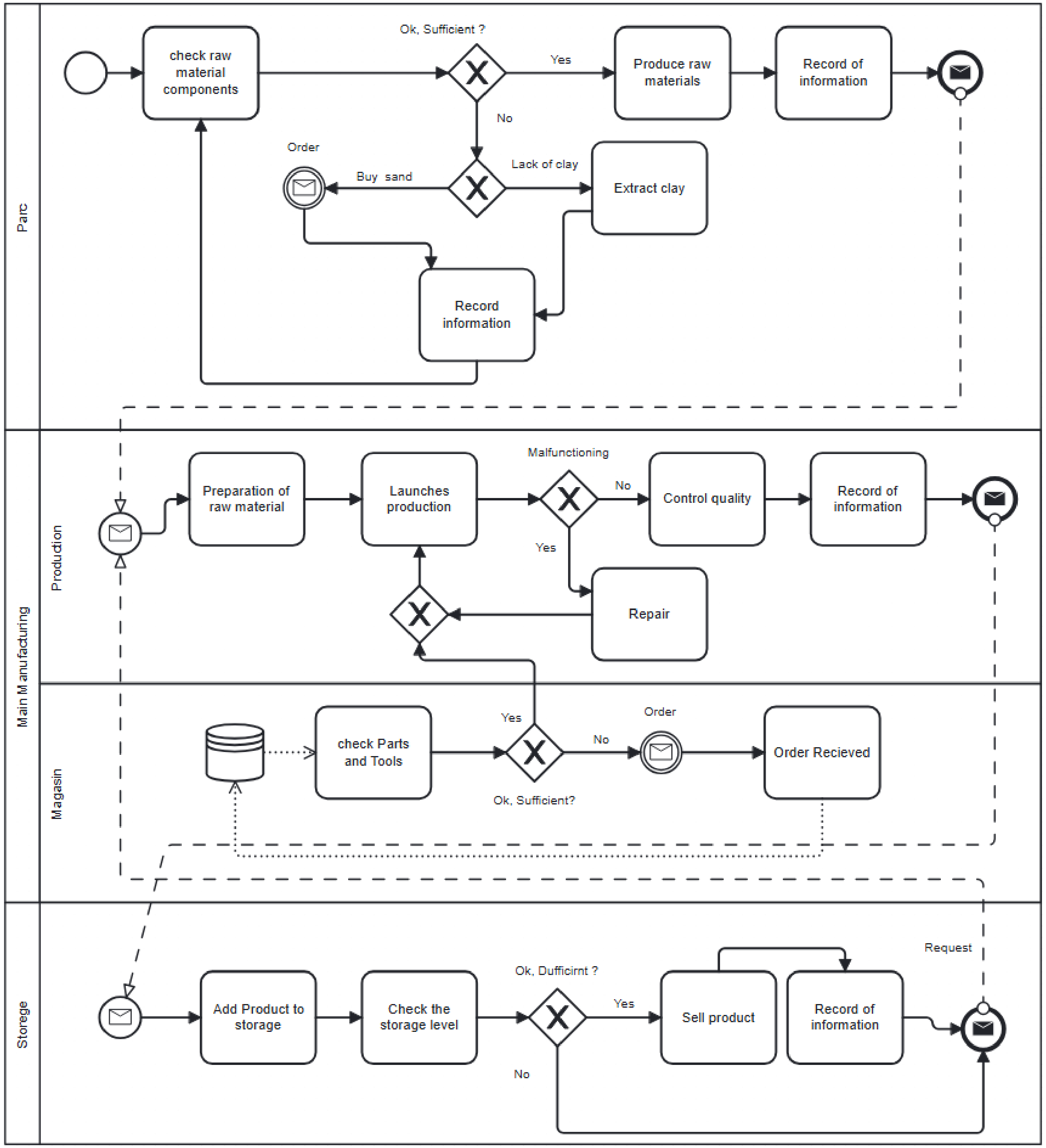
Impacted Fields

- Stock control
- Tracking
- forecasting
- Replenishment

2

Role of Blockchain

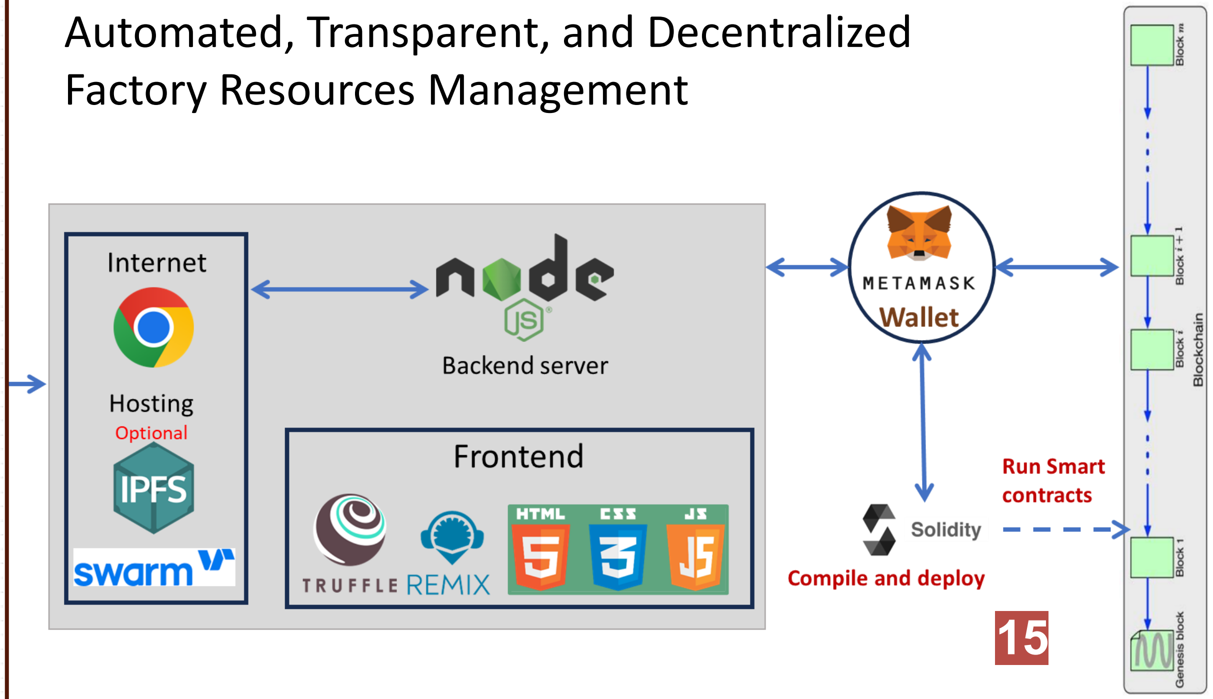
- Real-time data tracking
- Tamper-proof and transparent records



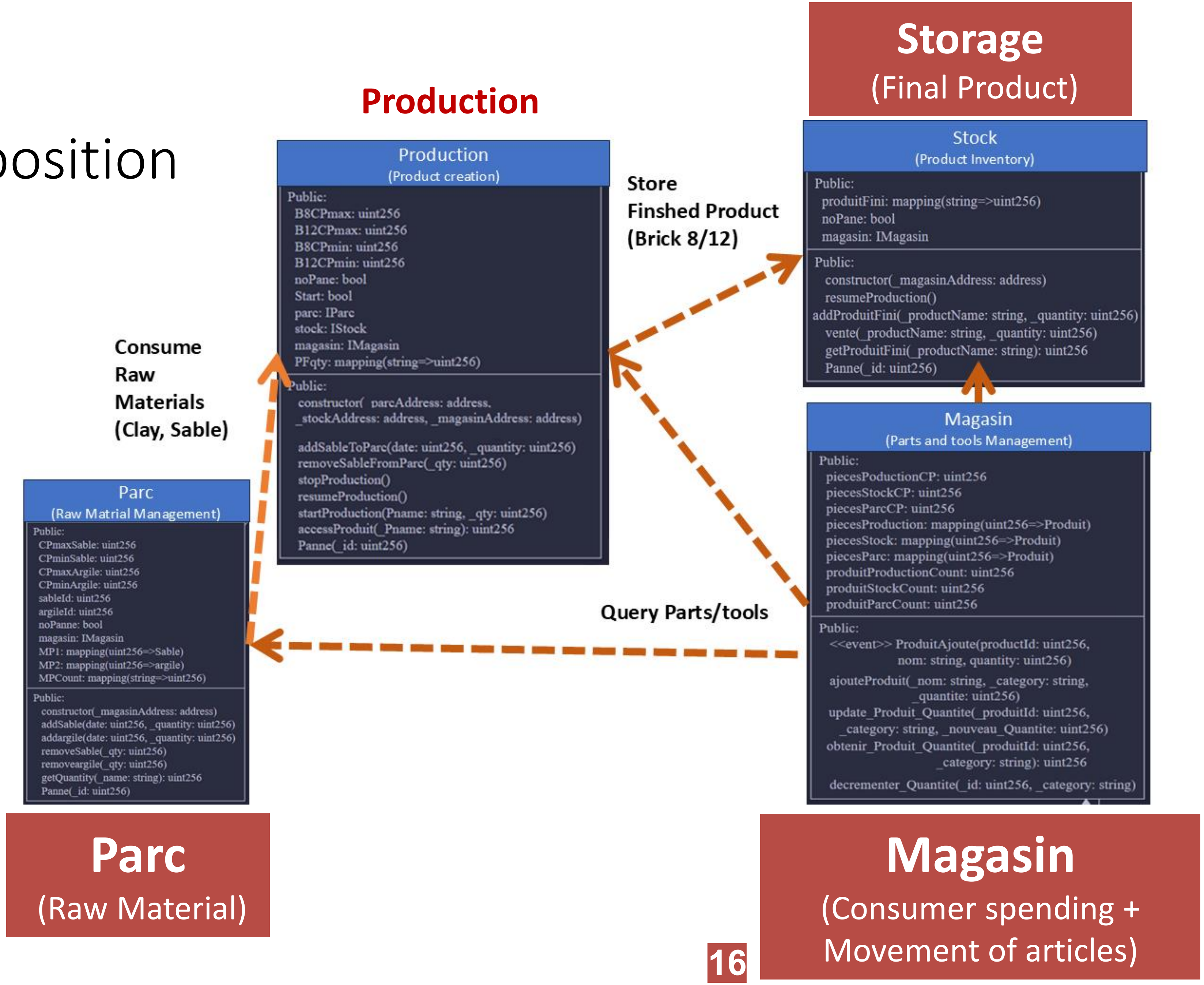
From Workflow to Blockchain

1. **Model Resource Flow**
BPMN 2.0 Diagram (Factory Workflow)
2. **Translate to Smart Contract Logic**
Tasks as Functions, Events as Triggers, Roles as Access
3. **Implement with Blockchain Tools**
Solidity, HTML, JS (Firefox), IPFS for Storage

Result:
Automated, Transparent, and Decentralized Factory Resources Management



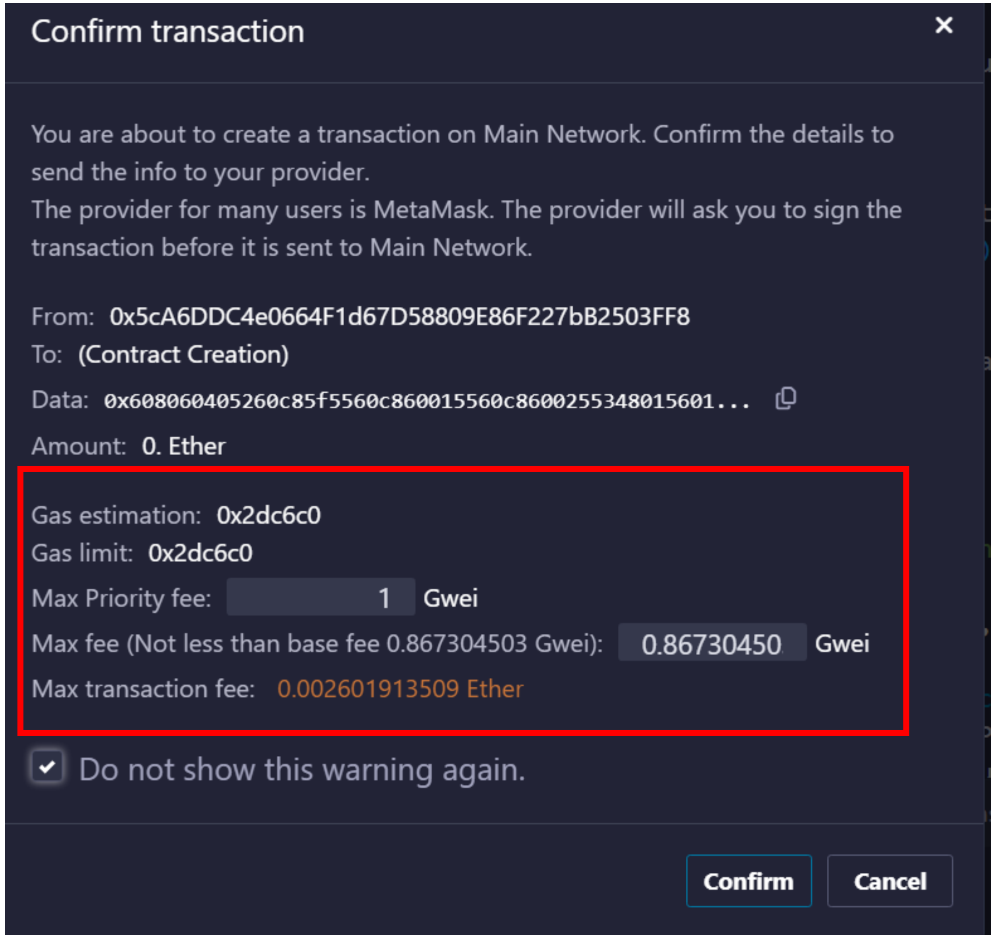
5.2
Smart Contracts Proposition



Simplified UML Class Diagram
for contract modules

5.4
Minimizing Gas Costs in Smart Contracts

- Gas is the fee required to perform operations on the blockchain.
- High gas usage = higher execution costs.
- Optimizing smart contract design reduces gas consumption and improves efficiency.

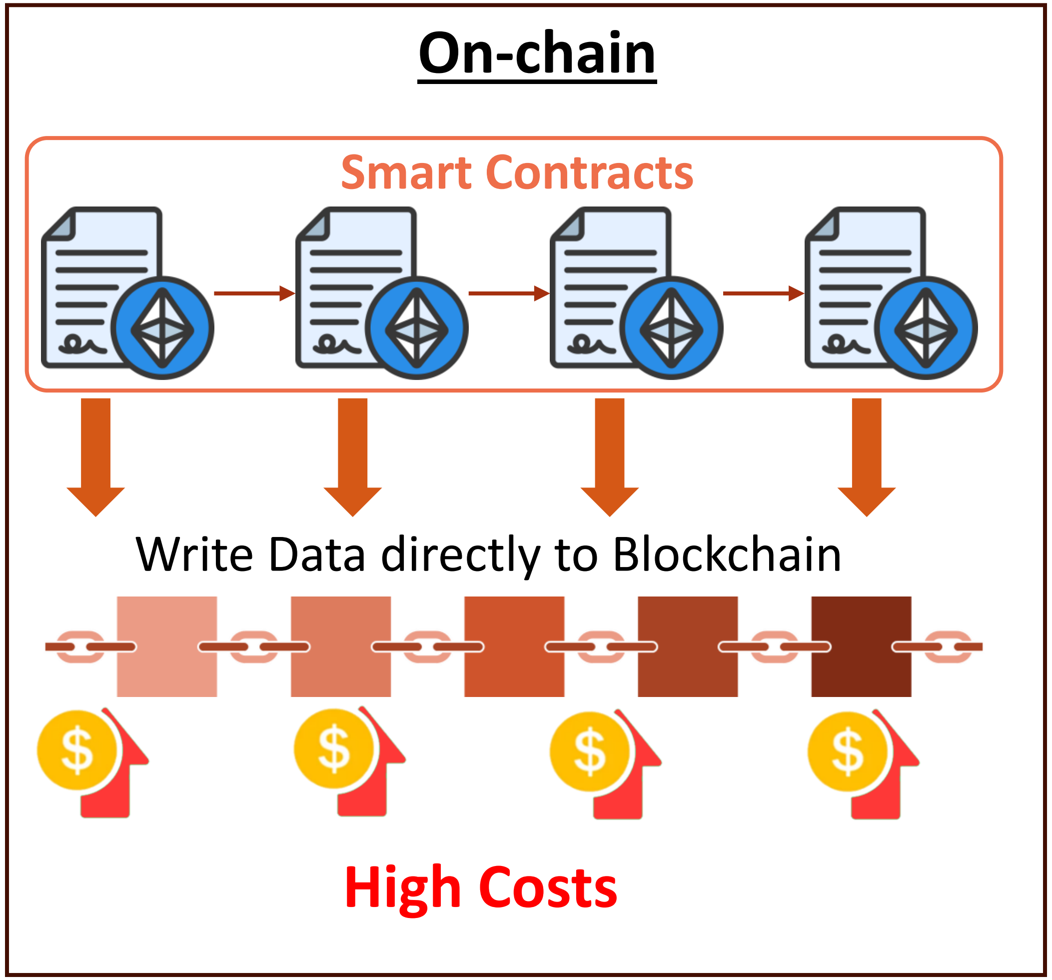


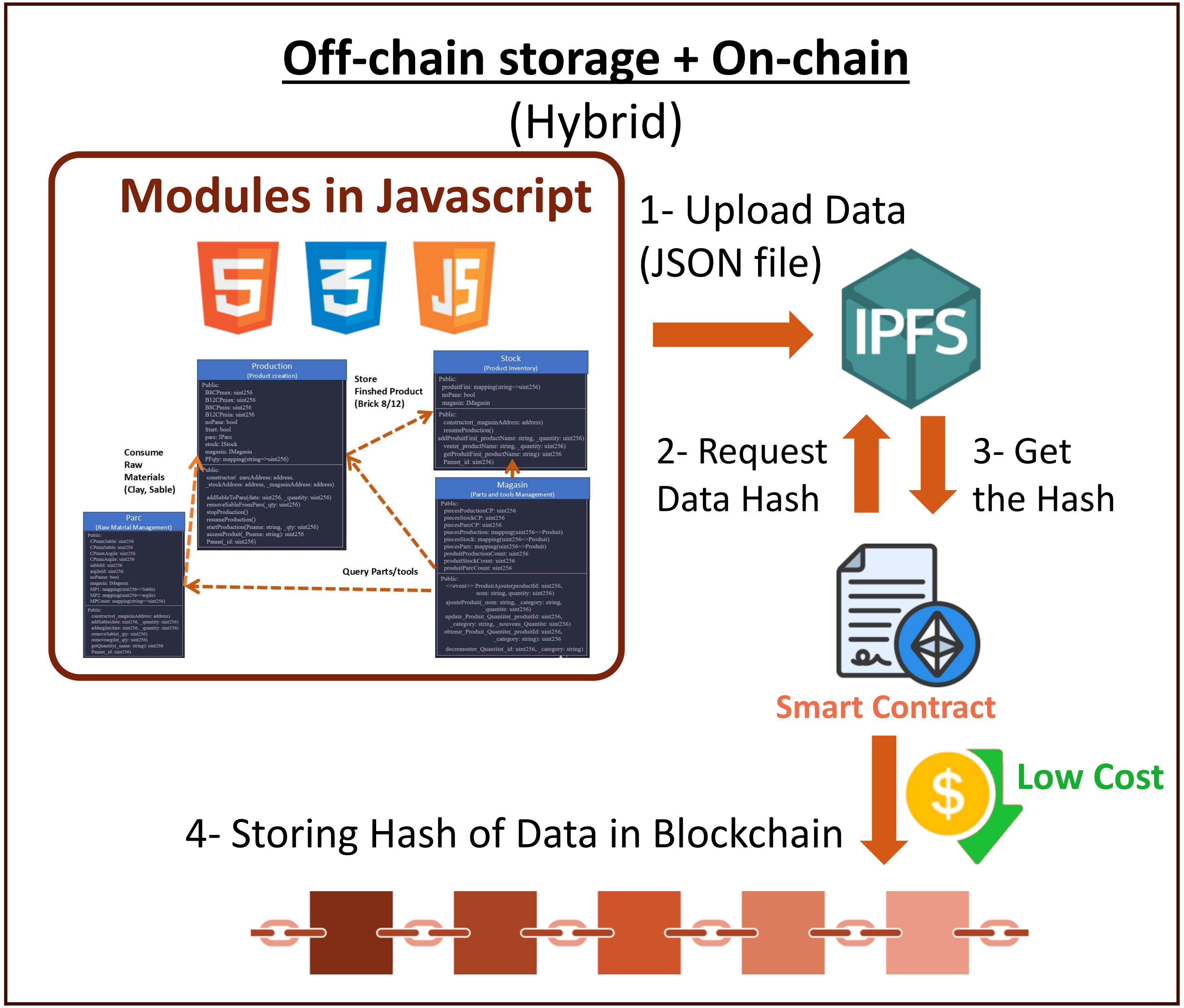
(On-Chain vs Hybrid) DApps in Industrial Blockchain Applications: The Case of SNG Brick Manufacturing

Feature	On-Chain DApps	Hybrid dApps (On-Chain + Off-Chain)
Cost	High	Lower
Performance	Low (limited throughput)	Higher (off-chain processing)
Transparency	Full	Partial (depends on off-chain choices)
Decentralization	Full	Partial
Auditability	Easy	More complex
Development Speed	Slower	Faster (due to off-chain flexibility)

Github:
- On-Chain: https://github.com/AimeneBoughrira/Smart-contract-ressource-management
- Hybrid: https://github.com/AimeneBoughrira/RessourceManagement

On-Chain VS Hybrid Architectures



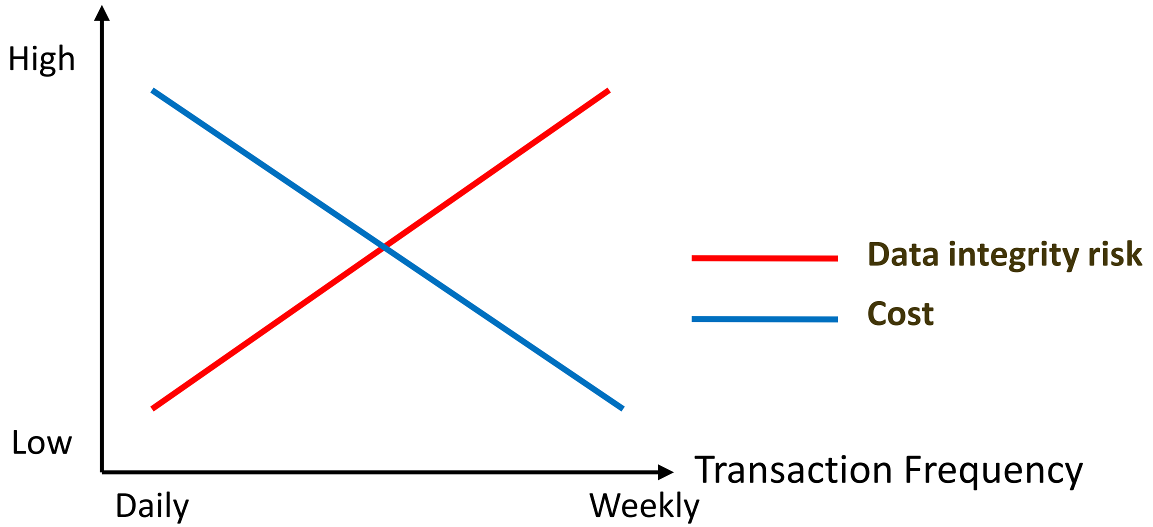


Data Saving Interval and Cost

(DApp) Update Frequency to Blockchain	Parc (Raw Materials Order)	Magasin (Consumer spending + Movement of articles)	Storage (Final Products Order)
Transaction Interval (per month)	≃ 90	≃ 97	≃ 300

(Dapp) Update Frequency to Blockchain	Every Transaction	Every Day	Every Week	Every Month
Cost (per year)	≃15,605 USD **(High)**	≃1,190 USD	≃169 USD	≃39 USD
Data integrity risk	Very Low	Low	Medium	High

(Ethereum as an exemple in 05/05/2025, Data SNG 2024)



PME Pro
vs
Smart Contracts

Resources Feature	PME Pro (Traditional Application's Brick Factory)	DApps with Smart Contracts (Solidity)
Cost	N/A	Low
Time consumption	High	Low
energy consumption	Low (Single factory operations)	High (ex: BC that uses Proof of Work, Public BC) Low (ex: BC that uses Proof of Stake, Privat BC, etc.)
Data system	Centralized (Vulnerable)	Decentralized (Secure)
Physical waste	High (Ineffective tracking)	Low (Accurate tracking)
Communication	Fragmented communication across departments	Integrated and decentralized communications protocol
Automation	Manual	Automated
Data integrity risk	Very High	Low

6. Conclusion & Future Work

This work demonstrates that blockchain technology, particularly through smart contracts, offers significant potential to transform traditional manufacturing processes. Applied to the SNG brick factory, the proposed solution improves **traceability**, **automates** operations, and enhances resource management **efficiency**. The implementation revealed the comparative benefits of on-chain and hybrid DApps in industrial environments. Future research will focus on **integrating IoT** for real-time data acquisition, **minimizing gas costs**, and deploying the solution on green and scalable platforms like **Solana**. Ultimately, this initiative aims to pave the way toward a sustainable and green blockchain infrastructure for Algerian industry.

7. References

[9] Bassan, F., & Rabitti, M. (2024). From smart legal contracts to contracts on blockchain: an empirical investigation. Computer Law & Security Review, 55, 106035.
[10] Veeramachaneni, V. (2025). Decentralized Trust Management in Web 3.0: A Comprehensive Approach to Network Security. Recent Innovations in Wireless Network Security, 7(1), 9-26.
[11] Carreira, F., Cunha, P. R. D., Barata, J., & Estima, J. (2024, August). Tamper-proof Blockchain-based Contracts for the Carriage of Goods by Road. In International Conference on Information Systems Development (ISD) (No. 32nd).
[12] Hossain, M. I., Steigner, T., Hussain, M. I., & Akther, A. (2024). Enhancing data integrity and traceability in industry cyber physical systems (ICPS) through Blockchain technology: A comprehensive approach. arXiv preprint arXiv:2405.04837.
[13] Agrawal, R., Singhal, S., & Sharma, A. (2024). Blockchain and fog computing model for secure data access control mechanisms for distributed data storage and authentication using hybrid encryption algorithm. Cluster Computing, 1-16.
[14] Sanyaolu, T. O., Adeleke, A. G., Azubuko, C. F., & Osundare, O. S. (2024). Harnessing blockchain technology in banking to enhance financial inclusion, security, and transaction efficiency. International Journal of Scholarly Research in Science and Technology, August, 5(01), 035-053.
[15] Naik, M., Singh, A. P., & Pradhan, N. R. (2024). Decentralizing ride-sharing: a blockchain-based application with smart contract automation and performance analysis. Multimedia Tools and Applications, 1-28.
[16] Antonino, P., Ferreira, J., Sampaio, A., Roscoe, A. W., & Arruda, F. (2024). A refinement-based approach to safe smart contract deployment and evolution. Software and Systems Modeling, 1-37.

[17] Sowmya, G., Sridevi, R., & Shiramshetty, S. G. (2024). Transforming Finance: Exploring the Role of Blockchain and Smart Contracts. In Fintech Applications in Islamic Finance: AI, Machine Learning, and Blockchain Techniques (pp. 255-271). IGI Global.
[18] Daraghmi, E., Jayousi, S., Daraghmi, Y., Daraghmi, R., & Fouchal, H. (2024). Smart Contracts for Managing the Agricultural Supply Chain: A Practical Case Study. Ieee Access.
[19] Dhillon, D., Diksha, & Mehrotra, D. (2024). Smart Contract Vulnerabilities: Exploring the Technical and Economic Aspects. In Blockchain Transformations: Navigating the Decentralized Protocols Era (pp. 81-91). Cham: Springer Nature Switzerland.
[20] KorkusuzPolat, T., & Baran, E. (2024). A Blockchain-Based Quality 4.0 Application for Warehouse Management System. Applied Sciences, 14(23), 10950.
[21] Vaka, D. K. (2024). Integrating inventory management and distribution: A holistic supply chain strategy. the International Journal of Managing Value and Supply Chains, 15(2), 13-23.
[22] Kadam, S., Senta, R., Sah, R. K., Sawant, A., & Jain, S. (2024, March). Blockchain revolution: A new horizon for supply chain management in hotel industry. In 2024 International Conference on Emerging Smart Computing and Informatics (ESCI) (pp. 1-8). IEEE.
[23] Mittal, S. (2024). Framework for Optimized Sales and Inventory Control: A Comprehensive Approach for Intelligent Order Management Application. International Journal of Computer Trends and Technology, 72(3), 61-65.
[24] Saraswat, H., Manchanda, M., & Jasola, S. (2024). An efficient secure predictive demand forecasting system using Ethereum virtual machine. IET Blockchain.

[25] Rahman, M. H., Menezes, B. C., & Baldacci, R. (2024). Exploring the role of blockchain technology, warehouse automation, smart routing, and cloud computing in logistics performance. Production & Manufacturing Research, 12(1), 2393614.
[26] Groenewald, E., & Kilag, O. K. (2024). E-commerce Inventory Auditing: Best Practices, Challenges, and the Role of Technology. International Multidisciplinary Journal of Research for Innovation, Sustainability, and Excellence (IMJRISE), 1(2), 36-42.
[27] Bajar, K., Kamat, A., Shanker, S., & Barve, A. (2024). Blockchain technology: a catalyst for reverse logistics of the automobile industry. Smart and Sustainable Built Environment, 13(1), 133-178.
[28] Hong, L., & Hales, D. N. (2024). How blockchain manages supply chain risks: evidence from Indian manufacturing companies. The International Journal of Logistics Management, 35(5), 1604-1627.
[29] Buterin, V. (2014). A next-generation smart contract and decentralized application platform. white paper, 3(37), 2-1.
[30] Remix Plugin Directory Documentation », déc. 2020. https://remix-plugins directory.readthedocs.io/_/ downloads/en/latest/pdf/ [Visited: 15/01/2025].
[31] Grabsi, E. H., Aitouche, S., Boughrira, A., Aouag, H., Zermane, H., & Zireg, K. (2023). Green Blockchain and Smart Homes: A Systematic Review. In 2023 International Conference on Decision Aid Sciences and Applications (DASA) (pp. 326-330). IEEE.

THANK YOU

CONTACTS

Aimene BOUGHRIRA

ACADEMIA

Google Scholar

R^G

Aimene.boughrira@univ-batna2.dz

ORCID

https://orcid.org/0009-0008-0203-3996